Gila River Corridor Invasive Weed Control Project - #11-173WPF

Final Report
Submitted to:
Arizona Water Protection Fund Commission
3550 North Central Avenue
Phoenix, Arizona 85012

Submitted by:

Linda Searle, Program Manager

Coronado Resource Conservation & Development Area, Inc.

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"The Arizona Water Protection Fund Commission has funded all, or a portion, of this report or project. The views or findings represented in this deliverable are the Grantees and do not necessarily represent those of the Commission or the Arizona Department of Water Resources."

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Cover photo: Whitetop (Hoary Cress) infestation in disturbed riparian reclamation area. Photo F. Hayes 05-31-12

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1. EXECUTIVE SUMMARY

The Gila River is a 649-mile tributary of the Colorado River, entering Arizona from New Mexico just west of Virden. Farming in the Duncan Valley basin, including Virden, became organized under the direction of the Franklin Irrigation District (District) in 1922. The District encompasses several thousand acres of agricultural farmland in the Gila River corridor, extending up through the hamlet of York, which is included in the 30 miles of the project area within Arizona. The Gila River corridor in Arizona is also recognized as an important riparian and riverine habitat for many wildlife and fish species, including the federally protected Southwestern Willow flycatcher (SWWF). One of the four Critical Habitat segments in the Upper Gila Recovery Unit encompasses about 41 miles of the Gila River corridor beginning near Red Rock Box in New Mexico and extending into Arizona, ending just north of the Town of Duncan. In 2010, the Coronado Resource Conservation and Development Board proposed a grant with the Arizona Department of Water Resources, Arizona Water Protection Fund Commission (WPF) for expanding invasive weed inventory and control in the Gila River corridor in Greenlee County. WPF funded the Invasive Weed Control Gila River Corridor, Greenlee County grant 11-173 WPF for four years starting in 2011. The purpose of the grant was to fund a comprehensive approach to identifying and addressing barriers to treatment of invasive, noxious weeds in the Gila River corridor in Greenlee County and to aid in restoration of the native riparian corridor. The project area of focus was a ½ mile wide portion of the river corridor along the 30 mile stretch of the Gila River from the New Mexico State line to the Graham-Greenlee County line. Inventory of private land parcels for noxious weed presence was initiated in the spring, 2012, followed with treatment of targeted noxious weeds (Russian knapweed, Whitetop (Hoary Cress), Malta and Yellow starthistle) by a few participating land owners. Riparian tree cover class and composition transects were established adjacent to parcels where infestations were documented. Monitoring, inventory, and mapping of noxious weed infestations continued through the field seasons of 2013 and 2014. Concurrently, additional riparian tree cover transects were established adjacent to or encompassing parcels where noxious weed infestations occurred. Riparian cover transects were established at 29 sites, 18 in SWWF Critical Habitat, and 11 in non-critical habitat. A total of 1524 acres, involving 104 parcels of land, were inventoried including rangeland, farmland, residential, and utility uses. Of these, 27 parcels were clean of noxious weeds and 77 had infestations of one or several targeted species. Russian knapweed was found to occupy 501 acres of lands within the inventoried area, Whitetop on 241 acres, and Malta and Yellow starthistle on 50 acres. Most of the acreage occupied by Whitetop is within the protected riparian flood plain, making management and control challenging. Fourteen land owners participated in the direct control herbicide program in 2014 offered through the Gila River Corridor grant program, treating 118 acres of Russian knapweed, 52 acres of Whitetop, and 40 acres of Malta and Yellow starthistle.

2. INTRODUCTION

The Gila River is a 649-mile tributary of the Colorado River, draining an arid 60,000 square mile area in Arizona, and entering from New Mexico just west of Virden[41]. Numerous archeological sites have been found along the banks of the river throughout Arizona, including the 30 mile stretch of the Gila River located within Greenlee County, and support the fact that farming and irrigation have been practiced by humans for over 2000 years in the Duncan valley. The town of Duncan, originally known as Purdy, was established as a stop on the railroad between Clifton and Lordsburg in 1883[8]. Farming in the valley was established by Mormon settlers from Mexico who were also instrumental in establishing Virden, New Mexico in 1916[41].

Farming in the Duncan Valley basin, including Virden, became organized under the direction of the Franklin Irrigation District in 1922[1]. The District encompassed several thousand acres of agricultural farmland in the Gila River corridor, extending up through the hamlet of York, which is included in the 30 miles of the project area within Arizona, (Figure 1.0). At perhaps the peak of farming in the District, about 4700 acres were managed through flood and pivot irrigation for various crops. With the loss of water rights during the last decade, this number is estimated to have dropped about 11%, down to 4167 acres[7]. In 2007, one estimate indicated that only about 3,450 acres were being irrigated in the District[33], a decline of about 26%. Though the actual effect of the latest water uses decree is unknown, it is expected that this number will decline even further[7]. Numerous factors have affected the acreage of farmland irrigated within the District over the past several decades. As mentioned, loss of water rights through the sale of surface rights or lack of farming activity has also reduced the actual number of acres currently being farmed in the District. Several decrees that directed the amount and extent of irrigation available to farmers have been another factor, including the most recent settlement involving the Gila River Indian Community and the San Carlos Apache Indian Tribe[27].

The Gila River corridor in Arizona is recognized as important riparian and riverine habitat for many wildlife and fish species[4], including the federally protected Southwestern Willow flycatcher (SWWF). The most recent designation of Critical Habitat for the SWWF established and recommended guidelines for four management segments in the Upper Gila Recovery Unit[34]. One of these segments encompasses about 41 miles of the Gila River corridor beginning near Red Rock Box in New Mexico and extending into Arizona, ending just north of the Town of Duncan (Figure 2). Another segment encompasses about 48 miles of the Gila River corridor in Arizona that includes the Gila Box National Conservation Area and extends to the boundary of the San Carlos Apache Indian Reservation.

The Coronado Resource Conservation and Development Council (Coronado RC&D), in conjunction with University the of Arizona Cooperative Extension, have long recognized the values of both productive farmlands and the Gila River riparian corridor in Greenlee County and

the threats to these values. In 2010, Coronado RC&D proposed a grant with the Arizona Department of Water Resources (ADWR) for expanding invasive weed inventory and control in the Gila River corridor in Greenlee County[4]. ADWR funded the Invasive Weed Control Gila River Corridor, Greenlee County grant 11-173 WPF for four years starting in 2011. The purpose of the grant was to fund a comprehensive, aggressive approach to identifying and addressing barriers to treatment of invasive, noxious weeds in the Gila River corridor in Greenlee County. Aiding in the restoration of the native riparian corridor by control of targeted invasive weeds was an additional overriding goal of the grant. The project area of focus was a ½ mile wide portion of the river corridor along the 30 mile stretch of the Gila River from the New Mexico State line to the Graham-Greenlee County line (Figure 3). About 9600 acres of lands were mapped to be included within the project corridor. The project area included about 7.3 miles of critical habitat designated for SWWF management (~2400 acres) of this riparian corridor from New Mexico to Duncan (Figure 4).

3. BACKGROUND

The stretch of the Gila River corridor that enters Arizona and travels through Greenlee County is considered the "gateway" to the Gila River in Arizona, and is recognized as the crucial first front to focus on the management and control of invasive weeds moving into Arizona[4]. Targeted invasive weeds of concern entered the Duncan Valley through various sources. Hay or straw purchased for feed or bank stabilization for many years has not been provided as "weed free". Contaminated seed mixes for various highway or other river reclamation projects has likely also introduced non-native species, including invasive weeds. Equipment brought in from other parts of the southwest or country could have certainly brought seeds or plant parts that introduced invasive species.

Though there are numerous non-native species that inhabit the Duncan valley, five species categorized as both noxious and invasive by Arizona Administrative Code are of most concern to Coronado RC & D and Cooperative Extension. Yellow starthistle (*Centaurea solstitialis*) was the first of this suite of species to be observed in the District, sometime in the mid-1980's, followed soon after by Malta starthistle (*Centaurea melitensis*), and bull thistle (*Cirsium vulgare*). It is likely that these species arrived in contaminated hay purchased for feed. Both Yellow and Malta starthistle have spread throughout the northwest states at an alarming rate of 6,000-18,000 acres per year since 1981[32]. Although first observed near San Simon in 1993, Russian knapweed (*Acroptilon repens*) was first readily observed in fields in the Duncan Valley in the late 1990's, and the University of Arizona Cooperative Extension took the lead on researching physiology and control of the plant.[20] The presence and expansion of Russian knapweed triggered the formation of the Southeastern Arizona Weed Management Area to develop and implement local on-ground control strategies. Whitetop (*Cardaria draba*), also known as Hoary Cress, is the fifth species known to occur in Arizona since the late 1990's at least in the Verde Valley[25]. Observations of this invasive noxious weed in the Duncan town area

occurred sometime around 2009[20], but is believed to have been present on at least one farm since 2000[9], and may have been brought in with transport of animals or associated feces.

Noxious weeds are considered "invasive" if they are able to move into and dominate native or managed systems, disrupting normal functions of native species. Yellow starthistle and Malta starthistle have expanded rapidly from first being introduced in California in the early 1820's to now occupying 30 million acres in North America, 20 million in California alone[32]. First introduced from Eurasia in 1898, Russian knapweed (and its sister species) have spread over most of the lower United States and Canada[19], and is believed to occupy between 7-10 million acres across the west. Whitetop or Hoary Cress, first introduced from Europe as filler for dry flower arrangements, is now found in all states except the southeast, and in four Canadian provinces[28]. Whitetop occupies both agricultural and rangelands, and establishes aggressively in disturbed soils.

Weeds are designated "noxious" by state law if they can and do cause economic and biological harm. Yellow starthistle, when consumed after seed set, is known to cause injury and death to horses, and Whitetop can be toxic to livestock in later stages of development. Much literature exists that documents the economic impacts across each state where these five species have become established and dominated rangeland and agricultural sites. For instance, one study in the late 1990's in Montana estimated the cost of three knapweed species exceeded $42 million dollars on rangelands, wildlife capacity, and watershed capacity[31]. Because these five noxious weeds are adaptable, aggressive and tenacious in becoming established and spreading across both rangelands and agricultural grounds, both Coronado RC&D and Cooperative Extension recognized that a multi-organizational approach was needed to effectively address the management and control of these species, not simply just herbicide applications. The continued existence and expected expansion of these noxious, invasive weeds is threatening the ecology of natural functioning processes within the riparian corridor of the Gila River. Infestations from adjacent lands are contributing to the establishment and expansion of weed populations. While control of some of these noxious weeds has been ongoing on adjacent agricultural and rangelands during the last decade, there is a lack of general knowledge about the existence and potential for damage that these noxious weed species may cause. At the time of the grant proposal in 2010, there was an estimated 1400 acres infested with these five species. Russian knapweed was the most widespread at about 800 acres infested, occupying both rangelands and agricultural lands. The starthistles and bull thistle occupied a variety of lands, mostly irrigation ditch borders and agricultural lands on about 600 acres, with Whitetop observed on only about 18 acres in and around the town of Duncan[4]. If left unchecked, these noxious, invasive weed species are expected to impact downstream riparian and watershed habitat values, as well as a significant economic impact to agricultural operations supported by riparian related water programs.

The goal of the project proposal was the protection of the integrity of the Gila River riparian corridor through the use of an integrated weed management program that would educate, promote, and manage the eradication of invasive, noxious weeds from the 30 mile river corridor in Greenlee County.

Objectives of the proposal were threefold initially. First, the extent of infestations needed to be quantified by mapping and maintaining a data base of inventory information. Secondly, concurrent with mapping, treatment of invasive, noxious weeds should be promoted and managed using the appropriate herbicide and application rates to help restore infested lands and riparian areas to a more healthy and resilient condition. Lastly, to educate not only the landowners who are impacted within the river corridor, but cooperating agencies or communities and the general public about the economic and biological impacts of invasive weeds, with the over-arching objective of creating a community-based partnership for management of noxious weed species. A fourth objective was added during development of the monitoring phase with the intent of attempting to identify the extent of impacts to riparian vegetation in the corridor that included classification of associated riparian vegetation adjacent to, or impacted by weed infestations.

4. INVASIVE, NOXIOUS WEED SPECIES BIOLOGY

The suite of noxious weeds that are of focus for this proposal includes two annuals (Yellow starthistle and Malta starthistle). A biennial, (Bull thistle), and two deep rooted perennials (Russian knapweed and Whitetop). A brief discussion of each species is important and warranted for a better understanding of the challenges faced with the inventory, treatment, and management of each species. Numerous references and guides are available from several sources about the biology and life history of each species. Two excellent field identification guides are listed below, and available through the Arizona Cooperative Extension.

Non-Native Invasive Plants of Arizona. 2001, 2009. Produced by Conservation Districts, Coronado RC&D Area, Inc., and the University of Arizona Cooperative Extension. #AZ1482.

Crop Weeds of Southern Arizona. 2007. Produced by Coronado RC&D Area, Inc., and the Conservation Districts of Southern Arizona.

Yellow starthistle – As an aggressive, cool season annual forb, this species germinates during cooler temperatures and can out compete native warm season perennial forbs and grasses. In the Duncan and York area, it has been observed to remain actively growing throughout early to mid-summer in irrigated pastures and can produce seed at that time if left untreated. It may grow 2-3 feet tall when completing a lifecycle in late spring or early summer, but will often grow in a prostrate form if heavily grazed or mowed during the latter part of the life cycle10.

Photo 1. Yellow starthistle showing prostrate form after herbicide treatment in June, 2013..

Since it is often found in association with Malta starthistle and Bull thistle, it is best distinguished by deeply lobed basal leaves that form a rosette during early spring, or a wet warm fall. An extension of the leaf runs down the stem, giving it a winged appearance. Flowers are bright yellow, with bracts that produce stiff, sharp spines that can grow up to 1 inch long. The plant produces entirely by seed, and even the most unproductive plants if left to complete growth, can produce viable seed. As an annual, seed remains in the ground for many years.

Yellow starthistle can apparently be readily grazed by livestock during the rosette stage without harmful effects12, 17a. Consumption when the seed stalk is formed it can cause "chewing disease", a neurological disorder that appears several weeks or months after consumption, in horses32.

Management of Yellow starthistle requires an integrated weed management approach where detection and containment of existing populations is accomplished while plant density (and thus seed density) is reduced. Prevention through sustainable crop rotations and aggressive removal/treatment appears effective where populations have not been allowed to expand beyond manageable acreages26. Chemical control can be accomplished with various herbicide applications at different growth stages, but are most effective when the rosette is fully developed, during bolting, and prior to the spiny flower stage.

Photo. 2. Rosettes of Yellow Starthistle and Malta Starthistle. 3/26/13

Malta starthistle – A close relative of Yellow starthistle, this species also is a cool season grower, often infesting the same locations as its cousin. In the Duncan area, it appears to be a somewhat less aggressive species, perhaps because it does not seem to grow as robustly as Yellow starthistle, though found in similar soils and conditions of disturbance and depleted soils. It is easily identified by the rosette shape that has pointed leaflets rather than lobed, and yellow flowers that are smaller than its cousin, with bracts tipped with many short small spines (less than ¼ inch) that are often tinted yellow, brown, or purple. In some instances in the Southwest, Malta starthistle has been observed growing as a weak biennial, making management more challenging since it may resist herbicide applications[30].

Grazing can be used to minimize spread and reduce vigor of infestations of Malta starthistle (Donaldson 2011; Hayes pers. obs. 2013), and is generally not considered toxic to livestock. Consumption when the rosette is active reduces vigor and productivity of the plant, perhaps making it more susceptible to herbicide applications, or burning for control. Management of this annual forb is best accomplished by reducing density of plants and seed production, through prevention and expanded, effective control measures that are integrated with other sustainable agricultural practices. Prescribed burning has been shown to be effective in damaging or removing rosettes when there is enough fine fuel available to carry fire. Chemical control can be accomplished at various life stages, but appears most effective after the rosette

is completely developed, after bolting, and prior to flower development, usually when the plant is 4-6 inches in height[39].

Bull thistle- Like similar non-native thistles (Musk and Scotch), this species is a biennial forb that forms a rosette in the first year, and then bolts and produces seed the following year. The rosette is identifiable with lobes that are double toothed and end in a spine. Favoring moist locales for becoming established, this plant can become well established in disturbed or areas of decadent grass or forb production (e.g. at the head or tail end of flood irrigated fields, tail water ditches). Normally, it grows in relatively small colonies. Though the plant can grow very large (2-4 feet) and is a prolific seeder, it is most easily controlled in the rosette stage either through hand removal or herbicide application. Once the plant bolts or is approaching flowering stage, it appears difficult to prevent seed development[12].

Photo 3. Bull thistle rosette, 3/26/13

Russian knapweed – A creeping, often robust perennial forb, Russian knapweed can form dense colonies supported by a very deep (8-20 ft) spreading root system that dominates the occupied site. When in a rosette, Russian knapweed resembles Indian blanket flower (Galliardia aristata), but once stems become erect and flowering, there is no resemblance[13]. One distinguishing characteristic of Russian knapweed are black or brown roots compared to most other similar perennial forbs (white or light tan). Rosette growth initiates in early spring with flowering from May through July and often going dormant during mid to late summer. However, Russian knapweed that has been mowed or grazed heavily until summer rains may actually produce flowers in September and remain actively growing into the fall.

Several factors contribute to the competitiveness of Russian knapweed with other plants, and the difficulty in management and control of this invasive species. The deep, drought resilient root system makes eradication difficult to achieve through most practices except repetitive herbicide applications. Though the species can and does reproduce by seed, the propensity for the plant to reproduce or re-sprout vegetatively creates a significant challenge for integrated weed management. The plant competitiveness of the species is believed to be related to an ability to release harmful allelopathic chemicals that can inhibit growth of other plants. The

species has also been shown to cause an eightfold increase in zinc concentration in adjacent soil surface areas[31].

Photo 4. Old growth Russian knapweed plant. Plant is 32" in height. FFA Parcel south of High School. 4/19/13. Note successive years growth on this one single plant as evidenced by shading of dead dry material. This area has not been disturbed in three or four years of growth.

Photo 5 taken in same infestation area where removal of dead tops has occurred each year. All the green plants in the photo are Russian knapweed, note density of plants, photo taken on same date Photo 4.

Russian knapweed is opportunistic in establishing colonies in both disturbed and undisturbed lands of all types, whether open rangeland, fallow farmlands, areas where seedlings can become stablished (rock scree or riprap), or along roadside ditches. Once established in dense colonies, common practices that have some success in control and management of other noxious weed species appears to only invigorate Russian knapweed. Fire during early rosette stages or early bolting will set back the plant, but seems to invigorate late season or the following season's productivity[12]. Mowing is effective in reducing above ground vegetative and seed production, but it is unknown the length of time necessary to create physiological stress to the point where the plant succumbs to drought or severe removal.[15, 17] Grazing by livestock, including both cattle and sheep, can be used to control spread and seed production[16], especially during winter and early spring months before the plant bolts. However, release of the plant, even in dryer dormant summer periods will result in seed production. Russian knapweed has been shown to be toxic to horses causing chewing disease. Vegetative properties appear to make the colonies more resilient to both herbicide and other control methods.[10,11,15]

Photos 6 and 7. Photo 6 depicts heavy grazing by cattle of Russian knapweed, left side of fence, April, 2013. Photo 7 shows response of Russian knapweed first growing season following removal by fire, 07/10/13.

Whitetop (Hoary Cress)- This invasive perennial forb that is relatively new to the Duncan valley grows between 6" and 2 feet tall in the area, depending on soil and moisture availability. Though some references indicate it prefers alkaline soils,[25,36,37,29] the species inhabiting the project corridor has shown to occupy a diverse array of soils that might be alkaline in PH, but vary from shallow hard packed silty clay soils, deep loamy soils, to sandy loams.[17] Aptly named Whitetop because of the multi-branched flower (Photo 8), like Russian knapweed, this perennial is very deep rooted (6-8 feet), and can become established by seed or vegetatively. New plants and newly established populations were observed in 2014 following flooding in the Gila during late August, 2013 (See Photos 9 and 10).

Photo 8. Whitetop growing in Highway ROW, Duncan. Note soil and substrate. 3/26/12. Plants are into early flowering for this time of year, triggered by poor soil and limited water. Height 10-12”.

Photos 9 and 10. Left - Whitetop tubers and seedlings established in silt aggraded during late August 2013 floods, 10/04/13. Knife is 6” length. Seedling near knife, tuber with rosette from older plant buried in flood silt. Right- Newly established Whitetop population in backwater flood eddy, Parcel 425 in river corridor, 5/01/14. Plants are 12-16” height.

Several references indicate that Whitetop prefers open, unshaded areas that have experienced significant soil disturbance.[25,29] It was noted during the project time period that Whitetop became well established in shaded, moist riparian areas as well, and actually appeared more prolific when shaded. Another trait of Whitetop is the capability to establish large colonies in disturbed (or aggraded) soils. Research has shown that a single plant growing in disturbed soils without competition can spread over an area 12 feet in diameter in a single growing season.[18,25]

These traits of a deep tubered root system, drought resilience, seed and vegetative capabilities to reproduce, and responses to disturbed soils and diverse habitat uses make control of Whitetop difficult once established. Although grazing with sheep has been shown to be effective to reduce seed production and plant expansion,[9] it may also result in spread of seeds if plants are grazed after full flowering occurs. Mowing can reduce seed production, but does may actually encourage vegetative reproduction, similar to effects of grazing or fire. Good perennial grass cover is one of the best methods of controlling infestation of areas by Whitetop,[28,22,18] and observed by the author (Note Photos 11-12).

Photos 11 and 12. Pastures that were observed to reduce Whitetop establishment and expansion. Left Photo 11 is a dormant Bermuda grass pasture (3/07/14) that has one single Whitetop rosette while the adjacent residence site (background in picture) is inundated with Whitetop. Right Photo 12 shows locations of isolated Whitetop plants in excellent condition permanent perennial grass pasture. Whitetop plants are single stemmed, and display low vigor. 4/08/14.

Management and control of Whitetop, because of identified and observed traits that confirm this to be an extremely aggressive, invasive, noxious weed, require careful planning and commitment to an integrated approach. Once established, populations of Whitetop are extremely difficult to control. Special emphasis should be placed where Whitetop has invaded and become established within riparian corridors.[22,28,18,29]

5. OUTREACH

The goal of outreach during this project was to inform and educate the public, land management agencies, and other land managers about the benefits of protecting the Gila River Corridor from invasive weeds and making management decisions based upon comprehensive monitoring. Outreach activities to landowners and the general public, with the goal of establishing Early Detection – Rapid Response teams, was the key to long-term control through identification, tracking and trending invasive weeds allowing communities to proactively respond and eradicate any further outbreaks. This complemented the efforts by the Southwest New Mexico Weed Management Area, which implements similar efforts on their side of the state line.

The Coronado RC&D along with the University of Arizona Cooperative Extension used a mailing list obtained from Geenlee County for reaching landowners in the targeted parcels. The targeted audiences for workshops were farmers and small acreage landowners and others involved in management of riparian areas along the Gila River and in-between, New Mexico State line and Graham County line.

A variety of methods were used to reach the maximum number of individuals per year which included contacting previous attendees via phone, use of post cards, and placing announcements in the local paper and posters in the area. Presentations discussed basic riparian ecology and noxious weed biology, steps of the project, techniques used for treating and monitoring invasive weeds, and sharing general results.

2012- In the first year one noxious weed identification and herbicide application workshop was hosted in Duncan on April 20, by the University of Arizona Extension and National Resource Conservation Service (NRCS). A total of 17 participants attended. Following the workshop, landowners who had infestations of targeted weeds could check-out herbicide, surfactant, and equipment at the Extension office to treat noxious weeds on their private land.

2013- Two noxious weed and herbicide application workshops were hosted in Duncan during the spring, February 19th and April 18th. Following the workshops, landowners who had infestations of targeted weeds could check-out herbicide, surfactant, and equipment at the Extension office to treat noxious weeds on their private land. Prior to and during that time frame, another 27 land owners were contacted, in additional to previous program participants. Personal contacts continued throughout the field season.

2014- Two noxious weed and herbicide application workshops were again hosted in Duncan by Cooperative Extension and NRCS. The first, on January 21, targeted community and county leaders, partner agencies (County, State), and program participants. The second workshop, held on April 8, was directed at new potential participants. Because this was the last field season for the program, there was a concerted effort to contact as many land owners within the critical areas of inventory needs to request and obtain permission for access to conduct inventories. Fortunately, these included several parcels that encompass large blocks of fallow farmland and the riparian corridor. In addition, a presentation to the Greenlee Board of Supervisors on November 18, was given to educate its members concerning the program and its results and recommendations.

Volunteer Assistance and State Grant Support: During initial networking on weed infestations with the Duncan Town Manager early in the 2013 field season, it was noted there was a parcel of land adjacent to and apparently owned by Duncan schools, but outside of the Gila River corridor program. Although this five acre parcel had recently been cleaned of weeds by the Town, a significant amount of residual Russian knapweed remained. Photo 5 was taken on the day of "discovery", and Photo 4 during initial inventory of this infestation. During the 2013 and 2014 field seasons, with donated labor and equipment, the Town of Duncan and a local farmer/rancher removed weeds from the site, and agreed to keep the parcel mowed to reduce seed production and vigor of knapweed plants. The Duncan High School FFA participated in a weed education afternoon in May, 2013, where weed free straw donated by the Forest Service Clifton Ranger District was used to cover about an acre on a sloped area (see photos below) to reduce growth on a patch of the infestation. In the latter part of the field season of 2014, funding became available through an Arizona State Forestry (AZSF), grant to assist with noxious weed eradication in areas not included in the Gila River Corridor program. The grant provided assistance with herbicide and a certified applicator to treat some areas that had not been mowed by late July, 2014. In hopes that Duncan schools would provide support for long-term integrated weed management of this parcel, and utilize a portion of the funds as match for additional grants, Frank Hayes volunteered time to craft a draft Management Plan for the land and submitted to Duncan schools for review and comment. Though the FFA instructor was extremely interested in the potential for developing a plan, no progress has been forthcoming.

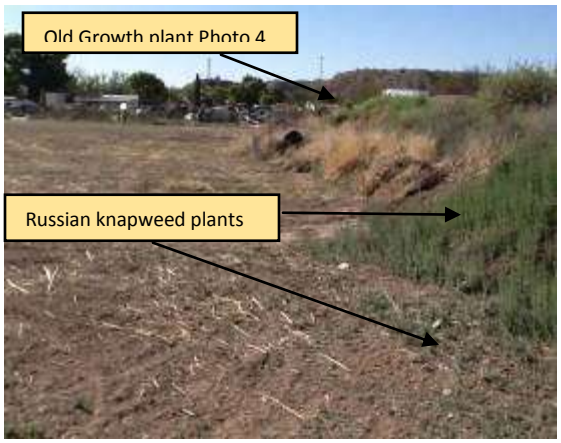

Photo 13 left – Photo 14 right. Duncan High School FFA land parcel. Left photo shows cleanup work by Town of Duncan where sloped area on west side was not cleaned, photo looks south. 4/19/13. Right photo shows FFA students spreading weed free straw to cover the area along this bank on opposite end of photo 13, this photo looks north. 5/14/13

6. METHODOLOGIES

Access Authorization and Parcel Determination: Following approval of the Monitoring Plan in May, 2012, Agreements for Access were reviewed and categorized by those that had included contact information, and those devoid of this data. An attempt was made to obtain phone numbers through normal sources, and those not obtained were returned to the Project Coordinator. Land owners were contacted by phone to discuss the intent of the program, get general locations of the parcel of land, and set a time when an inventory was to be accomplished. Though it was not necessary that land owners be present, many offered to participate in the program. A spreadsheet supplied by Greenlee County included Parcel Number by owner to confirm what parcel or parcels would need to be inventoried.

A complete set of geo-referenced Parcel maps of the project area were created by Andrew Brischke, Research Specialist with Cooperative Extension, which overlaid land parcels on Google imagery with the mapped ½ riverine corridor. In the Avenza PDF maps Apple application provided real time GPS tracking and mapping of infestations within each parcel. An interesting development surfaced that these parcel sheets could be downloaded into the Avenza PDF Maps application on an iPAD which used geo-referenced maps as a GPS locator (Figure 1.), for locating within or among parcels, and pinpointing coordinates for infestations.

Figure 1

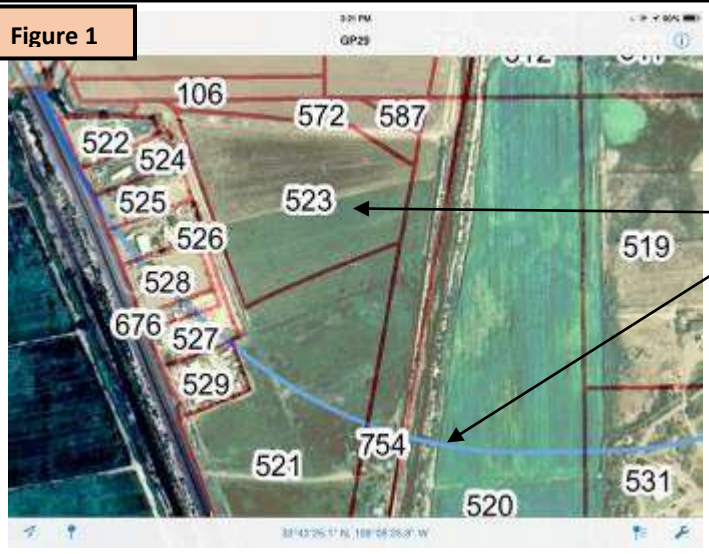

Figure 1. Portion of Parcel Sheet 29 that identifies parcel 523. Blue line is the ½ mile Gila River corridor included in the Noxious Weed Control project.

The same basic process to confirm and obtain access and participation was used in each successive field season, though *Access Agreements* reduced in number substantially by 2014. The availability and use of the parcel maps and this general process was especially useful for planning and outlining work for inventory assistants in the 2014 field season by producing copies of each applicable parcel sheet, once again using iPAD technology. An example of the *Agreement for Access* is included in Appendix A.

The approach to acquiring access was adjusted as the 2014 field season progressed when it became obvious that several large blocks of land encompassing numerous parcels would not be inventoried since the owners were not included in signed *Access Agreements*. The contractor went door to door, or contacted these owners by phone, requesting permission to inventory these lands. At this time in the program, all of the mentioned land owners openly and gladly provided permission, though none agreed to participate in the weed treatment program.

Inventory of Parcels- Mapping and Documentation of Weed Infestations: Priority of inventory was established, in part from known infestation data provided by the Cooperative Extension and also by previous contact with landowners and their knowledge, concerns and involvement and history with treating infestations. Known infestations with active management were generally chosen over new parcels of unknown conditions or status. Inventory of parcels was accomplished by an initial walk-through of the parcel to ascertain the specific location, juxtaposition with the river corridor, and presence/absence of noxious weeds, and extent or density of populations to determine the most appropriate mapping attribute (AZSF 2007). In many instances, the parcel extended into the river corridor, or across the river corridor, and could not be accessed or was unavailable due to habitat avoidance constraints.

Extensive use of the iPAQ and associated Garmin eTrex mapping system provided by the Cooperative Extension office was used for plotting and populating data for point, line, or polygon infestation locations (Photo 15). Shape files for each infestation present were created and automatically downloaded onto an SD card for later reference and transfer to a computer. Field assistants were trained and familiar with the use of the system for their 2014 season inventory and mapping efforts.

Photo 15. iPAQ and Garmin GPS combined for a geospatial tool kit that provides a relatively simple set of tools into a turnkey, field-based mapping tool (eXtension.org). Instructions and guidelines proved invaluable in field operations.

The iPAQ mapping technology was supplemented with the use of the iPAD and Apple applications for delineation of GPS coordinates displayed on topographic or Google map

imagery (examples shown in Fig. 2 and 3), along with digital photos of various inventory areas, infestations, and weed species. Use of geo-referenced parcel maps overlaid on Google imagery (developed by Andrew Brischke) with the mapped riverine corridor and associated land parcels in the Avenza PDF maps Apple application allows real time GPS tracking and mapping of infestations within each Parcel.

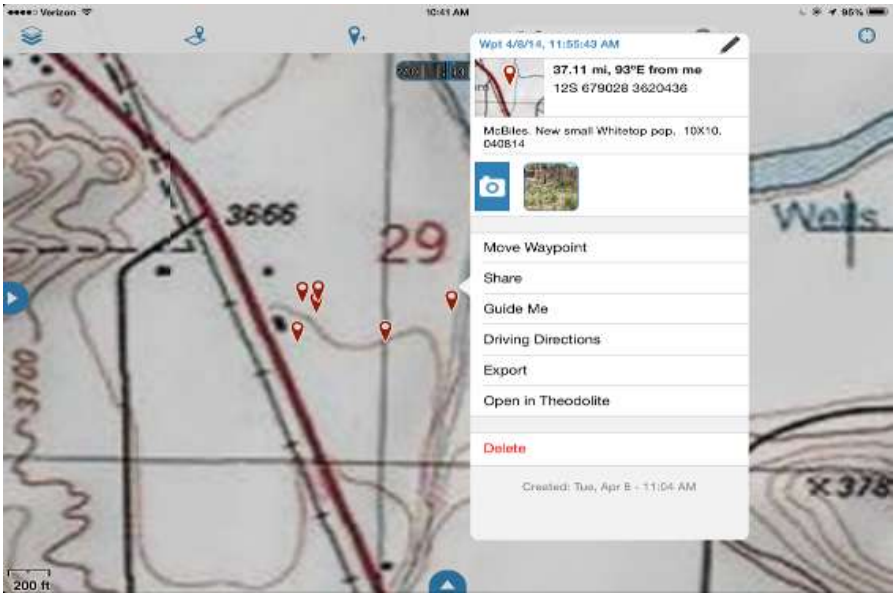

Figure 2: Topographic map application with GPS capability, provides narrative and technical data, including UTM coordinates of new Whitetop infestation. Parcel 523, 4/08/14

Figure 3: Parcel map 29 used with Avenza PDF application. Capability to calculate area or linear distances, GPS locations, and narratives with coordinates . Parcel 523. 4/08/13

With the initiation of inventory activity in 2013, a situation surfaced where multiple parcels owned by one land owner were located on farmland that had various changes in management (fences, ditches, changes in crops and field use, etc.) not related to parcel boundaries. With assistance from the NRCS GIS specialist at the Safford office, a geo-reference Google earth image was overlaid with parcel boundaries of interest. This technique and product allowed the contractor to locate and depict inventory descriptions for infestations that crossed parcel boundaries or in some cases were in the same parcel, but different field, and often different species.

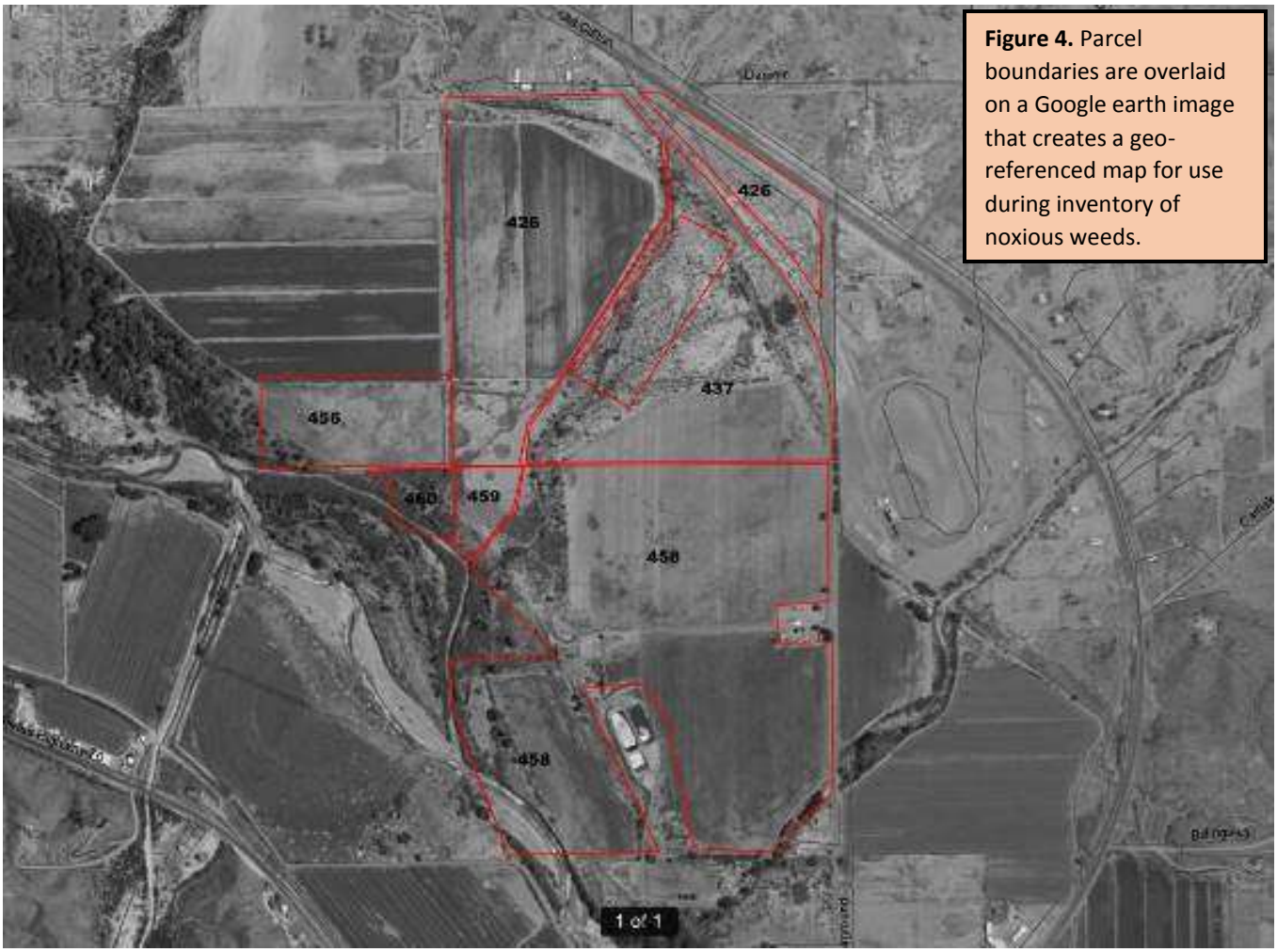

Figure 4. Parcel boundaries are overlaid on a Google earth image that creates a geo-referenced map for use during inventory of noxious weeds.

Although the focus of the project was to inventory within the identified river corridor (blue line shown in Figure 5 example), there were some parcels that overlapped out of the corridor but had potentially direct influence to infected fields that included lands outside this area but with direct influence into the river corridor. Since it was more practical and advantageous for control of targeted weed species to address infestations directly adjacent to and associated with the corridor (blue line), these parcels were inventoried as part of the project.

Figure 5. Parcel Sheet 52 that encompasses portion of a farm. Blue line is the east side of the Gila River riparian corridor identified for inventory. Note Parcel numbers and approximate boundaries of parcels.

For ease of description and discussion with several land owner/farmers, inventory was completed for the entire farm referencing established units of the farm that would likely be treated concurrently, regardless of parcel or the river corridor (noted in Figure 6). Several farms were inventoried with this approach.

In 2012 and 2013 basic field data was captured on the *Noxious/Invasive Weed Inventory and Treatment Monitoring* form developed by Cooperative Extension personnel. Following the second field season, with expectations of increased inventory, monitoring, and treatment in 2014, three separate forms were developed for field use. Examples of the three inventory forms used are presented in Appendix B. Data was also collected at this time for completion of the SHPO Review form, to be signed by the cooperator prior to treatment activities.

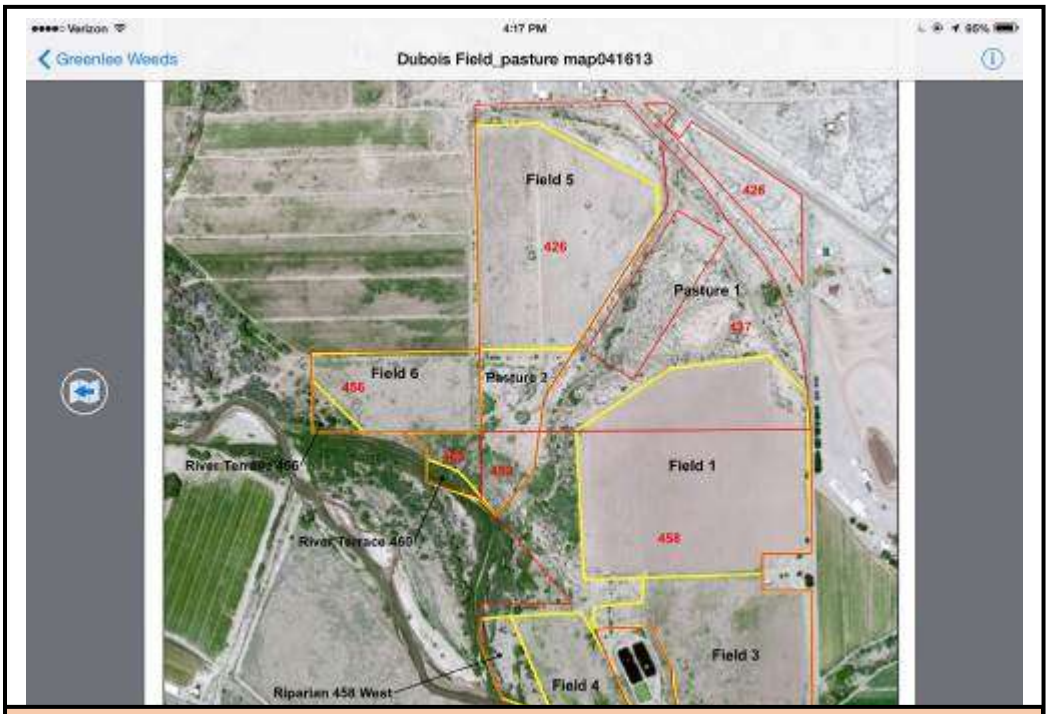

Figure 6. One example of a farm separated into temporary field or pasture units for inventory and later herbicide treatment. Note that Field 1, for example, includes parcels 437 and 458, and Pasture 1 parcels 426, 437, 458.

Photographs were taken at all infestations during inventories in 2012 and 2013, and for several new infestations noted in 2014. Many locations inventoried in 2014, especially where Russian knapweed was noted and mapped, did not have substantial growth to be effectively displayed in digital images. It should also be noted here that extensive photographic documentation was completed for all riparian canopy sampling locations. One set of examples from the 2013 field season is captured below.

Photos 16 and 17. Parcel 523, 4/08/13 Photo on left of small Whitetop population along fence line between Parcel 523 (left of fence) and 521. Very small number of plants. Photo on right 4/08/14, new Whitetop population inventoried Parcel 523, same fence line. None observed on 521.

Noxious Weed Infestation Treatment: Confirmation of a noxious weed infestation did not automatically result in treatment with herbicide. Once the extent and acreage of infestation was obtained through the GPS/iPAQ technology, a direct discussion usually occurred between the contractor and the land owner concerning a desire or willingness to treat infestation(s) with herbicide. If the land owner desired to treat with herbicide, it was confirmed whether they were certified applicators (many farm operators have obtained this basic training), or had attended one of the workshops for applicators training offered by the Cooperative Extension. The location of infestations were discussed (and often flagged with pin flags where few plants existed, see Photo 12) and visited if the land owner was unaware of the situation. Various aspects of the treatment approach were discussed thoroughly, including timing, method of application, application rates, the appropriate herbicide and adjuvant and in many cases, integration of other control methods. In rare cases other methods of control were being practiced, such as concentrated grazing on farms and rangelands infested with Russian knapweed (See Photo 6).

The process for implementing treatment of noxious weeds for land owners followed a step by step approach. One farm is rather complex, about 300 acres, with numerous parcels and various agricultural fields and pastures (note Figures 4 and 6). Documentation was used in the multiple step process to authorize and enable treatment of infested areas and is noted below.

Step 1. Transfer of inventory data (species, acreage infestation, coverage level) to identified area of treatment for completion of SHPO forms and herbicide calculations.

Step 2. Calculations of actual herbicide and adjuvant needed for treatment by species.

Step 3. Issue herbicide, adjuvant, appropriate Label copy, Personal Protective Equipment as requested, using Check-out sheet.

Step 4. Review and obtain signature on Herbicide Use Agreement with land owner/applicator.

Step 5. Provide general guidelines, conversion table, and examples of herbicide calculations.

Step 6. Review and obtain signature on the SHPO Review form.

In most instances, pre-treatment photos were obtained during inventory where an expectation existed that participation in the noxious weed control program would occur. In a very few instances, the private land owner was assisted with both calibration of equipment and actual treatment of infestations. Most farm owners were or had been recently approved to apply herbicides available through the project. Herbicides, personal protective equipment, and a small amount of loanable application equipment was provided by the Cooperative Extension office in Duncan, housed in a separate building set up for the storage and inventory of these chemicals. A log of inventory and chemical dispersal is maintained in the building, along with applicable Material Safety Data Sheets (MSDS) for each chemical. While the contractor

maintained a separate notebook for documentation related to the step by step process outlined above, original signed documents were maintained in the files at the Cooperative Extension office or Coronado RC&D office in Willcox.

Weed Infestation Monitoring: Monitoring (Task #5) was the first and last task of each summer field season, often incorporated into other task work. Early monitoring efforts were conducted primarily to check on the results of previous or current year applications of herbicides and confirm new growth of weeds in early fall. Because of the level of work to accomplish in one field season, site visits began as early as February, and often ran through August. Early monitoring efforts (Feb-March) were conducted to confirm the presence or absence of species, particularly Whitetop, and approximate growth stage (Example Photo 18). Monitoring during the summer field (April-August) season involved several aspects of the program. A substantive amount of monitoring occurred to confirm the growth stage of plants for planned treatment, and to notify land owners when that optimum time might occur. Once applications were completed, land owners notified the contractor, who scheduled follow-up monitoring visits to try and ascertain the effectiveness of herbicide applications. This often resulted in return visits to confirm the presence (or absence) of re-appearing or new species, or new populations in several cases on adjacent properties, and document further treatment if needed. Attempts were made to conduct late season follow-up monitoring after final treatments were completed and applied herbicides had an opportunity to begin taking effect.

An effort was made to document on the *Vegetation Monitoring Form* growth activity of targeted noxious weeds, if present during the early spring period, growth stage and estimated density or concentration. Often this proved challenging due to the presence of other species or the lateness of further weed development. A substantial amount of monitoring documentation was completed in narrative summaries of each infestation inventoried and treated during each season. Photographic confirmation of treatments were obtained were feasible and practical, along with completed treatment forms, added for the 2014 field season. For example, some Whitetop populations did not show results of herbicide applications for several months as depicted in Photo 19. Other populations appear to decline rapidly to the point of complete loss of residual plants or only a small percentage left on site (Photo 20). It's likely that the small but active Whitetop population in Photo 19 was older, had been burned over in March, and was resistant to treatment initially, while the population in Photo 20 was relatively young, established in late August, 2013 following bank full flood events on the Gila River, and more susceptible to herbicide applications.

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Photo 18. 3/10/14. Parcel 269 Pivot. Orange flag shows location of Whitetop rosette where several can be seen just emerging. As the soil warmed, the small colony erupted from this west most location to the pivot sprinkler in the background. Treatment of this area in 2013 was thought to be 90% successful, but was retreated in 2014.

Photo 19. 7/10/13. Left photo shows a spot infestation of Whitetop, Parcel 7, sprayed with Escort and MSO in April, 2013. Wilt in plants did not appear until late June but recheck in early March showed no reappearance. **Photo 20. 6/27/14.** Right photo shows the location of a young spot infestation of Whitetop, Parcel 288, sprayed with Escort, late March. Plants have wilted and almost completely disappeared from residual, with no evidence of rosette formation.

Riparian Canopy Cover: Sampling of riparian canopy cover during the three field seasons was stratified based on the location of an infestation and/or access to parcels that are adjacent to the infestation and encompass riverine corridor. Not all acres along the Gila River corridor within the inventoried project area were accessible due to bank steepness, water depth, or lack of land owner participation.

Inventory of parcels within the corridor adjacent to the Gila River riparian vegetation zone determined the presence or absence of targeted noxious weed infestations. Often it was relatively easy to determine if infestations extended into the riverine zone. In many instances, parcels extended into the riparian zone and included inventory efforts. If infestations were present, the closest parcel or parcels encompassing the riparian corridor were selected for vegetation sampling within the area directly adjacent to or within a parcel. Sampling of riparian vegetation used methods adopted from Medina[20] and Robinett[23] consisting of three belt transects (40 meters long by 3 meters wide) and a 3 meter graduated rod. Classification of riparian vegetation types follows Brown[3]. Belt transects were established and data recorded to estimate the composition of riparian species occurrence by canopy cover and size class. Assessment of riparian condition or ecological status considered various protocols,[20] with a very basic approach using ocular observations for determining proper functioning condition.[23]

Locations of the start of each belt transect were determined first by the closest proximate location within the riparian flood plain. The determination of whether belt transects were run parallel or longitudinally, was made based on the existing Google parcel map, and the approximate distance to the river. In several cases, it was determined that the Gila River was too deep or banks too steep to safely cross during sampling.
Since the depth or extent of riparian vegetation within the established ¼ mile corridor (on either side of the Gila River) varied significantly within the inventoried project area, adjustments in sampling technique were utilized, while the technique of determining the actual location of transects (GPS coordinates), canopy sampling, and recording data remained consistent. Google imagery available on the Parcel Sheets assisted in the determination of the initial placement of the group of belt transects. The preference was to initiate sampling from the river bank perpendicular to the river channel and extend the series of three belt transects along the same bearing (Figure 7). Where this situation occurred, belt transects were offset ten steps (normal paces), and the next transect conducted along the same bearing as the first. Ininstances where the length from start to completion of a single belt transect would enter or nearly cross the greenline (wetted area along the river bank), transects were established parallel, offset ten steps, yet still perpendicular to the river channel. There were rare occasions when the set of transects were placed within a very narrow riparian corridor that required

numerous offsets that were recorded on the field sheet. In some several instances, riparian corridor vegetation was so narrow that only photographs were obtained at the site (Photo 21).

Figure 7. Farm on parcel map showing waypoints established for four riparian canopy cover transect sets. Points are shown for start of each belt transect and the end point for Transect 3.

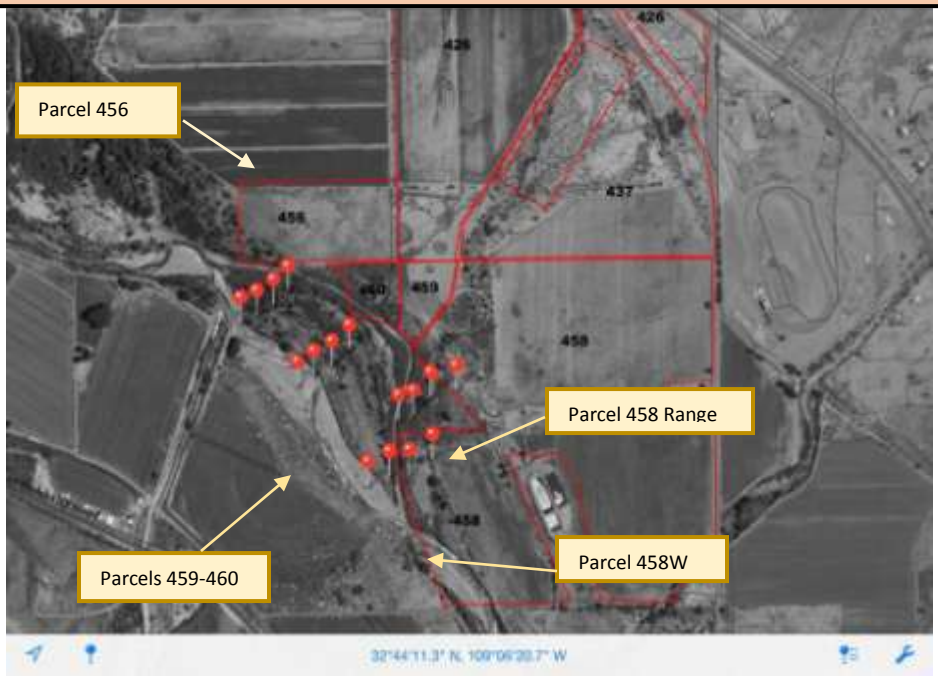

Photo 21. Parcel 382. 11/05/14 Riparian corridor limited to none-existent. Photographs taken at site, no canopy cover transects established

Canopy data was recorded on the *Riparian Tree Canopy Cover* field data sheet (example in Appendix D), for each transect within the set, including canopy estimates by species, notes, coordinates and bearings, and references to photos. Two persons were required to collect riparian canopy cover data, a technician to estimate canopy cover by species using the 3 meter graduated rod (Photo 22), and a data recorder (Photo 23). The presence or absence of noxious weeds was noted on the field sampling form. In many cases infestations had been inventoried prior to the establishment of transects. Coordinates were obtained for the location of all established transects using GPS technology on the iPAD, recorded both as UTM and Latitude/Longitude data, and were obtained at the start of each belt transect (Figure 8). Photographs were taken at the start and end of each set of three transects in all cardinal directions, including the direction of travel (bearing), and also taken in the direction of travel at transect 2 and 3. Data was transferred from the field sheet to the Field Data Summary and assimilated onto the Riparian Canopy Cover Summary (Appendix D). Riparian data collection was conducted in early fall primarily to avoid invasive impacts to Southwestern Willow flycatchers, which was also timely to avoid heat, snakes, and floods. Data collection was delayed during both the 2013 and 2014 seasons due to bank full flows that made traversing the riparian corridor difficult and dangerous. As can be seen in Photo 22 and 23, transect establishment and data collection often required working through obnoxious weeds (mostly Kochia) and dense coyote willow thickets.

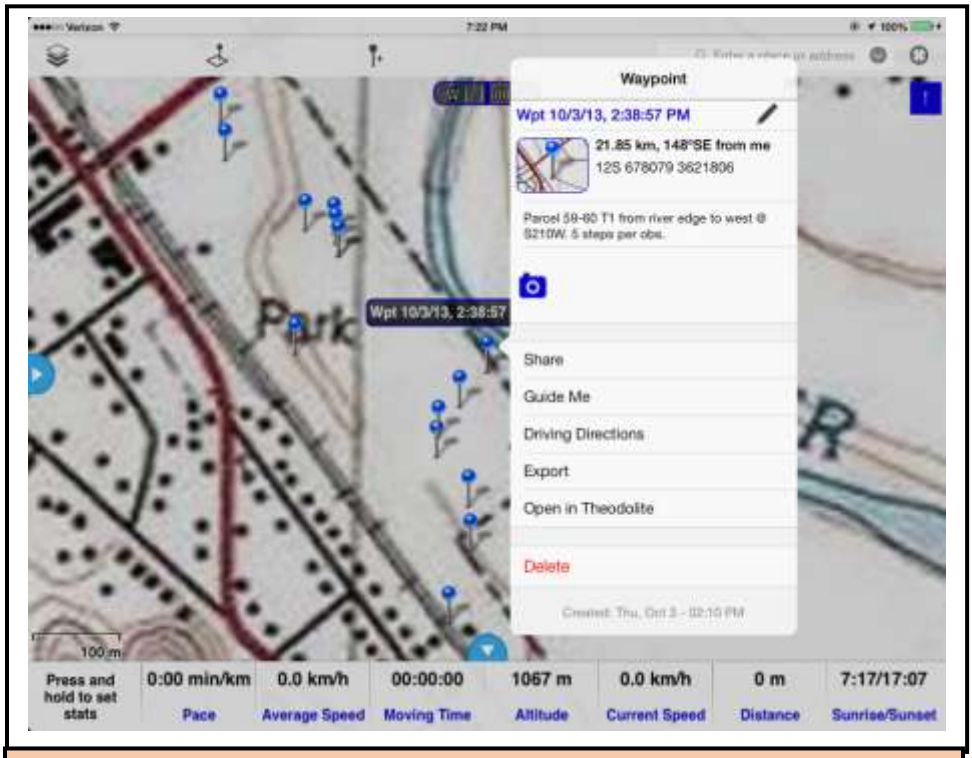

Figure 8. Example of UTM coordinate locations of Transect 1, Parcels 59-60 obtained using the GAIA topographic Apple application.

Photo 22. Riparian with overstory of multiple species, or sometimes dense stands of kochia weed. Photo shows the 3 meter rod used for estimating canopy cover of overstory species. **Photo 23.** Dense willows!

Data Assimilation and Progress Reporting: Following the progressive collection and technical review of data and anecdotal information related to various tasks accomplished for the project each season, data (in its many forms) was collected and stored by the contractor in personal project notebooks, on the iPAD, and in established files within a personal laptop. Once any data source (e.g Inventory Sheet, UTM map, photos, etc) was finalized, information was moved over to electronic storage for access by Coronado RC&D and Cooperative Extension personnel.

To expedite the transfer and review of data and large documents, a mutually shared Dropbox application was established in 2012, and used extensively throughout the life of the project. The application, loaded onto both laptop and iPAD devices, allowed the download of shape files, data files, photographs, inventory forms, maps, reports, etc. for shared use. These applications for sharing information greatly increased the efficiency in data, information, and invoice transfer.

Assimilation of information required a significant amount of project time. For instance, although inventory and monitoring forms were available for completion on the iPAD, in 2014 the use of field technicians required completion of the hard copy forms and transfer of this data into an electronic format to store and use at later dates. A substantial number of photographs were obtained in the 2012 and 2013 field season, but required a substantial concentrated effort to download, label, and store in electronic format. Additionally, riparian field data forms required transcribing onto two summary forms for later analysis, another example of time-consuming relatively technical data assimilation.

Midyear progress reports were the primary method of transferring the technical information obtained during a field season, as well as anecdotal and objective observations, to the Project Coordinator and Cooperative Extension Specialist. Reports were purposely structured to

highlight task activities and summarize, in some detail, actual inventory and interactions with various land owners. Special attention was given to knowledge about the extent of weed infestations and various approaches to treatment and control by land owners.

7. RESULTS OF PROJECT ACTIVITIES

Inventory of Parcels: Specific data by owner and parcel number (or a set of parcels) for all field seasons can be found on the *Inventory and Treatment Spreadsheet* located as a separate document to this report. The following data in Table 1 was obtained in part from that spreadsheet.

Inventorying parcels for noxious weed species increased substantially by the third season of the project. The late spring start in 2012 contributed greatly to the amount of inventory conducted. By the 2013 season, early monitoring and field activity resulted in a significant increase in both acreage and the number of parcels inventoried, and concurrently the number of acres of infestations documented. As depicted in Table 1. below, inventory and monitoring once again more than doubled the number of parcels inventoried as well as the total acreage. This was due in part to an early start date for monitoring, but primarily from the addition of two field technicians to assist with inventory efforts.

Table 1. Number of Parcels and Acreages Inventoried Through Project Period 2012-2014.

YEAR	Parcels and Acres Inventoried	Clean Parcels	Infected Parcels	Acres Infested+				Parcel Land Type++				
				RK	WT	MS YS	Total	M	F	R	RI	RG
2012	16 / 256 ac.	8	8	58	14.1	.1	72	4.5	5	1	5	.5
2013	32/650 ac.	3	29	117	45	42	204	16	8	1	5	2
2014	56/1524	16	40	501	241	50	792	10	29	3	12	2
Total	104/1524*	27	77	** 501	** 241	** 50	** 792	30.5	42	5	22	4.5

+ RK – Russian knapweed; WT – Whitetop; MS/YS – Malt and Yellow Starthistle

++ Parcel classification is a broad representation of the current status of most or all of the parcel. M – Areas under some level of management; F – Fallow ground; R – Residential; RI – Riparian; RG – Rangeland.

***Total acreage includes both Clean and Infested parcels at the close of 2014 field season.**

****Acreages of infestations are cumulative through the three year inventory period, based on current infestation level**.

Unlike 2013, where inventory was focused on larger blocks of land that were known to have infestations of weeds (hence less than 10% of parcels inventoried were clean), efforts in 2014 were to inventory as many parcels as possible with *Access Agreements*, and to cover as much of the project area as feasible. Consequently, the results of 2014 inventory appear to be more representative of data distribution than either previous field year. With this in mind, the data

suggest that almost 75% of parcels within the project area are infested with one or more targeted noxious weed, a disturbing situation considering the number of parcels not inventoried to date, both up and down river of the three years of work. Data (based on field observations) indicate a very high percentage of inventoried parcels, both small and large (1-40 acres), are fallow ground, where no level of management is being applied. In review of parcel land status data, it appears that less than 35% of parcels have some level of applied management (whether farmland, residence, or community facility).

A review of inventory data digitally expressed across the project area provides some insight into the results and inferences of that data, and more importantly gaps in information and future work ahead. While the number of parcels inventoried might appear substantial, a small section of the project area pulled from the Apache Grove (Map 4) set of parcel maps provides a more detailed view of the task remaining. Parcel numbers and boundaries have purposely been left on this map with an overlay of parcels inventoried. In the center of the map, the large round green area (a pivot sprinkler) is located in Parcel 269. While much of this parcel and adjacent parcels 270 were inventoried, the west side of parcel 270 was not accessible and not surveyed. (Note that inventoried acres were calculated based on actual land area covered in field observations, not parcel acreage). Also, as Map 4 depicts, there are several parcels on the map that were inventoried, but many more that were not in the program.

The complexity and depth of the inventory task accomplished related to what was left to complete is presented in two formats (Map 5 and Map 6). Both maps reflect the spatial area that was covered with inventory efforts, from York to Franklin, but several miles of the Gila River corridor exist on both sides of this depiction. Map 5, though somewhat "busy", includes inventory parcels overlaid on parcel boundaries throughout this section of the project area, providing an overview of the extent of parcels not addressed. Map 6, is a much simplified version of the same data that is a clearer depiction of the location of inventories, the Gila River corridor, and "blank space" yet to be addressed. (Note that the large parcels in the southern part of the map, clearly outside of the corridor blue line, were inventoried with a different state grant, and this data was not included in the spreadsheet in Table 1.

Noxious Weed Infestations: Midyear summary reports for each year provided very site-specific information for each parcel(s) by owner, in regards to inventory and occurrence of targeted noxious weeds, as well as a summary of their efforts (when applicable) toward weed management. There is much value in referencing this information to understand the level of effort that occurred through the Gila River corridor program, what various tools are being applied for weed management, and more importantly, what are some key issues influencing the reduction in weed spread. A final updated version of this information and data, much too lengthy for this document, will be provided in a separate document.

Referencing Table 1 again, 27 parcels inventoried were clean of noxious weeds at the time of inventory. Parcels clean of targeted weed species were scattered throughout the project area,

and included varied land status, though most were relatively small acreages or rangeland. Map 7 depicts the location of clean parcels, including a group of parcels at the north end of the project area. Inventories in 2014 did include a group of parcels within the river corridor and did not reveal any newly established Whitetop colonies. Because this location has the potential to be the "pinch point" for ensuring control of downstream movement of Whitetop, an attempt to gain access to inventory a large group of parcels of actively managed farmland and riparian corridor for the 2014 season was made, but was unsuccessful. There is concern that Whitetop will or has moved into this area in very small colonies, similar to the small colony established in River Parcel 260 following the flooding of 2013.

Photo 24. 031014 The most northern known population of Whitetop in Greenlee County, newly established at this location following flood events, fall 2013. This site was discovered and inventoried in 2012, where a very small Russian knapweed population existed was treated, and was being monitored in early 2014. **12S 668611E 3638251N**

In a large part, the documentation of infestations of noxious weeds, particularly Russian knapweed and Whitetop, increased dramatically as the amount of inventory increased, graphically displayed for each year of the program, Map 8 (2012), Map 9 (2013), and Map 10 (2014), and the three year program captured on Map 11. One important consideration to note is the apparent and observed expansion of Whiteop from 2013 to 2014, clearly discernable by comparing acreages of infestation shown in Table 1, along with comparing Maps 9 and 10. The data suggests about a 435% increase in infestation acreage of Whitetop between the two years. While the data for Russian knapweed indicates a similar increase (328%), much of this can be attributed to the acreage inventoried in 2014 that was known to have knapweed occupancy in 2013 but simply not surveyed. However, much of the acreage actually inventoried in 2014 where Whitetop infestations were documented, were also areas that were sampled for riparian canopy cover in 2013. In addition, they were either absent Whitetop, or the populations were not active or large enough to detect. Based on observations of actively growing rosettes of Whitetop in the fall of 2013 (Photo 25) and 2014, the documentation of Whitetop in 2014

accurately reflects the aggressive, invasive increase in this noxious weed species. Most of the Whitetop populations documented north of Duncan Water Treatment Plant (parcels 2, 470, 473), with the exception of the populations at Apache Grove area (Parcels 269 and 270), appeared to be young populations recently established.

Photo 25. Parcels 6-7 10/14/13. Whitetop rosettes from rhizomes sprouting through silt deposition following high water in Gila River in late August and September, 2013.

Russian knapweed occupies the most acreage inventoried during the project period, not surprising since previous inventory information indicated that about 800 acres of lands within the Duncan valley (much outside of the riparian corridor) were infested with this knapweed species. The apparent three fold increase in acreage infested by Russian knapweed appears morrelated to the number of parcels of large acreages inventoried that are and have been occupied by the species than by an actual change in population numbers or size. Although Russian knapweed has been found occupying lands within the Gila River corridor, observations and inventory indicate this is a more dryland species, readily occurring and maintaining viable, albeit reduced density populations, on fallow farmlands or rangeland conditions (Photos 26 and 27).

Unlike more extensive populations documented on fallow ground, several small populations of Russian knapweed were documented in open rangeland conditions where either animals or flood waters deposited seeds (Photo 28). These populations were generally restricted to smaller areas, as compared to areas where substantial disturbance had occurred (soil disturbance, grazing, burning, mowing (See Photos 4, 6, 7, 18). In very few situations was Russian knapweed found extensively occupying wetter, moist soils in riparian habitats as compared to Whitetop. The following photos show examples where knapweed was mapped directly on a dryland bench above a riparian corridor, and only a small number of plants were observed along the tree line edge.

Photos 26- 4/15/13. Photo 27 – 4/12/13, Rangeland parcel 437. Russian knapweed in fallow ground. Note density of plants in left photo. Right photo small patch knapweed, grazed. Open rangeland.

Photos 28 (6/16/12) and 29 (5/22/12): Russian knapweed population on River Parcel 260, small patch on sandy soils at edge of riparian corridor. Whitetop right photo, within riparian corridor, Russian knapweed found in small numbers only on dry bench within 100 feet of this location.

Noxious Weed Management: Involvement in the noxious weed program supported by the Gila River Corridor project understandably increased with each year of the project. While the focus of management in 2012 was application of herbicides for direct control, several land owners were either purposely or inadvertently using other practices to manage the spread of targeted noxious weeds. With increased interest and involvement by more land owners in 2013 and 2014, and increased inventory and documentation of noxious weed species occurrence, we gained both insight and actual data on these practices. It should be noted that many other land owners/farmers are likely utilizing one or more of these practices to control or manage noxious weed species, but did not choose to participate in the Gila River Corridor program.

Accomplishments: Table 2 provides information from the 2014 field season, including acres by species treated by herbicide, and an estimate of acreages from other methods applied by land owners to control or manage noxious weeds at some level of infestation, based on inventory data and observations. A total of 14 land owners or managers participated in the herbicide treatment program during 2014, with 3 land owners who participated in 2013 not being active. Inventory and/or monitoring on lands owned by these participants accounted for about 42% of the total acreage surveyed in 2014 (647 acres vs. 1524 acres, including clean parcels). Participants in 2014 also accounted for only about 54% of the total land owners where infestations were observed (14 vs. 26).

Of the 14 participants who utilized some form of management to address noxious weed spread and control, rarely were they able to treat the entire infestation with direct control or other practices. For instance, in 2014, only about 56% of the acres infested with Russian knapweed were treated with herbicide by these participants (118 acres vs. 210 acres), and this treatment accounted for only about 24% of the total acres (118 vs. 501 acres) inventoried in the Gila River Corridor project. Direct control of Whitetop with herbicides was more focused by participating land owners (52 acres vs. 80 acres – 64%), but overall direct control efforts with herbicide treatment of Whitetop across the project area was low (52 acres vs. 241 acres – 22%). The one focused area was the attention to direct and indirect control of Malta and Yellow starthistle by herbicide treatment combined with early and seasonal grazing with livestock in Sheldon. A graphic depiction of the occurrence and treatment of noxious weeds within the Gila River Corridor is provided on Map. 12.

Table 2. Noxious weed management approaches observed within the Gila River Corridor Project Area

NOXIOUS WEED MANAGEMENT – Greenlee County River Corridor Project						
PRACTICE AND SPECIES TREATED (Species/Acres) 2014 RK – Russian knapweed, WT-Whitetop, MS&YS (Malta and Yellow Starthistle.						
Owner/Inventoried Acreage	**Infestation**	**Herbicide**	**Tillage-Crop**	**Grazing**	***Pasture**	**Mowing**
Landowner 1 – 98 ac. Parcels 269/270/575/629	WT- 27.4	WT – 26.01	0	27	27	0
Landowner 2 - 222.71. ac. Parcels 426, 437, 456 458, 459, 460	RK – 172.3, WT – 1.85	RK – 104, WT -.45	65 ac.	227	25	30
Landowner 3 – 2ac. Parcel 2	RK – 1.3, WT - .4	WT - .4	0	0	0	0
Landowner 4 -45.4ac Parcels 3/588/632/683	RK – 2.4 WT – 4.122	RK – 2.4, WT – 4.122	28.1	6.7	6.7	0
Landowner 5 - 43 ac. Parcels 308/314/319/ 320	RK - .53 MS&YS – 39.9	RK - .53, MS&YS – 39.9	6.4	39.9	33.5	0
Landowner 6 - 6.4ac. Parcel 523	WT - .04	WT - .04	0	6.4	6.4	0
Landowner 7 - 6.9ac. Parcel 252	RK - .001	RK - .001	0	0	0	3
Landowner 8 - 48.8ac. Parcels 444/445/462/756	RK - .011 WT – 4.95	RK - .011, WT - .15	22.4	1.2	1.2	0
Landowner 9 - 5.9ac. Parcel 260 River	RK - .01 WT - .001	RK - .01, WT - .01	0	0	0	0
Landowner 10 - 53.3ac Parcels 466/467/469	RK – 22.84 WT – 22.8	RK – 3.0, WT – 3.0	0	0	0	0
Landowner 11 - 6.8ac. Parcel 288	WT - .13	WT- .13	0	0	0	0
Landowner 12 - 39.9ac Parcels 2/5/40/43/58/59/60/ 470/473	RK – 9.4 WT – 3.553	RK – 7.71, WT – 2.461	0	0	0	0
Landowner 13 – 31ac. Parcels 353/355	RK - .85	RK - .85	0	0	0	0
Landowner 14 - 37.25ac Parcel 433/434	RK - .01 WT – 15.0	RK - .01, WT – 15.0	0	19.3	16.5	0
14 Participants / 647.36 acres	RK – 209.7 WT – 80.3 MS&YS – 39.9	RK – 118.2 WT – 51.77 MS&YS – 39.9	121.9	327.5	116.3	33

Weed Management Practices: There were several practices used in indirect control of the spread and vigor of targeted noxious weeds within the Corridor project area. The most effective method for limiting spread and reducing vigor appears to be maintaining productive and healthy pastures (Table 2. Owner 1, Owner 4, Owner 6) and vigorous croplands (Table 2. Owner 4, Owner 8) void of decadence and adjacent fallow ground. There are several examples of the use of seasonal pasture crops such as sudan or a winter grain (Table 2. Owner 2) to reduce density and vigor of both Russian knapweed and Whitetop. However, it was observed and documented that any tillage, even light disking and planting, can contribute to the invigoration and spread of Russian knapweed and particularly Whitetop (Table 2. Owner 1, Owner 2), and severe disturbance (burning, plowing, weed removal by equipment, dozing ground, etc.) greatly increases the spread and vigor of both species (Table 2. Owner 1, Owner 2, Owner 12) . If pasture grasses, both perennial and annuals are allowed to loose vigor and density, Whitetop will aggressively expand (Table 2. Owner 14). Additionally, observations clearly show that once Russian knapweed (and to a lesser extent Whitetop) was "released" from heavy grazing pressure, it was prolific with seed production (Table 2. Owner 2). Similar responses were noted with mowing of Russian knapweed.

Herbicide Applications: Observations, assisting land owners, and applied practices with species specific herbicides and adjuvants helped to gauge the success of herbicide treatment of various noxious weed species. Success depended on several factors, perhaps the most important following the recommended mixing ratio between adjuvant and herbicide provided from the product label. Mixing technique played a significant role in whether any chemical and adjuvant was properly "atomized", or broken into small enough particles to effectively bind together and to the plant. Mixing a granular form of herbicide (Escort) required careful attention to dissolving first, then agitating, and mixing with the adjuvant. However, this same technique proved critical for large tank applications of any herbicide, whether liquid (Milestone) or granular like Escort. Spray application equipment that provided effective atomized droplets consistently across plants was more effective than equipment that would not maintain pressure or a spray nozzle that was clogged and applied drops rather than a mist spray onto plants. Herbicides applied at the optimum, or peak growth time, when plants were putting up seed stalks (bolting), certainly appeared to be more effective than either early (rosette) or late growth stages (full flower).

Challenges: Other factors are or will contribute to the success or effectiveness of managing noxious weed spread with herbicides, or other practices such as grazing. While Russian knapweed is widespread within the Gila River corridor, most infestations are located on upland sites, in most cases outside of the actual riparian vegetation and habitat zone. Whitetop, however, is primarily found within this more shaded, wetter zone, somewhat of a contradiction to other findings or reports. In many instances, infestations are literally impossible to access and effectively spray by hand, and certainly not by any aerial option (Note Photos 30 and 31).

Photos 30 and 31. Left photo Whitetop infestation in Parcel 7, occupying green line of riparian vegetation (041013). Right photo Whitetop infestation well established in dense Coyote willow stand within Parcel 444 within critical habitat for Southwestern Willow flycatcher (4/04/14).

Disturbances that increase herbaceous and woody production (whether flood, fire, or equipment) are resulting in substantial increases in establishment of both common annual weeds like Kochia, as well as targeted noxious weeds, especially Whitetop. These conditions are creating an ecological dilemma. Increased woody and herbaceous production within the riparian corridor increases "roughness", improving functional conditions of the flood plain in the natural process of trapping sediments and aggrading the banks and increasing channel sinuosity. However, these same conditions make it impractical to apply herbicides because of plant density and cover over the top of noxious weed species. While many examples were observed during the 3 field seasons, two situations clarify this point.

In 2010 and 2011, ADWR and U.S. Fish and Wildlife Service, in conjunction with the Gila Watershed Partnership, funded substantial riparian restoration improvements to assist Parcels 269/270/575 with removal and reshaping the east bank of the Gila River along with removal of non-native woody obligate species (e.g. Salt cedar, Tree of Heaven), and replanting of native woody and herbaceous species. Substantial dozer work was completed, along with pole plantings, and seeding, by the time inventory work was initiated in mid-May 2012. During inventory, substantial but relatively new populations of Whitetop were documented, easily observable in all parcels inventoried, including 575 (Photo 32). Upon returning in the fall, 2012, the amount of growth of annual weeds was almost unmanageable to access these areas (Photo 33). Later herbicide applications to treat these populations conducted in both 2013 and 2014 were significantly hindered by the continued presence and increase of annual weed production.

Photos 32 and 33. Photo left (5/23/12) in Parcel 575, documenting Whitetop infestation in mid-ground. Note lathe stake and disturbance from removal of non-native tree species. Photo right (9/04/12) shows growth of annual weed species at same location.

In March, 2013, a wildfire in standing herbaceous production burned a portion of the riparian corridor of Parcels 6, 7, and 681 and adjacent upland areas just north of the Highway 75 bridge at Duncan, Arizona (Photo 34). As the photo depicts, this had a devastating effect on many riparian overstory trees, removing virtually the entire herbaceous understory, leaving the small narrow green line along the Gila River (far left side of photo). Inventory of this area in mid-April 2013, documented several populations of Whitetop and Russian knapweed, most of which had been impacted by fire (Photos 19, 30). Colonies in the open areas were easily treated with herbicide later in April of 2013, as Photo 19 shows. However, fire only invigorated both Russian knapweed and Whitetop, and the level of annual herbaceous production increased dramatically in the absence of any control, to the point where it was impractical to treat, as the comparison shown in Photo 35 provides.

Photos 34 and 35. Parcels 6/7. Photo on left was a wildfire in March, 2013. Note home in background. Several Russian knapweed and Whitetop colonies were noted and treated with herbicide later in April, 2013 on this site. Right photo 10/23/14. Note annual herbaceous production. Woman in photo is 5'5" in height, Kochia weed behind her is over 6ft. There is a colony of Whitetop to her left that is now inaccessible.

In addition to the issue with increasing herbaceous and woody species that cover or prevents direct access to noxious weeds for herbicide applications, is present management guidelines for reducing potential disturbance to SWWF within this section of the Gila River corridor. It is important to note that the optimum time to treat Russian knapweed is between April 15 and May 15, creating a direct conflict with current direction to avoid nesting birds.

Riparian Vegetation Canopy Cover and Riparian Conditions: Riparian vegetation cover sampling was conducted based on initial guidelines for establishing belt transects in parcels adjacent to or where noxious weed infestations were impacting the riparian flood plain. Though not completely random, mapped infestations and potential impacts influenced the approximate location of belt transects. Transect sets (3) were established at 6 sites in 2012, 12 locations in 2013, and another 11 locations in 2014, totaling 29 over the 3 field seasons (Map 13). As depicted on Map 13, belt transects are scattered throughout the project area. In addition, six (6) photo points were established where riparian vegetation or the flood plain was too narrow to sample. Of all transects established, 18 were located within Critical Habitat for Southwestern Willow flycatcher, and 11 were located outside of the designated habitat area.

Riparian Canopy Cover data was assimilated into a spreadsheet that provides average canopy cover and species composition by cover class and age class . Transects were segregated and data assimilated to reflect conditions within and outside of the SWWF Critical Habitat corridor, and this data was captured on worksheets also included in Appendix E. Because of the

significant range of canopy cover estimates between Parcel transect sets, data from the highest and lowest of each set of transects was removed to provide a data set that would have less variance. Results of this very basic analysis are presented in the following tables.

Table 3. Comparison of average canopy cover and common tree species composition by cover within and outside designated Critical Habitat for Southwestern Willow flycatcher, southern Greenlee County.

Habitat Designation SWWF	Average Canopy Cover Percent	Common Riparian Overstory Tree Species Composition by Canopy Cover				
		Velvet Mesquite	Salt Cedar	Freemont Cottonwood	Gooding Willow	Coyote Willow
Critical Habitat	59.6%	.3%	29.5%	15.8%	8.4%	44.6%
Non-critical	26.1%	20%	29.1%	11.8%	19.2%	10.8%

Table 4. Comparison of size class of common riparian tree species within and outside designated Critical Habitat for Southwestern Willow flycatcher, southern Greenlee County.

Habitat Designation SWWF	Common Riparian Overstory Tree Species Canopy Cover by Size Class* (Percentages)														
	Velvet Mesquite			Salt Cedar			Freemont Cottonwood			Gooding Willow			Coyote Willow		
	S	P	M	S	P	M	S	P	M	S	P	M	S	P	M
Critical Habitat	100	0	0	9.4	28.5	62.1	9.8	10.8	90.8	1.7	28.8	69.5	24.9	41.5	33.5
Non-critical Habitat	8.4	26.8	64.8	40.9	26.7	32.3	7.4	14.3	78.2	7.2	13.5	79.2	50.4	47.1	2.3

***Size class designations: S – Sapling; P – Poles; M – Mature.**

Comparison of canopy cover information clearly shows a distinction between the two riparian areas sampled during the past 3 field seasons. The data indicates a potentially significant statistical difference between average canopy cover between the two segments of the Gila River corridor. Although only 11 sites were sampled in the non-critical habitat portion of the project area, it is important to note that six (6) sites could not be sampled due to lack of adequate riparian corridor (examples Photos 36 and 37). Parcel 420N, depicted in Photo 37, is very close to the north end of designated Critical Habitat for SWWF. Figure 9 is a section of Parcel Sheet 24 that shows a portion of Parcel 420, with the photo point location of Photo 37. The photo point for this parcel was established immediately adjacent to the river bank, looking west, showing very active bank erosion occurring during any bank-full discharge of the Gila River, and no riparian overstory establishment. Note in Figure 9 the two large Freemont cottonwood trees on either side of the photo point location, and also the very large oxbow or meander that has developed by the river. At the time of photo point establishment, the large cottonwood to the south was creating a debris jam in mid-river!

Photos 36 and 37. Left is photo point for Parcel 371 (11/05/14), between Sheldon and north Duncan. Coyote willow thicket in mid-ground of photo is less than 30 feet wide, and occupies a perpendicular bank. Right is photo point for Parcel 420 (11/05/14), north side of Gila River. Note steep eroding bank on photo side, and point bar on opposite side of river.

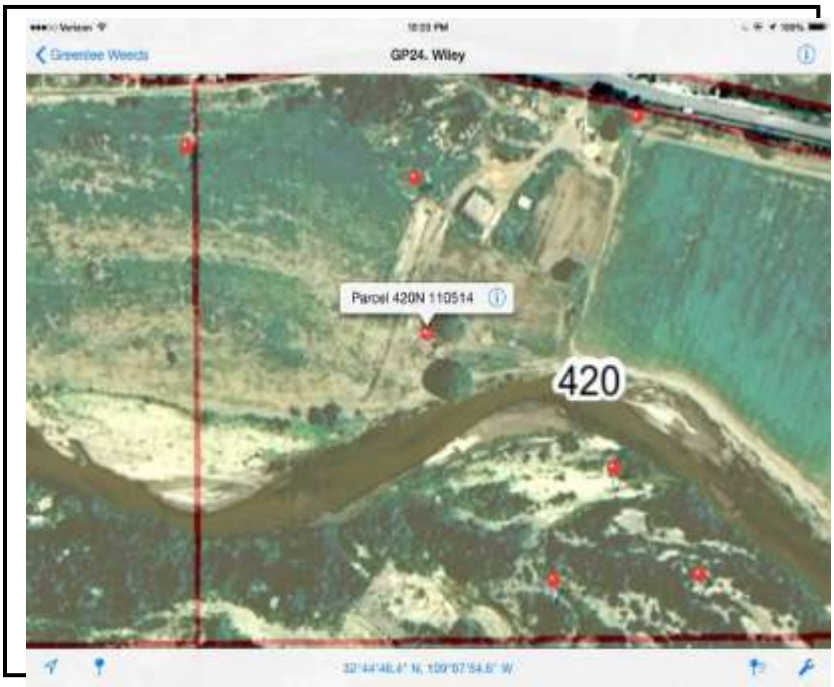

Figure 9. A portion of Parcel Sheet 24 showing part of Parcel 420. Note the photo point location for Parcel 420N. Large cottonwood tree south of the photo point is now in the middle of the river, and photo point is on river bank. Large point bar is filling in with young woody species (salt cedar, Coyote willow), but is infested with Whitetop.

Inventory of this point bar in 2012 revealed the presence of Whitetop along the edge of Parcel 433 (Photo 29), and extensive inventory of the adjacent parcels north (420) and west (425/435) revealed establishment of several new colonies. Canopy cover sampling in 2012 and 2014 showed a dominant presence of Salt cedar and Coyote willow, young age classes of both (Photos 38 and 39).

Photos 38 and 39. Left is photo taken on Transect 1, Parcel 433/434. 9/09/12, showing sapling Salt cedar in foreground, Coyote willow in mid-ground. Right is photo taken at start of Transect 1, Parcel 425/435 10/23/14. In foreground of photo are numerous Salt cedar seedlings, mid-ground pole size Coyote willow and Salt cedar. This area of the large point bar shown in Figure 9 was inundated by bank full flows in August 2013, and several flows in August-September, 2014. This point bar is infested with Whitetop.

From this point north, the occurrence of Whitetop is consistent with back water eddy deposition from flooding in 2013. Inventory indicated that these colonies were small and numerous.

Unfortunately, the opposite situation exists upstream (to the south) of Photo point 420N. Riverine functioning conditions are improving dramatically with expansion and development of extensive stands of Coyote willow, as depicted in Tables 3 and 4. Coyote willow comprises about 45% of the total composition of riparian cover species in this portion of the project area, followed by Salt cedar at 29%. More importantly, as documented by both observations and canopy sampling, Coyote willow is represented strongly by younger age classes (over 65% sapling and poles), indicating a strong upward trend in riparian cover condition characteristic of a riverine system healing through aggradation (Photos 40 and 41). Deposition of finer materials among dense stands of willows is contributing to the establishment of Whitetop, with little to no expansion of Russian knapweed noted within the river flood plain in this section of the river corridor.

Photos 40 and 41. Left is taken at the start of Transect 3, Parcel 681. 10/04/13. Photo looks north. Note the large amount of deposition on this long silt bar, and the encroachment of Coyote willow saplings on the older right bank. Aggradation here is at least 18" in depth. Right is taken at the start of Transect 1, Parcel 430/446. 11/07/14. Note the age class of Coyote willow in the foreground, and mid-ground. This area also shows substantial deposition of fines from bank full flooding in the early fall, 2014.

In the first season of inventory and sampling, efforts were made to characterize areas along the green line or wetted zone of the Gila River. It soon became apparent during inventory in 2013 that conditions in the wetted riparian zone adjacent to Parcels 270 and 575 (Photos 42 and 43) were not similar to that observed and sampled from the location of Photo point 420N. A large portion of this segment of the project area has an incised channel that does not flood beyond bank-full with relatively normal discharge.

Photos 42 and 43. Left is riparian corridor adjacent to Parcels 575/270, near Apache Grove 5/23/12, compared with the lack of woody and green line vegetation in the Right photo, Parcel 353. 11/05/14. Bank vegetation in this photo is Johnson grass and Kochia weed, with Velvet mesquite a distant

There appears a change in soils and parent material substrate from the point of 420N, but whether this has influenced changes in riparian conditions, or change in gradient is unknown. Canopy sampling does show that all the common riparian tree species are present, but in varying percentages of dominance. With the exception of riparian sampling conducted at River Parcel 260 (which was removed from the data set), mature Salt Cedar and Velvet mesquite dominate overstory cover, followed closely with mature Gooding willow. At the end of the inventory season, Whitetop and Russian knapweed had been documented within this segment of the Gila River corridor, but colonies were not well established.

8. MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

General:

Noxious weed management in Greenlee County requires consistent and constant vigilance to maintain energy and attention for an effective program. The program transcends more than just the riverine corridor at this point. Management of uplands, whether farmlands or rangelands, is influencing long-term conditions within the riparian corridor. Consistency in integrating more than a herbicide application program with a more holistic approach is needed where various control practices are supported by expertise and grant funding concurrently. A part time position is warranted for the basic tasks of noxious weed inventory, mapping, and treatment covered in the Gila River Corridor Noxious Weed Control program, not considering effective outreach and communication along with long-term planning and execution of an integrated program.

Outreach and Contacts:

- While the University of Arizona Cooperative Extension and Coronado RC&D do a quality job in promoting basic education and information sharing about noxious weed identification and management, there is a need to maintain a continual one-on-one relationship between an on-ground person and an integrated program.

- Leadership at a local or county level is needed with regards to involvement of community (Town of Duncan, Clifton, Morenci) and agency (County, State, BLM and Forest Service) to ensure that integrated management is effective.

- Access for inventory and mapping requires a significant amount of time, and should be accomplished well in advance of the primary field season if possible.

Noxious Weed Management:

- Several cooperators are involved in the eradication or control program for targeted noxious weeds using a variety of practices. While some cooperators have aggressively embraced the program, there exist large blocks of lands owned by separate individuals

that have little ongoing effort to manage noxious weeds. Most if not all of these parcels are infested with noxious weed species of concern. Many of these parcels are within the Gila River floodplain riparian corridor.

- The level of involvement with cooperators and local/county/state governments warrants a part time Greenlee County Noxious Weed position, similar to that funded in Grant County, who is a certified herbicide applicator and will operate separately from primary grant funded inventory/mapping programs.

- The magnitude and potential of the noxious weed infestation expansion, especially Whitetop, was accomplished for Greenlee County Supervisors in November, 2014. This information and education effort should occur for Graham county, as well as key organizations like Gila Valley Irrigation District, Franklin Irrigation District, and Freeport McMoran Inc.

- Given the occupancy of hundreds of acres within a protected riparian corridor, and location and aggressive expansion of Whitetop infestations (under riparian overstory canopy), neither hand nor aerial spraying is environmentally or economically feasible at this time for much of the infested acreages. New populations can be aggressively controlled with direct applications but existing infestations will be difficult if not impossible to control. Containment appears to be the most effective option.

- Integrated pest management options should be explored for the entire Duncan/Franklin/Sheldon/Apache Grove corridors, including prescribed and closely managed grazing programs to reduce the spread and vigor of Whitetop, and to a lesser extend Russian knapweed. A paradigm shift for the stabilization and re-vegetation of fallow or abandoned farmlands within the Duncan valley corridor should be considered and developed where abandoned farms are replanted into native grasslands, and included into productive but proactive grazing programs to reduce weed infestations including noxious weeds.

- Other program support for integrated pest management and noxious weed control should be pursued through various opportunities to assist cooperators who want to pursue integrated pest management options (grazing, mowing, and wildlife enhancement projects) for the control of targeted noxious weeds.

- Expand non-riparian related funding sources for a holistic approach for weed management. Example: Town of Duncan and Duncan Schools (County level) need to aggressively address the 6 acre parcel infected with Russian knapweed in the center of the town. There are substantial opportunities to involve the FFA and local community in

integrated management of this noxious weed species, while demonstrating sound, sustainable agricultural practices that can apply to many adjacent farm and fallow lands in the valley.

- Containment of Whitetop and Russian knapweed will require establishment of a clearly defined line for aggressive control of noxious weeds expanding or potentially leaving Greenlee County. Inventory early in 2014 revealed that neither Whitetop nor Russian knapweed had moved into the York Valley area, though getting close at Apache Grove. Although natural barriers to movement may exist in the closed or box canyon area just north of Apache Grove, before entering York, it is likely that small populations may have been established following bank-full flooding in fall, 2014. It is recommended that the area in York and north should be designated as a "weed free" zone and receive focused inventory and control activities.

Riparian Corridor Conditions:

- Collecting data related to riparian corridor conditions using the developed methods for the Gila River Noxious Weed Control project was time consuming both in field work and data assimilation.

- A revised methodology is needed to address the specific concern about issues related directly to establishment, occupancy, and more importantly options for noxious weed control and/or management with the flood plain riparian corridor. At face value, the actual occupancy of riparian wetlands by Whitetop, for example, does not seem to be affecting the ability or functionality of the riparian ecosystem. The potential for completion with other riparian obligate herbaceous species is of primary concern, but the occupancy of other non-listed weed species like Kochia or Tumbleweed are a significant concern related to increasing the risk of wildfire.

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APPENDIX A

Coronado Resource Conservation & Development Area, Inc.

450 S. Haskell Ave., Willcox, AZ 85643

AGREEMENT TO PROVIDE ACCESS

Purpose of Agreement: The Coronado Resource Conservation & Development Area, Inc (RC&D) and the University of Arizona Cooperative Extension, Greenlee County have received grant funding from the Arizona Water Protection Fund for the purpose of controlling invasive weeds in the Gila River and its riparian areas and adjacent flood plains through Greenlee County.

For the purpose of identifying and mapping invasive weeds in the targeted area:

Under this agreement, I _____ with the authority to represent _____, grant access to consultants and/or employees if the Coronado RC&D for the purpose of conducting an on the ground survey and mapping of the type and extent of invasive weeds on the river, riparian area and flood plains on my property.

The treatment of any invasive weeds found on my property will be dealt with under a separate access agreement that is in compliance with the funder's requirements and in accordance with a voluntary plan developed by myself with the technical assistance from the U of A Cooperative Extension and or the Natural Resources Conservation Service.

Any access in addition to that outlined in the contract will be discussed on a case by case basis and granted upon discretion of the landowner/manager.

_____

Landowner/Manager Date Phone number

PLEASE DROP OFF AT: OR MAIL TO:

Greenlee U of A Extension Office
1684 fairgrounds Rd.
Duncan, AZ
520.259.2261

Coronado RC&D
450 S. Haskell Ave.
Willcox, AZ 85643
520.766.3607

APPENDIX B

Noxious/Invasive Weed Inventory Form

Name: _____ Date: _____

General Location: _____

UTM/Long/Lat: _____

Species treated

□ Russian Knapweed □ Malta Starthistle □ Whitetop

□ Yellow Starthistle □ Onionweed □ Other _____

Property ownership or responsibility (check all that apply)

□ Private □ County □ BLM

□ ADOT □ State □ USFS

□ Other: _____

Land type (check all that apply)

□ Rangeland

□ Cropland (current crop: _____)

□ Abandoned Cropland

□ Roadways

□ River or Stream Bottom

□ Residential

□ City or Town

□ Other: _____

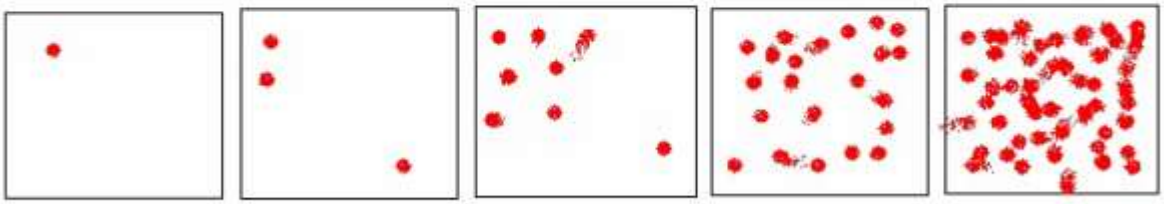
Number of acres inventoried: _____

Number of acres infested: _____

Dominance Rating General Descriptions (circle one)

Dominance Rating	Definition
1	It can be found by searching in and around other species. A dominance of "1" is not obvious.
2	It can be seen only by moving through the vegetation or by searching for it while standing in one place. A patchy pattern observed by moving through the vegetation rates a dominance of "2".
3	It is easily seen by standing in one place and glancing around, but it is not an obvious dominant. In a mixed stand, several species may fall into this category.
4	It is at least co-dominant. It shares dominance relative to cover or is considered slightly subordinate to other species, native or introduced; for example: Russian knapweed in a rangeland community or a mixture of weeds on abandoned farmland.
5	It dominates the site. It is dominant in the sense that it provides essentially total cover when viewed casually.

Rough Sketches of Dominance Categories



1 = plant 2 = few 3 = easily seen 4 = >50% cover 5 = >90% cover

Please attach photos or email them to kimm@cals.arizona.edu.

Drop this form off at your local Cooperative Extension office or mail to:

Kim McReynolds
Cochise County Cooperative Extension
450 S Haskell Ave
Willcox, AZ 85643

Noxious/Invasive Weed
Treatment Form

Name: _____

Location: _____

UTM/Long/Lat: _____

Species treated

9 Russian Knapweed 9 Malta Starthistle 9 Whitetop
9 Yellow Starthistle 9 Onionweed 9 Other _____

Treatment Date: _____ Number of acres treated: _____

Treatment Used (describe): _____

_____

_____

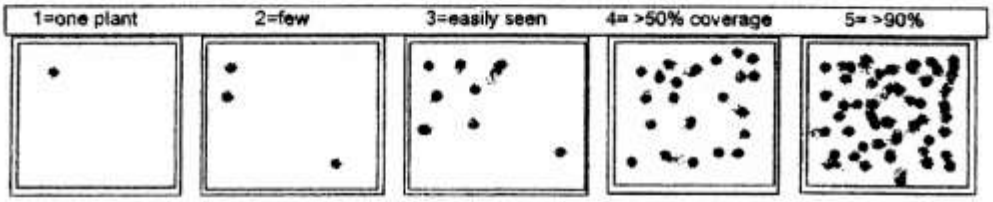
Noxious/Invasive Weed
Monitoring Form

Name: _____ Date: _____

Dominance Rating General Descriptions (circle one)

Dominance Rating	Definition
1	It can be found by searching in and around other species. A dominance of "1" is not obvious.
2	It can be seen only by moving through the vegetation or by searching for it while standing in one place. A patchy pattern observed by moving through the vegetation rates a dominance of "2".
3	It is easily seen by standing in one place and glancing around, but it is not an obvious dominant. In a mixed stand, several species may fall into this category.
4	It is at least co-dominant. It shares dominance relative to cover or is considered slightly subordinate to other species, native or introduced; for example: Russian knapweed in a rangeland community or a mixture of weeds on abandoned farmland.
5	It dominates the site. It is dominant in the sense that it provides essentially total cover when viewed casually.

Rough Sketches of Dominance Categories



Pleas attach photos or email them to kimm@cals.arizona.edu.

Drop this form off at your local Cooperative Extension office or mail to:

Kim McReynolds
Cochise County Cooperative Extension
450 S Haskell Ave
Willcox, AZ 85643

APPENDIX C.

STATE HISTORIC PRESERVATION OFFICE
REVIEW FORM

The State Historic Preservation Office (SHPO) must review each grant application recommended for funding in order to determine the effect, if any, a proposed project may have on archaeological or cultural resources. To assist the SHPO in this review, the applicant is required to submit the following information with each application for funding assistance:

1. A completed copy of this form, and
2. Any 7.5' USGS maps relative to this project are REQUIRED, and
3. A copy of the cultural resources survey report if a survey of the property has been conducted, and
4. A copy of any comments of the land managing agency/landowner (i.e., state, federal, county, municipal) on potential impacts of the project on historic properties. NOTE: If a federal agency is involved, the agency must consult with SHPO pursuant to the National Historic Preservation Act (NHPA); a state agency must consult with SHPO pursuant to the State Historic Preservation Act (SHPA), OR
5. A copy of SHPO comments if the survey report has already been reviewed by SHPO.

Grant Program: 11-173WPF Project Title: Gila River Corridor Invasive Weed Control

Applicant Name and Address: _____

_____

Current Land Owner/Manager(s): _____

Project Location -- including Township, Range and Section: _____

_____

Please answer the following:

1. Total project area in acres (or total miles if trail): _____

2. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground? _____YES _____ NO
3. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected. Attach extra sheets if more space is needed.

_____

4. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Attach extra sheets if more space is needed. Attach photos of project area to document condition.

_____

_____

5. **Are there any known prehistoric and/or historic archaeological sites in or near the project area?** **_____YES** **_____NO**

6. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? _____YES _____NO _____UNKNOWN

If yes, please submit a copy of the survey report. Please attach any comments on the survey report made by the land managing agency and/or SHPO.

7. Are there any buildings or structures (including mines, bridges, dams, canals, etc.) which ar 50 years or older in or adjacent to the project area? _____YES _____NO

If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form, and submit it with your application.

8. Is your project area within or near a historic district? _____YES _____NO
   If YES, name of district _____
   Please sign on the line below certifying all information provided for this application I accurate, to the best of your knowledge.

_____ _____

Applicant Signature /Date Applicant Printed Name

Phone Number _____

APPENDIX D

PARCEL 458 West_ DATE 100713_
RIPARIAN TREE CANOPY DATA SUMMARY

SPECIES	SAPLINGS	POLES	MATURE	TOTAL PERCENT	RELATIVE CANOPY COVER*
Velvet Mesquite ***Prosopis velutina***					
Seep Willow ***Bacharis salicifolia***					
Salt Cedar ***Tamarix ramosissima***	**2.0**	**7.1**	**17.3**	**26.3**	**16.3**
Freemont Cottonwood ***Populus freemontii***	**-**	**-**	**8.9**	**8.9**	**5.5**
Gooding Willow ***Salix goodingii***		**5.9**		**5.9**	**3.7**
Coyote Willow ***Salix exigua***	**1.5**	**48.3**	**7.7**	**58.8**	**36.5**
Osage orange ***Maclura porifera***					
Netleat hackberry ***Celtis reticulate***					
Tree of Heavan ***Ailanthus altissima***					
Pale wolfberry ***Lycium pallidum***					
				100	**62.1%**
Noxious Weeds Present	Russian knapweed along fence at T1, but not in riparian corridor. Not Treated in 2013.				

***Relative canopy cover by species is calculated by summing total canopy cover (with 87% being highest average possible), for each set of Transects. Objective is to provide a comparison figure for amount of tree density across the area sampled.**

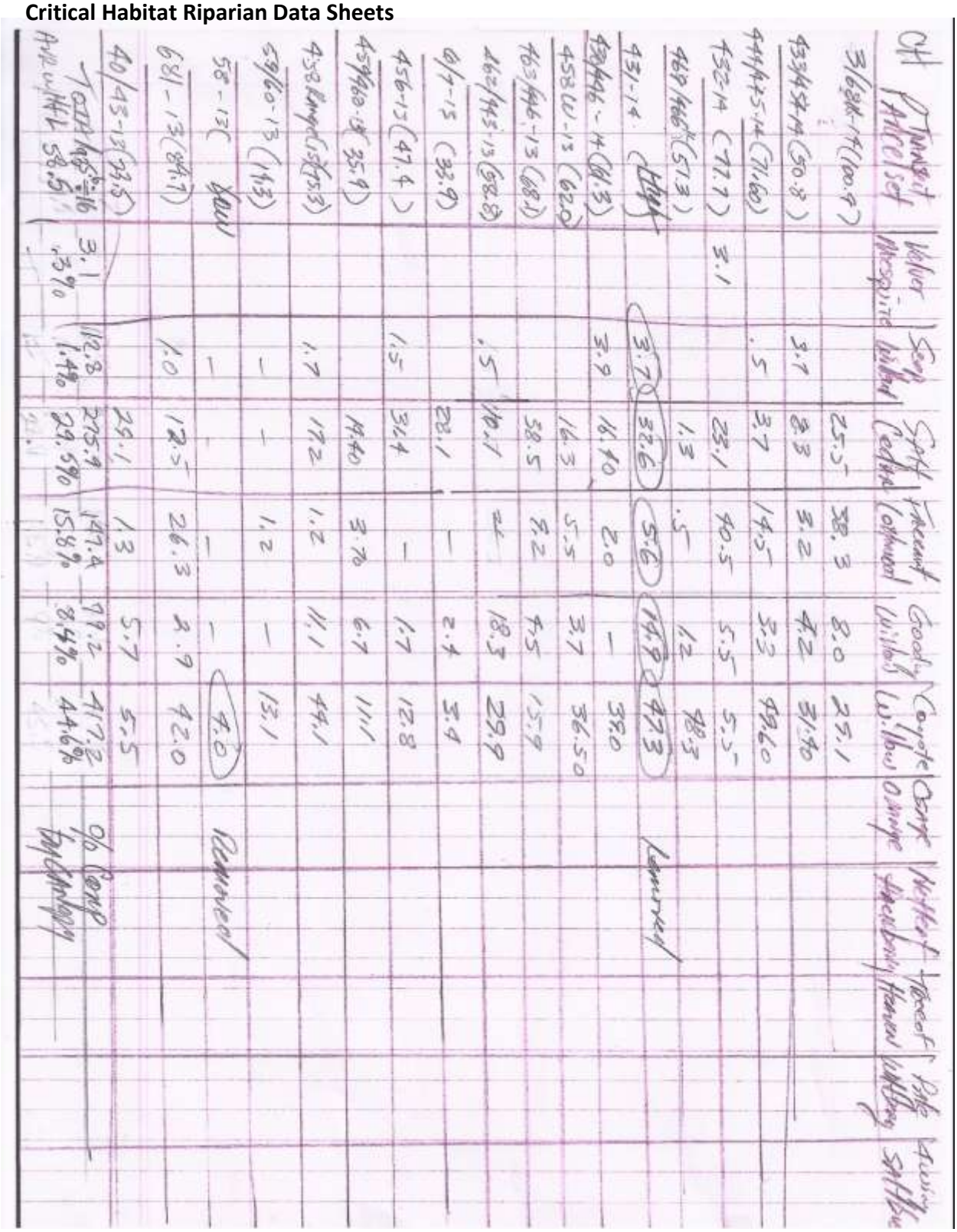
RIPARIAN TREE CANOPY FIELD DATA SUMMARY
SOUTHERN GREENLEE COUNTY NOXIOUS WEEDS INVENTORY

PARCEL NO.458 West_ PARCEL SHEET 26__ INVASIVE SPECIES OF CONCERN: Russian knapweed DATE DATA COLLECTED 100713_ GPS COORDINATES : T1- Zone 12 677399E, 3623304N; T2- 677390E, 3623271N; T3- 677291E, 3623261N. Lat/Long T1- 32°43'59.8" / 109°06'24.5"

SPECIES		T- 1	T-2	T-3	SUMMARY	PERCENT	RELATIVE % CANOPY COVER
Prgl	Saps	-	-	-	-		
	Poles		-	-			
	Mature	-	-	-	-		
Basa	Saps						
	Poles						
	Mature						
Tasa	Saps		38		38	2.0	1.2
	Poles		62	76	138	7.1	4.4
	Mature		162	174	336	17.3	10.7
			262	250	512	26.3	16.3
Pofr	Saps						
	Poles						
	Mature	87	-	87	174	8.9	5.5
		87		87	174	8.9	5.5
Sago	Saps						
	Poles			115	115	5.9	3.7
	Mature						
				115	115	5.9	3.7
Saex	Saps	15	15	-	30	1.5	1.0
	Poles	164	660	140	940	48.3	30.0
	Mature	87	-	62	149	7.7	4.8
		266	675	202	1143	58.8	36.5
	Saps						
	Poles						
	Mature						
		353	937	654	1944	100	62.1
Relative Canopy %							
12 Observations per Transect @ 87% Maximum cover = 1044 per Transect X 3 = 3132 Div.							
Noxious Weeds Present		T1	T2	T3	Russian knapweed against fence at start of T1 but not observed in remainder of transect. Not treated in 2013.		
		Yes	No	No			

APPENDIX E

Critical Habitat Riparian Data Sheets



CH

Transect Parcel/Set	Velvet Mes. Saps	Poles	M	SatCedar Saps	Poles	M	Primary Species: Cottonwood Saps	Poles	M	Goodding Willow Saps	Poles	M	Coyote Willow Saps	Poles	M
3/681-14				.5	.9	23.9	0	0	38.0	0	0	7.9	1.8	15.7	11.2
437/454-14				3.5	12.8	.0	0	0	6.2	0	0	8.3	53.0	8.7	0
444/445-14				0	.7	4.5	0	0	20.2	0	0	4.6	8.5	34.2	69.2
432-14	4.0	0	0	.1	0	29.5	0	0	52.0	0	0	7.1	0	0	7.1
469/466-14				0	.2	2.4	0	.9	0	0	2.4	0	33.8	54.5	5.7
430/446-14				5.2	15.9	5.6	0	0	3.2				18.3	39.3	6.1
458(W)-13				2.0	7.1	17.3	0	0	8.9	0	5.9	0	1.5	48.3	7.7
463/446-13				0	9.6	43.5	0	.8	13.8	0	0	7.1	3.4	21.7	0
462/445-13				2.4	4.5	10.2		–		0	1.0	30.4	13.8	8.9	28.0
6/7-13				21.1	39.2	27.5				0	3.6	3.5	2.8	3.6	3.6
456-13				.8	18.1	53.7		–		2.1	0	.8	8.1	55	8.1
459/460-13				4.7	0	35.4	10.4	0	0	0	18.7	0	27.9	3.3	0
458/Range-B				0	8.0	14.8	0	1.6	0	0	0	14.8	7.5	28.8	22.3
59/60-13							0	0	8.4				0	32.9	52.6
681-13				1.1	8.9	5.8	6.8	15.6	8.5	0	3.4	0	14.6	26.9	6.1
40/43-13				0	0	.1	0	0	48.5		–		7.2	0	44.3
TOTAL	4.0			41.4	125.9	294.2	17.2	18.9	159.2	2.1	55.0	84.5	201.7	337.3	272
		4.0			441.5			195.3			121.6			811	
Age Class % by CANOPY	100%			9.4	28.5	62.1	9.8	10.8	90.8	1.7	28.8	69.5	24.9	41.5	33.5

Non Critical Habitat Riparian Data Sheets

NCH Percent Comp. by Size Class

PRIMARY SPECIES:

Transect Parcel/Set	Velvet Mes. Saps	Poles	M	Salt Cedar Saps	Poles	M	Fremont Cottonwood Saps	Poles	M	Gooding Willow Saps	Poles	M	Coyote Willow Saps	Poles	M
433/434-12				41.1	28.8	0	0	3.1	0	1.0	2.9	10.7	0	13.0	0
270-12	.3	0	0	5.4	0	0	1.7	0	43.3	0	.7	41.5	0	0	1.7
575-12				16.5	0	0				10.1	0	44.4			
287-12	7.1	11.4	0				0	0	10.0	0	6.4	59.80			
308-13	0	0	27.2				6.5	0	0	3.2	16.7	0	23.0	3.2	0
408-14				14.7	10.4	68.5							4.2	2.1	0
4255-14				9.0	17.4	0	0	6.9	24.9				13.7	21.2	1.9
353/355-14							0	6.1	0				35.0	31.3	0
252-12	2.5	20.2	49.2				.2	0	10.5						
Total	9.9	31.6	76.4	86.7	56.6	68.5	8.4	16.1	88.2	14.3	26.7	156.4	75.9	70.8	3.6
		117.9			211.8			112.7			197.4			150.3	
Age class % by canopy	8.4	26.8	64.8	40.9	26.7	32.3	7.4	14.3	78.2	7.2	13.5	79.2	50.4	47.1	2.3

NCH Transect Parcel set	Velvet Mesquite	Seep Willow	Spiny Cedar	Fremont Cottonwood	Goodding Willow	Coyote Willow	Osage Orange	Netleaf Hackberry	Tree of Heaven	Pale Wolfberry	Arizona Saltbush
433/434-12			29.1	1.3	5.7	5.5					
270-12		45	1.5	12.8	12.0	.04				.1	
575-12		1.2	1.9	—	6.0		2.2				
287-12	5.0	.90	2.7	—	18.4					0.4	
252-12	38.0	9.1	—	5.5							
260-12 High	.4	21.8	13.9	19.3	30.3	10.5					
308-13	4.0	2.9	1.0	—	2.9	3.9					
425/409-14 Low	—	—	.04	—	—	1.5					
408-14	—	—	25.7	—	—	1.7					
455 14	—	—	6.4	7.6	—	9.0					1.4
353/355-14 (7.9)		2.2	—	.5	—	5.2					
234.9 Total ÷ 9	47 (47.4)	17.8 (39.6)	68.3 (22.2)	27.7 (41.0)	95.0 (75.3)	25.3 (37.3)	2.2			.04	1.4
Ave. w/o 4th											
Ave. w/o 4th out 26.1%											
% By Canopy All											
% by Canopy 4th Comp.	2.0%	7.6%	29.1%	11.8%	19.2%	10.8%	.9%			T	.5%

RIPARIAN CANOPY COVER DATA

Parcels Average Canopy Cover by Year Established

Year Established	Parcel(s)	Habitat Designation – Average Canopy Cover Southwestern Willow Flycatcher	
		CH – Critical Habitat	NCH – Non Critical Habitat
2012	433/434		41.6
	270		27.8
	575		11.3
	287		27.4
	252		52.6
	260River		96.2*
2013	458 West	62.0	
	446/463	68.1	
	443/462	56.8	
	681	84.7	
	6/7	33.9	
	456	47.4	
	459/460	35.9	
	458 Range	75.3	
	59/60	14.3	
	58	4.0*	
	40/43	23.5	
	308		14.7
	444	Photo Point only	
	314		Photo Point only
2014	425N/409		1.5*
	408		27.4
	425/435S		24.4
	353/355		7.9
	432	77.7	
	3/681	100.9	
	443/454	50.8	
	444/445	71.6	
	469/466/467	51.3	
	431	104.1*	
	430/445/446	99.9	
	420		Photo Point only
	371		Photo Point only
	381		Photo Point only
	382		Photo Point only
TOTALS		59.6% Avgerage Canopy Cover	26.1% Average Canopy Cover

Riparian Worksheet

Parcels with Riparian Canopy Sampling - 56	
Average Canopy Cover per Parcel -	
Row 15 Sum F+K+P ALL SHEETS / 56	
	24.26
Average Canopy cover by Species	
By each species row Sum F+K+P ALL sheeets	
/ 56	
Average Canopy cover by Size Class	
Saps	**12.54**
Poles	**16.59**
Mature	**23.61**

	Totals
Velvet Mesquite	122.40
Seep Willow	131.2
Salt Cedar	734.21
Freemont Cottonwood	365.6
Gooding Willow	364.01
Coyote Willow	1055.5
Osage Orange	18.9
Netleaf Hackberry	
Tree of Heaven	
Pale wolfberry	1.7
Four Wing Saltbush	

	Totals /56
Velvet Mesquite	2.19
Seep Willow	2.34
Salt Cedar	13.11
Freemont Cottonwood	6.53
Gooding Willow	6.50
Coyote Willow	18.85
Osage Orange	0.34
Netleaf Hackberry	0.00
Tree of Heaven	0.00
Pale wolfberry	0.03
Four Wing Saltbush	0.00
	0.00

	Canopy		**Saps**	**Poles**	**Mature**
	53.34		136.7	62.9	100.1
	223.3		68	72.1	158.6
	136.9		88.4	101.5	109.9
	227.4		41.1	161.4	96.2
	211.6		44.2	101.3	153.4
	96		74.1	103.9	126.5
	125.5		50	99.3	148.3
	69.1		77.6	119.8	103.51
	66.54		60.5	68.6	225.3
	148.8		61.5	38.3	100.1
Total	**1358.48**	Totals	**702.1**	**929.1**	**1321.91**