Monitoring Riparian Birds at Ouray National Wildlife Refuge: 2013 Field Season Report

January 2014

Stewardship
Rocky Mountain
Bird Observatory
Education
Science

ROCKY MOUNTAIN BIRD OBSERVATORY

***Mission**: To conserve birds and their habitats*

***Vision**: Native bird populations are sustained in healthy ecosystems*

***Core Values**: (Our goals for achieving our mission)*

1. ***Science** provides the foundation for effective bird conservation.*
2. ***Education** is critical to the success of bird conservation.*
3. ***Stewardship** of birds and their habitats is a shared responsibility.*

RMBO accomplishes its mission by:

***Partnering** with state and federal natural resource agencies, private landowners, schools, and other nonprofits for conservation.*
***Studying** bird responses to habitat conditions, ecological processes, and management actions to provide scientific information that guides bird conservation efforts.*
***Monitoring** long-term trends in bird populations for our region.*
***Providing** active, experiential, education programs that create an awareness and appreciation for birds.*
***Sharing** the latest information in land management and bird conservation practices.*
***Developing** voluntary, working partnerships with landowners to engage them in conservation.*
***Working** across political and jurisdictional boundaries including, counties, states, regions, and national boundaries. Our conservation work emphasizes the Western United States, including the Great Plains, as well as Latin America.*
***Creating** informed publics and building consensus for bird conservation needs.*

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EXECUTIVE SUMMARY

In 2013, Rocky Mountain Bird Observatory in cooperation with the U.S. Fish and Wildlife Service implemented the fifth year of a project designed to monitor riparian bird populations at Ouray National Wildlife Refuge in eastern Utah. In total, 162 point counts were conducted at four transects along the Green River at Ouray National Wildlife Refuge in 2013. All four transects were surveyed three times during the course of the season between 26 May and 27 June, 2013.

ACKNOWLEDGEMENTS

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INTRODUCTION

Riparian habitat represents a small percentage of the landscape in the western United States, but this habitat is extremely important to wildlife in general, and birds in particular (Taylor 1986). One recent publication compiling information about riparian areas in the western U.S. lists several threats to riparian habitat: dams, pollution (point and nonpoint), grazing, land use change, timber harvesting, water diversion, road construction, recreation, mining, groundwater pumping, invasive species, climate change, salinity, fire, insect and diseases, woody encroachment, watershed degradation, elimination of native vegetation, beavers, fire suppression, and fuel management (Poff et al. 2011). Exotic tree and shrub species have caused dramatic changes to riparian areas in the western U.S. Tamarisk (*Tamarix* sp.), a plant species intentionally introduced into western riparian areas to control erosion, has spread rapidly and displaced native species (Glenn and Nagler 2005). Biologists have studied the relationship between birds and invasion of tamarisk in riparian ecosystems of the Lower Colorado River Basin for several decades (e.g., Anderson et al. 1977). In the Lower Colorado River Basin, use or avoidance of tamarisk by birds varied among avian species, river systems, and resident status (Hunter et al. 1988, Ellis 1995, Sogge et al. 2008, Van Riper et al. 2008). Avian species abundance in some areas peaked at intermediate levels of tamarisk cover (Van Riper et al. 2008). No insect species native to the U.S. forages on tamarisk. Other non-native plants, such as Russian olive (*Elaeagnus angustifolia*)**,** Siberian elm (*Ulmus pumila*), and several species of knapweed (*Centaurea* sp) have also invaded western riparian areas.

Because invasion of non-native species has negatively impacted stream flow, stream sedimentation, soil salinity, fire regimes, livestock forage, and regeneration of native vegetation, various methods have been employed to remove tamarisk and other non-native plant species from riparian areas (Tamarisk Coalition, unpublished). These methods include mechanical removal, chemical treatment and, more recently, biological control. In 2001, the non-native tamarisk leaf beetle (*Diorhabda* sp) *w*as released in the Upper Colorado River Basin in an effort to control tamarisk. It is currently believed that the beetle eats only tamarisk leaves throughout its life cycle.

In contrast to the Lower Colorado River basin, little research has looked at bird/tamarisk relationships in the Upper Colorado River Basin. Furthermore, no published studies have investigated the effects of biological control of tamarisk on birds. Rocky Mountain Bird Observatory (RMBO), in cooperation with The Tamarisk Coalition, initiated a study in 2009 to evaluate the effects on birds of tamarisk defoliation by tamarisk leaf beetles in riparian habitat. Our primary objective was to estimate densities of bird species and bird species richness as a function of tamarisk cover and defoliation of tamarisk. This project has continued with varying amounts of survey effort each year since the first year.

METHODS

Study Area and Site Selection

All surveys conducted in 2013 were at the Ouray National Wildlife Refuge (Figure 1). The area surveyed consisted of three transects in riparian habitat along the Green River at locations originally chosen for surveys in 2009 and one transect formerly conducted by the Utah Division of Wildlife Resources (UDWR). 2013 was the first year the UDWR transect was surveyed by RMBO.

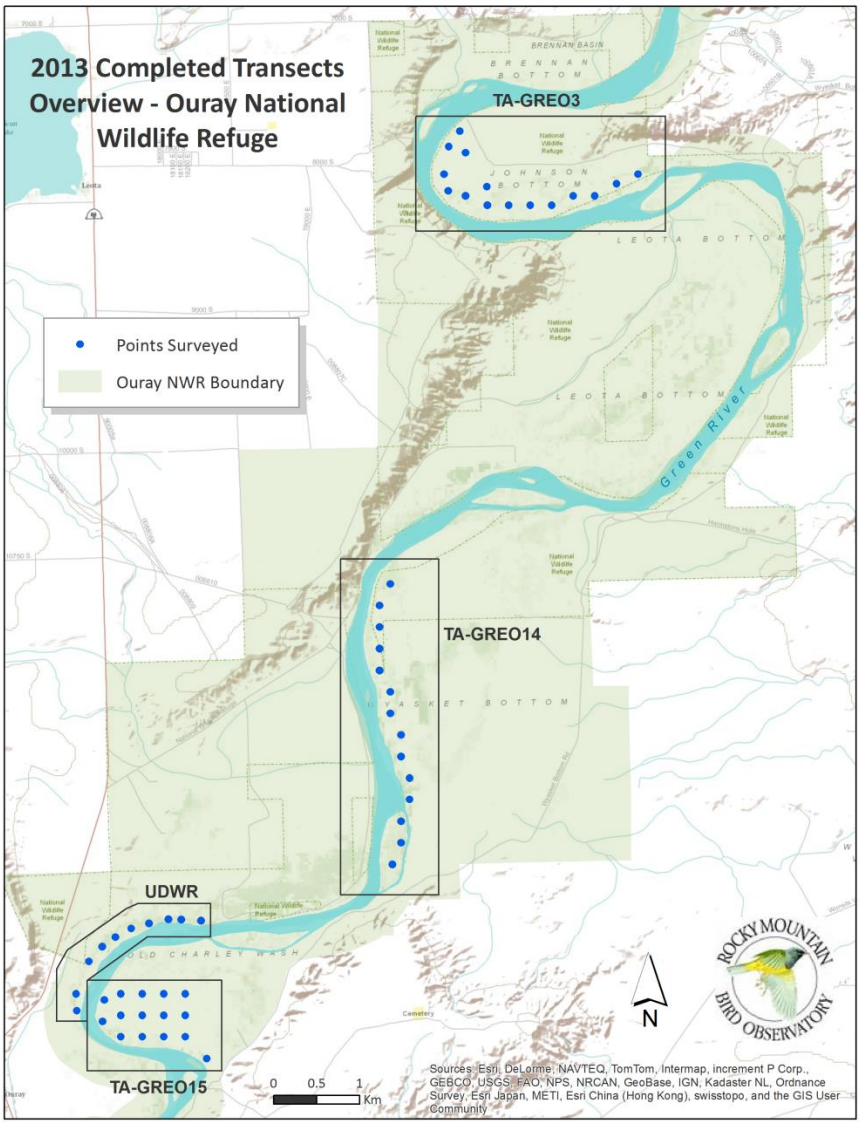

Figure 1. Point-count transect locations at Ouray National Wildlife Refuge, 2013.

We used ArcMap (ESRI 2005) and Google Earth (Google, Inc. 2009) software, and a digital map of vegetation cover from the Southwest Regional Gap Analysis Project (SWREGAP; Lowry et al. 2005) to characterize the study area. Land cover types we used were Invasive Southwest Riparian Woodland and Shrubland, and Rocky Mountain Lower Montane Riparian Woodland and Shrubland (Ecological System codes D04 and S093, respectively; Lowry et al. 2005). We defined our sampling unit as a 5-km^2 block. We originally selected 44 sampling units by the following process:

1. Using ArcMap, overlaid a 5-km^2 grid on the Utah and Colorado portion of the Upper Colorado River Basin.
2. Retained only grid cells that contained at least 3.5 km of the Colorado River and/or one of its major tributaries.
3. Overlaid digital maps of native and invasive woody riparian vegetation from SWREGAP.
4. Retained only grid cells than contained native and/or invasive woody riparian vegetation.
5. Categorized each grid cell with respect to whether it was inside or outside of the range of the tamarisk leaf beetle in 2008.
6. Randomly selected cells within and outside of the beetle range.
7. Overlaid a grid of potential sampling points (250 m spacing) within each grid cell.
8. Overlaid randomly selected cells and their associated points on satellite imagery in Google Earth.
9. Rejected any cell that contained < 8 points in woody riparian vegetation.
10. Rejected any cell that was inaccessible by automobile and foot.
11. For retained cells, rejected sampling points not occurring in woody riparian vegetation, or, sometimes, moved sampling points < 150 m to place them in riparian vegetation.
12. Selected the most contiguous 8-16 points within each cell for sampling.

Locations for three of the transects, TA-GREO3, TA-GREO14, and TA-GREO15, were selected using these guidelines and the TA-UDWR-1 transect has historically been conducted by the Utah Division of Wildlife Resources and was included with the RMBO surveys in 2013.

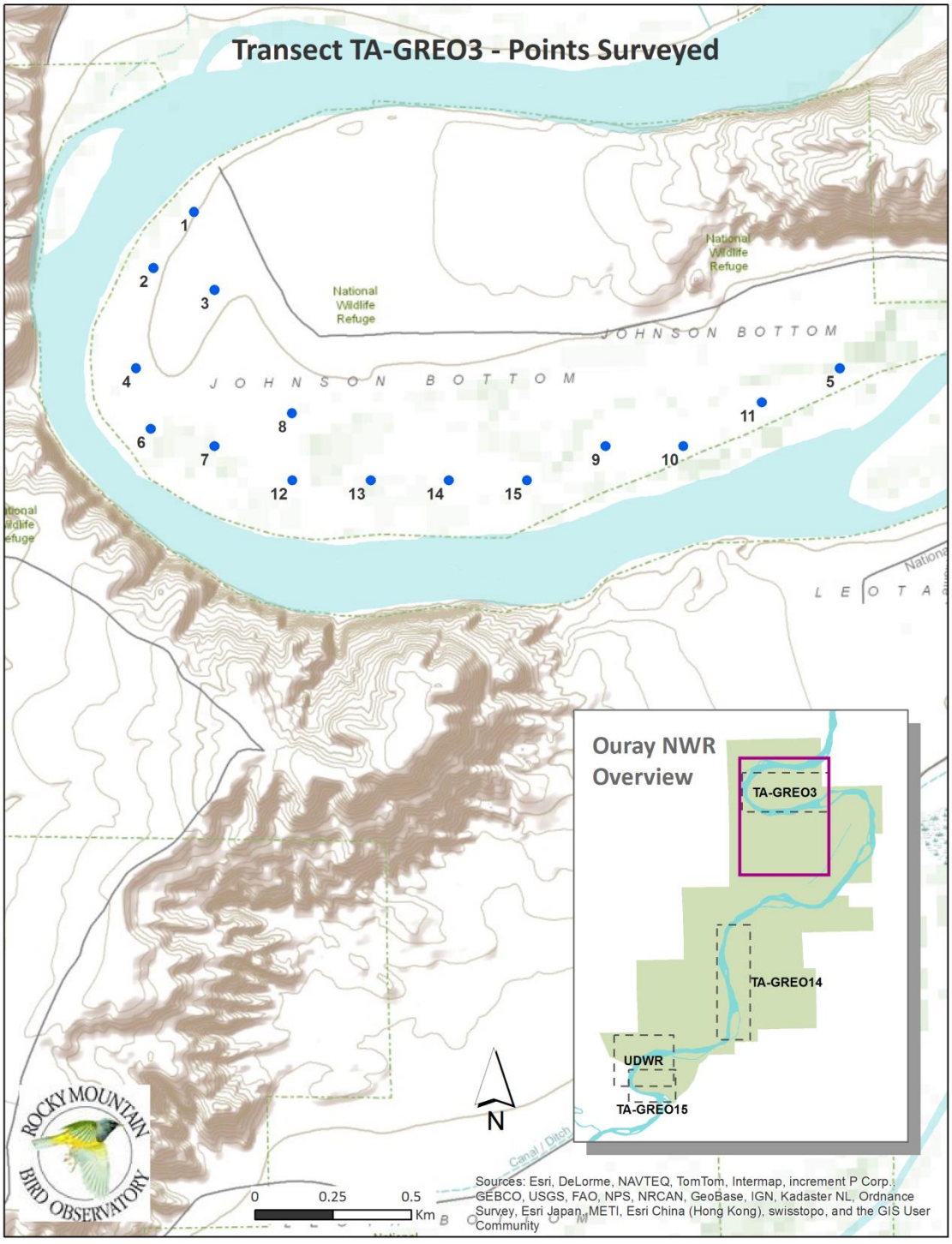

Figure 2. Transect TA-GREO3 point locations at Ouray National Wildlife Refuge.

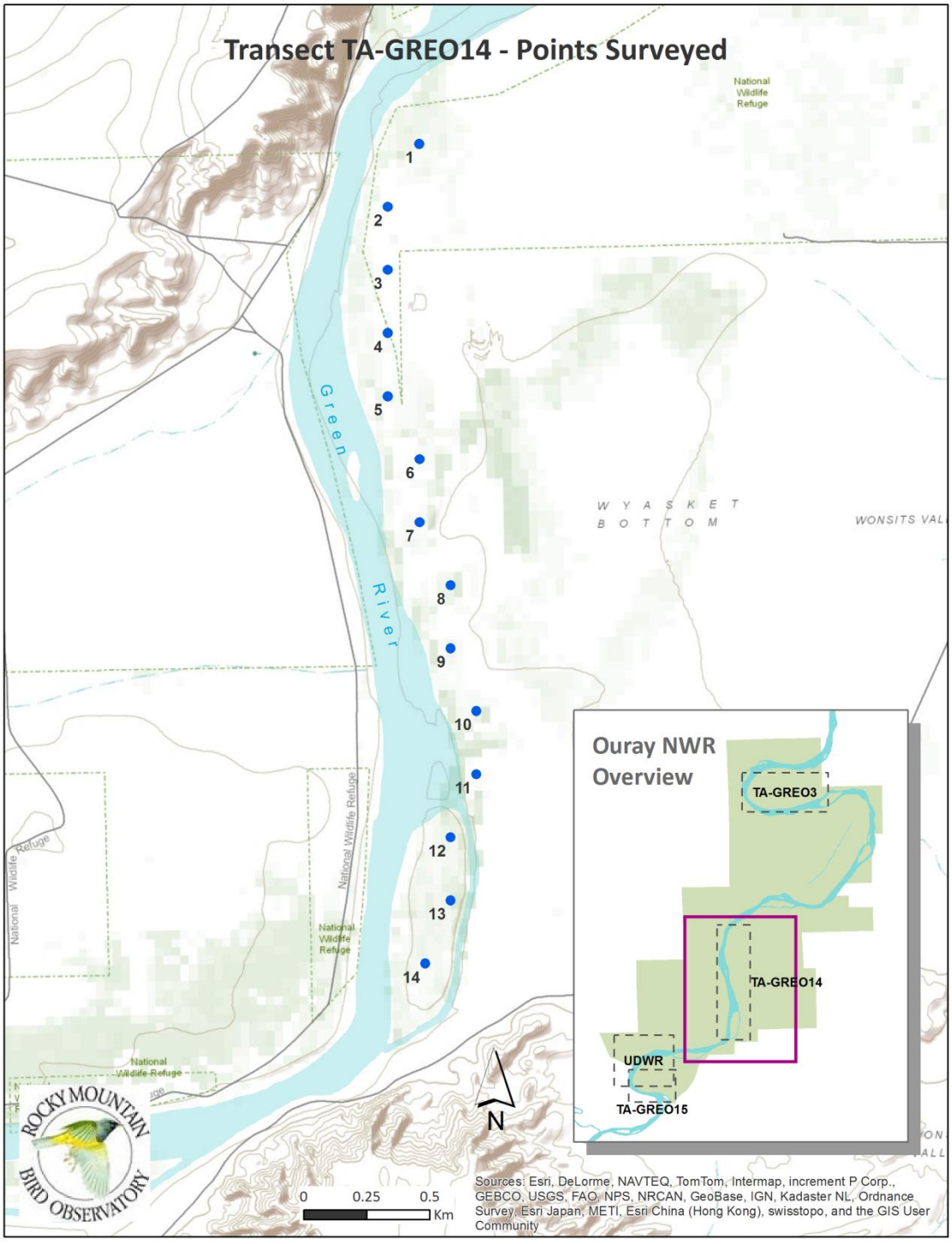

Figure 3. Transect TA-GREO14 point locations at Ouray National Wildlife Refuge.

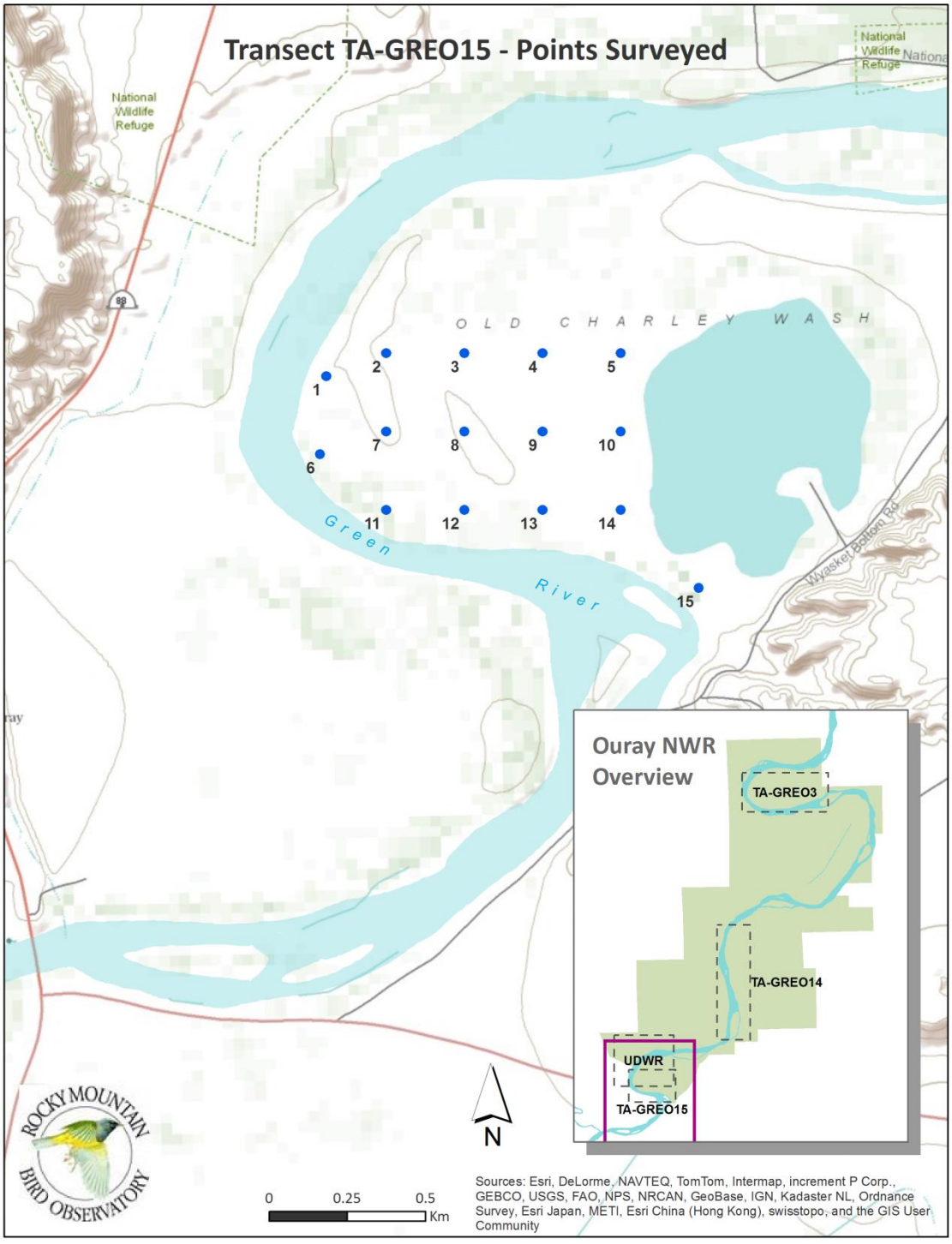

Figure 4. Transect TA-GREO15 point locations at Ouray National Wildlife Refuge.

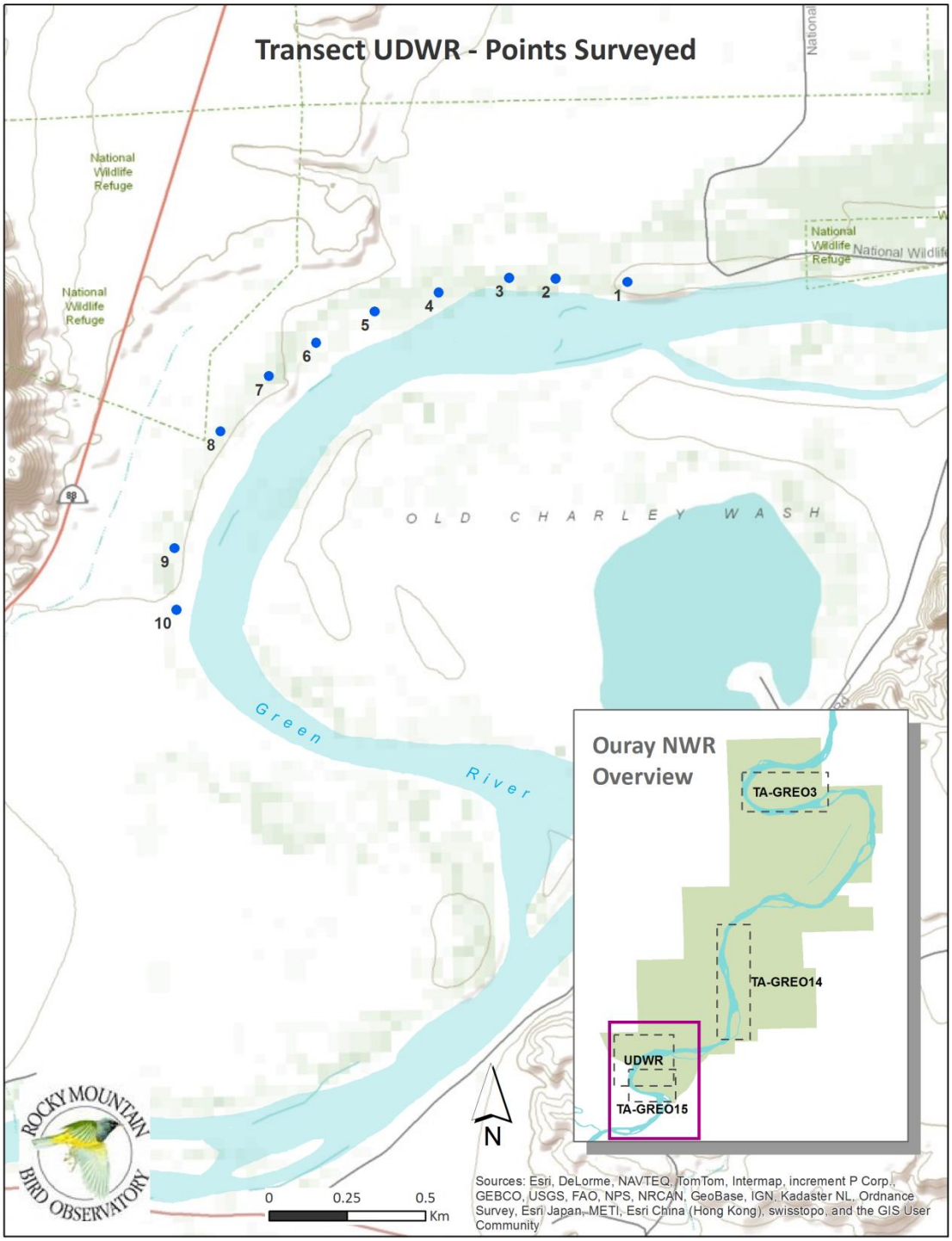

Figure 5. Transect TA-UDWR-1 point locations at Ouray National Wildlife Refuge.

Field Methods

Birds were surveyed from points using methods that allow for estimating detection probability through the principles of Distance sampling. Distance sampling theory estimates detection probability as a function of the distances between the observer and the bird detected (Buckland et al. 1993). The detection probability is used to adjust the count of birds to account for birds that were present but undetected.

We surveyed all transects in the morning between ½-hour before sunrise and 11 AM. We conducted six-minute point transects at stations located at 250-m intervals along each transect. We recorded all bird detections on standardized forms. We recorded flyovers (birds flying over, but not using the immediate surrounding landscape) but excluded them in analyses of density. We also recorded low-density birds detected between points to provide presence/absence information for less common species. For each bird detected during point counts, we recorded the species, sex, how it was detected (e.g., call, song, drumming), and horizontal distance from the observation point. Whenever possible, we measured distances using a laser rangefinder. When it was not possible to measure the distance to a bird, we often used rangefinders to gauge distance estimates by measuring to some nearby object. Laser rangefinders were used as often as possible but not for each detection.

We recorded atmospheric data (i.e., estimated temperature in degrees Fahrenheit, cloud cover, precipitation, and wind speed) and the time at the start and end of each transect. We measured distances between points using hand-held Global Positioning System (GPS) units. We used Universal Transverse Mercator (UTM) North American Datum 1983 for all GPS data.

We recorded vegetation data; including the primary habitat type, the habitat's structural stage, and the types, percent coverage, and mean height of trees, shrubs, and groundcover. We recorded these data prior to beginning each point count during the first visit to each transect. Vegetation data are recorded only during the first visit to each point for each transect. After each point we used nets to "sweep" for beetles on tamarisk present around the point (within 50 meters of point). If beetles were present, we counted and recorded the number of beetles that were present in the insect net. We also estimated the amount of tamarisk defoliation within 50 meters of each point.

Data Analysis

Distance sampling theory was developed to account for the decreasing probability of detecting an object of interest (e.g., a bird) with increasing distance from the observer to the object (Buckland et al. 2001). The detection probability is used to adjust the count of birds to account for birds that were present but undetected. Application of distance theory requires that three critical assumptions be met: 1) all birds at and near the sampling location (distance = 0) are detected; 2) distances of birds are measured accurately; and 3) birds do not move in response to the observer's presence (Buckland et al. 2001, Thomas et al. 2010). Removal modeling is based on mark-recapture theory; detection probability is estimated based on the number of birds detected during consecutive sampling intervals (Farnsworth et al. 2002). In this design, sampling intervals consist of one minute segments of the six minute sampling period. Removal modeling can also incorporate distance data.

Analysis of distance data includes fitting a detection function to the distribution of recorded distances (Buckland et al. 2001). The distribution of distances can be a function of characteristics of the object (e.g., for birds, size and color, movement, volume of song or call and frequency of call), the surrounding environment (e.g., density of vegetation) and observer ability. Because detectability varies among species, we analyzed the data separately for each species. The development of robust density estimates typically requires 80 or more independent detections ($n \geq 80$) within the entire sampling area. We excluded birds flying over, but not using the immediate surrounding landscape, and birds detected between points from analyses.

RESULTS

We surveyed four transects at Ouray National Wildlife Refuge along the Green River in eastern Utah between 26 May and 27 June, 2013 (Table 1). We surveyed 100% of transects and points counts at each that were scheduled to be conducted this year.

Table 1. Transect number, visit number, date of each visit, and number of points conducted at each transect at Ouray National Wildlife Refuge in 2013.

Transect	Visit	Date	Number of Points Conducted
TA-GREO3	1st	30-May	15
	2nd	23-Jun	15
	3rd	26-Jun	15
TA-GREO14	1st	28-May	14
	2nd	22-Jun	14
	3rd	25-Jun	14
TA-GREO15	1st	27-May	15
	2nd	21-Jun	15
	3rd	24-Jun	15
TA-UDWR-1	1st	26-May	10
	2nd	31-May	10
	3rd	27-Jun	10

We recorded 2,657 birds representing 68 species during surveys in 2013. We were able to report density estimates for 23 species at Ouray National Wildlife Refuge (Appendix A).

Survey effort, or total number of point counts conducted, each year of riparian surveys at Ouray National Wildlife Refuge is listed in Table 3.

Table 3. Survey effort by year at Ouray National Wildlife Refuge, 2009-2013.

Year	Number of Point Counts Conducted
2009	27
2010	94
2011	25
2012	220
2013	162

The overstory at survey conducted at Ouray National Wildlife Refuge is composed of Fremont cottonwood (*Populus fremontii*), willow (*salix* sp.), Russian olive (*Elaeagnus angustifolia*), and tamarisk (*tamarix* sp.) (Appendices C through J). The understory at ONWR was composed of Fremont cottonwood, greasewood (*Sarcobatus* sp.), rabbitbrush (*Chrysothamnus* sp.), Russian olive, sagebrush (*Artemisia tridentata*), serviceberry (*Amelanchier alnifolia*), skunkbush (*Rhus trilobata*), saltbush (*Atriplex* sp.), tamarisk, and willow. For abundance estimates for trees and shrubs in the overstory and understory at each transect see Appendices C through J.

DISCUSSION

The original objective of this project in 2009 was to determine the effects of tamarisk biological control on riparian bird species throughout the Upper Colorado River Basin. Since 2009, the main goal has become to monitor riparian bird populations at Ouray National Wildlife Refuge and along the Green River. Determining population trends requires a long term commitment because detecting a trend is not possible without several years of data. The U. S. Fish and Wildlife Service is to be commended for recognizing the need for monitoring wildlife as part of their effort to document the effects of biological control and other land management techniques on bird populations.

It is possible using Program Distance to construct a common detection function across years, and obtain separate density estimates for each year. Therefore, with each year of additional data we will be able to obtain stratum-level density estimates for more species using common detection functions. In other words, the number of species we will be able to monitor will increase annually as long as this project continues. Also, a greater survey effort will increase the number of species we will be able to monitor.

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Appendix A. Densities of bird species detected during riparian bird surveys at Ouray National Wildlife Refuge, 2009-2013.

Species	Year	Density[1]	CV	LCL[2]	UCL[2]	N[3]
American Goldfinch	2009	74.5	69.3%	10.1	172.0	7
	2010	6.2	57.4%	1.4	12.6	3
	2011	-	-	-	-	0
	2012	61.1	43.2%	25.8	113.9	65
	2013	68.4	29.9%	35.9	104.0	56
American Robin	2009	23.0	33.1%	11.9	35.1	10
	2010	43.1	22.1%	27.0	58.8	67
	2011	59.8	12.7%	48.8	73.7	24
	2012	52.5	30.6%	30.0	80.3	186
	2013	52.0	28.8%	27.8	77.3	136
Black-billed Magpie	2009	3.3	46.8%	1.0	5.8	2
	2010	3.8	40.5%	1.4	6.4	12
	2011	4.9	30.2%	2.9	7.8	4
	2012	7.7	42.0%	3.3	13.3	46
	2013	10.2	27.0%	5.9	14.8	35
Black-capped Chickadee	2009	35.3	24.2%	24.2	51.1	5
	2010	14.7	47.7%	5.2	27.9	10
	2011	-	-	-	-	0
	2012	40.3	21.0%	27.1	54.1	63
	2013	22.1	33.2%	11.7	35.1	20
Black-headed Grosbeak	2009	17.1	40.0%	7.9	29.2	9
	2010	15.7	30.9%	8.2	23.7	28
	2011	7.7	63.5%	1.6	17.5	3
	2012	16.9	25.2%	10.9	24.3	70
	2013	18.5	31.1%	11.4	29.3	56
Blue-gray Gnatchatcher	2009	289.4	27.7%	166.2	421.9	17
	2010	23.4	42.5%	8.6	38.9	5
	2011	-	-	-	-	0
	2012	69.3	49.6%	22.1	132.0	29

Species	Year	Density[1]	CV	LCL[2]	UCL[2]	N[3]
Blue-gray Gnatcatcher (cont.)	2013	41.7	33.4%	21.5	65.3	14
Brown-headed Cowbird	2009	120.0	25.5%	71.2	171.8	19
	2010	49.4	14.4%	38.4	61.7	29
	2011	41.4	37.1%	18.1	62.9	8
	2012	67.8	21.6%	43.8	91.2	93
	2013	43.7	28.0%	26.2	66.6	46
Bullock's Oriole	2009	37.3	40.9%	19.2	65.0	7
	2010	2.2	33.9%	1.1	3.2	2
	2011	8.7	87.3%	0.0	21.3	2
	2012	10.9	29.0%	5.4	16.1	23
	2013	5.1	17.2%	3.7	6.5	8
Canada Goose	2009	3.6	54.9%	1.0	7.1	4
	2010	-	-	-	-	0
	2011	-	-	-	-	0
	2012	10.5	42.8%	3.2	18.1	29
	2013	3.1	56.4%	0.7	6.2	10
Cliff Swallow	2009	24.5	87.7%	0.0	64.0	2
	2010	42.6	88.8%	0.0	112.9	5
	2011	-	-	-	-	0
	2012	103.4	69.1%	13.1	229.7	45
	2013	27.1	65.0%	3.1	58.5	12
House Wren	2009	50.7	20.4%	36.9	69.9	15
	2010	18.2	39.4%	6.7	28.7	19
	2011	3.3	72.8%	0.0	7.1	1
	2012	51.9	26.0%	32.5	74.9	121
	2013	122.8	21.7%	80.0	167.0	216
Lark Sparrow	2009	-	-	-	-	0
	2010	2.2	64.2%	0.5	4.9	2
	2011	6.6	46.7%	2.3	11.7	2
	2012	5.0	39.6%	2.1	8.1	16

Species	Year	Density[1]	CV	LCL[2]	UCL[2]	N[3]
Lark Sparrow (cont.)	2013	7.9	35.5%	3.9	12.5	20
Lazuli Bunting	2009	33.6	81.5%	0.0	74.0	7
	2010	18.4	16.1%	13.2	23.0	13
	2011	9.9	72.5%	0.0	19.9	1
	2012	16.0	35.4%	8.7	23.9	26
	2013	6.4	58.4%	0.0	12.6	8
Mourning Dove	2009	50.1	32.8%	24.8	76.3	31
	2010	13.7	19.7%	9.7	18.5	26
	2011	14.4	62.9%	1.8	29.2	7
	2012	31.8	33.1%	15.6	48.8	152
	2013	35.3	20.0%	24.3	47.7	129
Northern Flicker	2009	-	-	-	-	0
	2010	3.6	56.5%	1.1	6.9	4
	2011	3.0	85.5%	0.0	7.9	1
	2012	7.3	30.3%	4.3	11.1	20
	2013	2.9	40.0%	1.1	4.8	6
Plumbeous Vireo	2009	50.2	29.4%	27.8	73.8	14
	2010	30.1	32.3%	15.0	46.0	31
	2011	-	-	-	-	0
	2012	24.4	50.3%	7.8	44.1	55
	2013	26.5	29.3%	14.6	40.0	43
Red-winged Blackbird	2009	29.4	52.7%	7.5	56.8	7
	2010	28.7	58.4%	3.9	57.0	19
	2011	38.4	52.7%	8.1	71.8	9
	2012	12.4	56.8%	2.6	24.7	22
	2013	1222.1	3147.5%	1.4	10.1	7
Song Sparrow	2009	6.0	88.3%	0.0	15.0	1
	2010	3.0	82.3%	0.0	7.5	2
	2011	-	-	-	-	0
	2012	23.8	85.3%	0.5	57.2	35

Species	Year	Density[1]	CV	LCL[2]	UCL[2]	N[3]
Song Sparrow (cont.)	2013	22.8	76.9%	0.0	51.6	26
Spotted Towhee	2009	73.4	24.2%	48.8	98.3	22
	2010	57.5	31.2%	28.8	83.1	61
	2011	100.6	46.7%	23.8	175.0	28
	2012	138.8	14.7%	102.9	171.7	211
	2013	91.9	29.7%	50.3	138.1	164
Western Kingbird	2009	3.9	83.6%	0.0	9.6	1
	2010	3.3	41.6%	1.1	5.4	3
	2011	8.5	38.8%	3.7	14.0	2
	2012	2.6	46.3%	0.8	4.6	5
	2013	9.0	56.6%	2.5	18.2	11
Western Wood-Pewee	2009	9.6	21.5%	6.5	13.2	4
	2010	16.0	58.2%	2.1	31.8	24
	2011	-	-	-	-	0
	2012	13.6	47.2%	5.5	24.9	45
	2013	40.6	33.4%	20.9	65.4	97
Yellow-breasted Chat	2009	47.6	10.1%	39.9	54.9	25
	2010	37.2	17.3%	29.0	48.4	68
	2011	40.9	16.6%	30.0	50.9	20
	2012	28.7	16.9%	21.2	36.6	121
	2013	31.6	28.8%	18.1	46.7	96
Yellow Warbler	2009	295.6	28.7%	172.9	421.5	44
	2010	256.3	19.6%	174.9	333.2	140
	2011	253.3	10.8%	216.1	298.8	36
	2012	384.4	25.1%	261.4	544.1	483
	2013	407.6	21.8%	274.2	555.7	375

[1]Density=Birds per km^2

[2]LCL, UCL=Upper and Lower 95% Confidence Limits

[3]n=number of observations used to calculate density. Typically, 10%-20% of total number of observations are truncated during analyses

Appendix B. Observation totals for all bird species detected at Ouray National Wildlife Refuge, 2009 - 2013.

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
American Avocet	2012	0	0	5	0	5
American Bittern	2010	0	0	2	0	2
	2013	1	0	0	0	1
American Coot	2009	0	3	0	0	3
	2012	0	0	10	0	10
American Crow	2012	0	0	4	0	4
	2013	3	0	0	3	6
American Goldfinch	2009	9	2	0	0	11
	2010	0	2	2	0	4
	2012	45	14	18	0	77
	2013	56	10	21	22	109
American Kestrel	2009	2	0	1	0	3
	2010	1	0	1	0	2
	2012	3	1	1	0	5
	2013	1	2	0	1	4
American Robin	2009	5	4	1	0	10
	2010	45	21	16	0	82
	2012	93	92	26	0	211
	2013	71	69	15	25	180
American White Pelican	2010	0	0	10	0	10
	2012	23	1	3	0	27
American Wigeon	2012	0	2	0	0	2
Ash-throated Flycatcher	2009	0	2	1	0	3
	2010	0	3	3	0	6
	2012	4	9	4	0	17
	2013	2	2	1	0	5
Bald Eagle	2012	1	1	0	0	2
Barn Swallow	2012	2	2	2	0	6

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Belted Kingfisher	2012	0	0	1	0	1
Black-billed Magpie	2009	2	0	1	0	3
	2010	11	4	1	0	16
	2012	26	42	1	0	69
	2013	22	29	23	1	75
Black-capped Chickadee	2009	3	2	2	0	7
	2010	9	2	2	0	13
	2012	34	24	21	0	79
	2013	12	6	8	10	36
Black-chinned Hummingbird	2012	0	0	3	0	3
Black-crowned Night-Heron	2009	0	4	1	0	5
	2012	2	1	0	0	3
Black-headed Grosbeak	2009	6	1	2	0	9
	2010	23	9	10	0	42
	2012	38	19	21	0	78
	2013	13	20	18	28	79
Black-necked Stilt	2009	2	0	0	0	2
Blue Grosbeak	2009	0	0	4	0	4
	2010	2	2	9	0	13
	2012	0	0	3	0	3
Blue-gray Gnatcatcher	2009	3	5	9	0	17
	2010	3	0	3	0	6
	2012	9	4	28	0	41
	2013	7	3	11	2	23
Brewer's Blackbird	2012	0	6	0	0	6
	2013	0	18	0	0	18
Brown-headed Cowbird	2009	8	3	14	0	25
	2010	25	11	14	0	50
	2012	42	31	55	0	128

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Brown-headed Cowbird (cont.)	2013	26	18	16	22	82
Bullock's Oriole	2009	2	5	2	0	9
	2010	2	1	1	0	4
	2012	10	23	6	0	39
	2013	4	8	3	3	18
Canada Goose	2009	0	2	4	0	6
	2010	10	19	7	0	36
	2012	37	175	70	0	282
	2013	23	33	5	28	89
Cedar Waxwing	2009	1	7	0	0	8
	2010	1	0	1	0	2
	2013	0	0	0	2	2
Chipping Sparrow	2012	0	3	0	0	3
Cinnamon Teal	2012	0	0	6	0	6
	2013	0	0	1	0	1
Cliff Swallow	2009	0	0	18	0	18
	2010	1	8	50	0	59
	2012	10	9	187	0	206
	2013	1	19	51	0	71
Common Grackle	2010	0	7	0	0	7
Common Nighthawk	2012	0	1	0	0	1
	2013	2	0	2	0	4
Common Poorwill	2010	1	0	0	0	1
Common Raven	2010	2	1	2	0	5
	2012	9	2	13	0	24
Common Yellowthroat	2009	0	0	2	0	2
	2010	1	0	11	0	12
	2012	0	0	28	0	28
	2013	0	1	15	0	16

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Cooper's Hawk	2009	2	0	0	0	2
	2010	0	0	1	0	1
	2012	3	1	2	0	6
	2013	4	2	0	2	8
Double-crested Cormorant	2009	1	43	0	0	44
	2010	1	71	0	0	72
	2012	2	184	11	0	197
	2013	1	65	0	0	66
Downy Woodpecker	2010	2	0	0	0	2
	2012	1	0	0	0	1
	2013	0	1	0	0	1
Dusky Flycatcher	2013	0	0	1	0	1
Eastern Kingbird	2010	0	1	1	0	2
	2013	0	0	1	0	1
Eurasian Collared-Dove	2009	1	0	0	0	1
	2010	5	0	0	0	5
	2012	6	1	0	0	7
	2013	5	4	0	0	9
European Starling	2009	9	5	0	0	14
	2010	20	7	4	0	31
	2012	1	24	11	0	36
	2013	0	6	4	0	10
Ferruginous Hawk	2010	2	0	0	0	2
Forster's Tern	2009	0	0	16	0	16
	2010	0	0	1	0	1
Gadwall	2009	5	0	11	0	16
	2010	3	21	2	0	26
	2012	0	3	19	0	22
Golden Eagle	2012	1	0	1	0	2

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Golden Eagle (cont.)	2013	0	0	12	0	12
Gray Catbird	2009	0	1	0	0	1
	2010	0	0	1	0	1
	2012	0	0	2	0	2
Great Blue Heron	2009	4	10	4	0	18
	2010	3	1	10	0	14
	2012	23	6	24	0	53
	2013	0	0	1	1	2
Great Horned Owl	2010	1	0	0	0	1
	2012	0	1	5	0	6
	2013	2	0	1	1	4
Green Heron	2012	0	1	0	0	1
Green-winged Teal	2012	0	0	4	0	4
Hairy Woodpecker	2009	1	1	0	0	2
	2010	1	2	0	0	3
	2012	6	8	0	0	14
	2013	1	1	2	3	7
Hermit Thrush	2013	0	0	0	1	1
House Finch	2012	1	2	1	0	4
	2013	0	3	0	0	3
House Wren	2009	5	6	4	0	15
	2010	15	5	1	0	21
	2012	58	45	26	0	129
	2013	78	64	35	65	242
Indigo Bunting	2010	1	0	0	0	1
	2012	4	0	0	0	4
Indigo x Lazuli Bunting Hybrid	2012	0	1	0	0	1
Killdeer	2009	1	0	1	0	2
	2010	0	2	0	0	2

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Killdeer (cont.)	2012	0	4	8	0	12
	2013	0	0	0	3	3
Lark Sparrow	2010	0	3	3	0	6
	2012	3	11	6	0	20
	2013	5	19	6	1	31
Lazuli Bunting	2009	0	0	8	0	8
	2010	5	2	8	0	15
	2012	1	14	14	0	29
	2013	0	10	3	0	13
Least Flycatcher	2012	8	0	0	0	8
	2013	6	0	0	29	35
Lesser Goldfinch	2012	1	1	2	0	4
Lewis's Woodpecker	2010	1	2	0	0	3
Long-billed Curlew	2010	5	0	0	0	5
	2013	2	0	0	0	2
Long-eared Owl	2012	0	0	4	0	4
Mallard	2009	11	2	49	0	62
	2010	6	6	5	0	17
	2012	5	17	16	0	38
	2013	0	4	2	1	7
Marbled Godwit	2012	0	0	1	0	1
Marsh Wren	2012	0	0	8	0	8
	2013	0	0	1	0	1
Mountain Bluebird	2009	0	0	2	0	2
	2012	0	18	0	0	18
Mourning Dove	2009	11	2	19	0	32
	2010	40	16	38	0	94
	2012	52	31	99	0	182
	2013	39	42	75	41	197

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Northern Flicker	2010	0	2	2	0	4
	2012	12	11	8	0	31
	2013	5	7	3	1	16
Northern Harrier	2010	0	0	2	0	2
	2012	0	0	1	0	1
	2013	0	0	1	0	1
Northern Pintail	2012	0	1	1	0	2
Northern Shoveler	2012	0	3	0	0	3
Olive-sided Flycatcher	2009	1	0	0	0	1
Orange-crowned Warbler	2010	0	0	1	0	1
	2012	0	1	0	0	1
Osprey	2010	0	0	1	0	1
	2012	0	0	1	0	1
Pied-billed Grebe	2012	0	0	3	0	3
Plumbeous Vireo	2009	7	5	2	0	14
	2010	22	4	9	0	35
	2012	37	6	16	0	59
	2013	24	11	13	14	62
Red-breasted Nuthatch	2010	1	0	0	0	1
Redhead	2009	0	0	1	0	1
Red-tailed Hawk	2009	2	2	1	0	5
	2010	4	3	1	0	8
	2012	7	5	6	0	18
	2013	2	3	0	0	5
Red-winged Blackbird	2009	0	3	5	0	8
	2010	3	18	43	0	64
	2012	3	4	24	0	31
	2013	2	13	6	10	31
Ring-necked Pheasant	2009	0	0	6	0	6

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Ring-necked Pheasant (cont.)	2010	4	0	15	0	19
	2012	5	0	24	0	29
	2013	4	0	5	0	9
Ruddy Duck	2012	0	0	1	0	1
Sandhill Crane	2009	4	0	2	0	6
	2010	10	3	0	0	13
	2012	0	4	1	0	5
	2013	0	0	2	0	2
Say's Phoebe	2012	0	1	0	0	1
	2013	0	0	1	0	1
Sharp-shinned Hawk	2013	0	0	0	1	1
Song Sparrow	2009	0	1	0	0	1
	2010	0	0	2	0	2
	2012	0	2	38	0	40
	2013	0	2	28	0	30
Spotted Sandpiper	2010	0	1	0	0	1
	2012	0	2	5	0	7
	2013	0	0	1	1	2
Spotted Towhee	2009	10	3	10	0	23
	2010	42	2	24	0	68
	2012	73	145	120	0	338
	2013	42	25	89	32	188
Steller's Jay	2010	0	1	0	0	1
Swainson's Hawk	2010	8	0	0	0	8
	2012	1	0	0	0	1
	2013	20	0	0	0	20
Turkey Vulture	2010	0	0	2	0	2
	2012	1	10	5	0	16
	2013	0	0	2	4	6

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Unknown Bird	2009	0	1	0	0	1
	2012	66	64	87	0	217
	2013	9	5	0	2	16
Unknown Blackbird	2012	19	15	9	0	43
Unknown Buteo	2012	0	0	2	0	2
Unknown Dove	2012	1	0	0	0	1
Unknown Duck	2012	15	293	10	0	318
	2013	0	2	0	0	2
Unknown Empidonax	2012	1	1	0	0	2
	2013	0	1	0	0	1
Unknown Falcon	2012	2	0	0	0	2
Unknown Finch	2012	0	1	0	0	1
Unknown Flycatcher	2012	4	0	2	0	6
Unknown Gull	2012	107	0	3	0	110
Unknown Hawk	2010	0	1	0	0	1
	2012	1	0	0	0	1
Unknown Hummingbird	2012	1	0	1	0	2
Unknown Owl	2012	0	0	1	0	1
Unknown Sandpiper	2012	0	1	1	0	2
Unknown Sparrow	2012	0	6	3	0	9
Unknown Swallow	2010	0	0	2	0	2
	2012	47	20	11	0	78
Unknown Vireo	2012	1	0	0	0	1
Unknown Warbler	2012	3	0	1	0	4
Unknown Woodpecker	2012	9	9	0	0	18
	2013	2	1	0	2	5
Violet-green Swallow	2010	0	0	6	0	6
	2012	1	0	1	0	2
Warbling Vireo	2010	1	0	0	0	1

Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Warbling Vireo (cont.)	2012	2	2	0	0	4
	2013	2	0	0	0	2
Western Bluebird	2013	0	6	0	0	6
Western Grebe	2010	0	4	1	0	5
	2012	0	0	24	0	24
Western Kingbird	2009	0	0	1	0	1
	2010	2	1	2	0	5
	2012	0	4	5	0	9
	2013	3	5	3	9	20
Western Meadowlark	2009	1	0	1	0	2
	2010	2	0	0	0	2
	2012	0	0	5	0	5
	2013	1	0	5	0	6
Western Scrub-Jay	2013	0	0	0	1	1
Western Tanager	2009	1	0	0	0	1
	2010	0	2	1	0	3
	2012	3	0	1	0	4
	2013	0	1	2	0	3
Western Wood-Pewee	2009	1	1	2	0	4
	2010	27	5	1	0	33
	2012	32	7	8	0	47
	2013	40	20	18	35	113
White-breasted Nuthatch	2013	0	0	0	1	1
White-faced Ibis	2012	13	20	14	0	47
Wild Turkey	2009	5	1	3	0	9
	2010	3	0	0	0	3
	2012	4	2	4	0	10
	2013	4	6	5	2	17
Willow Flycatcher	2009	2	0	0	0	2

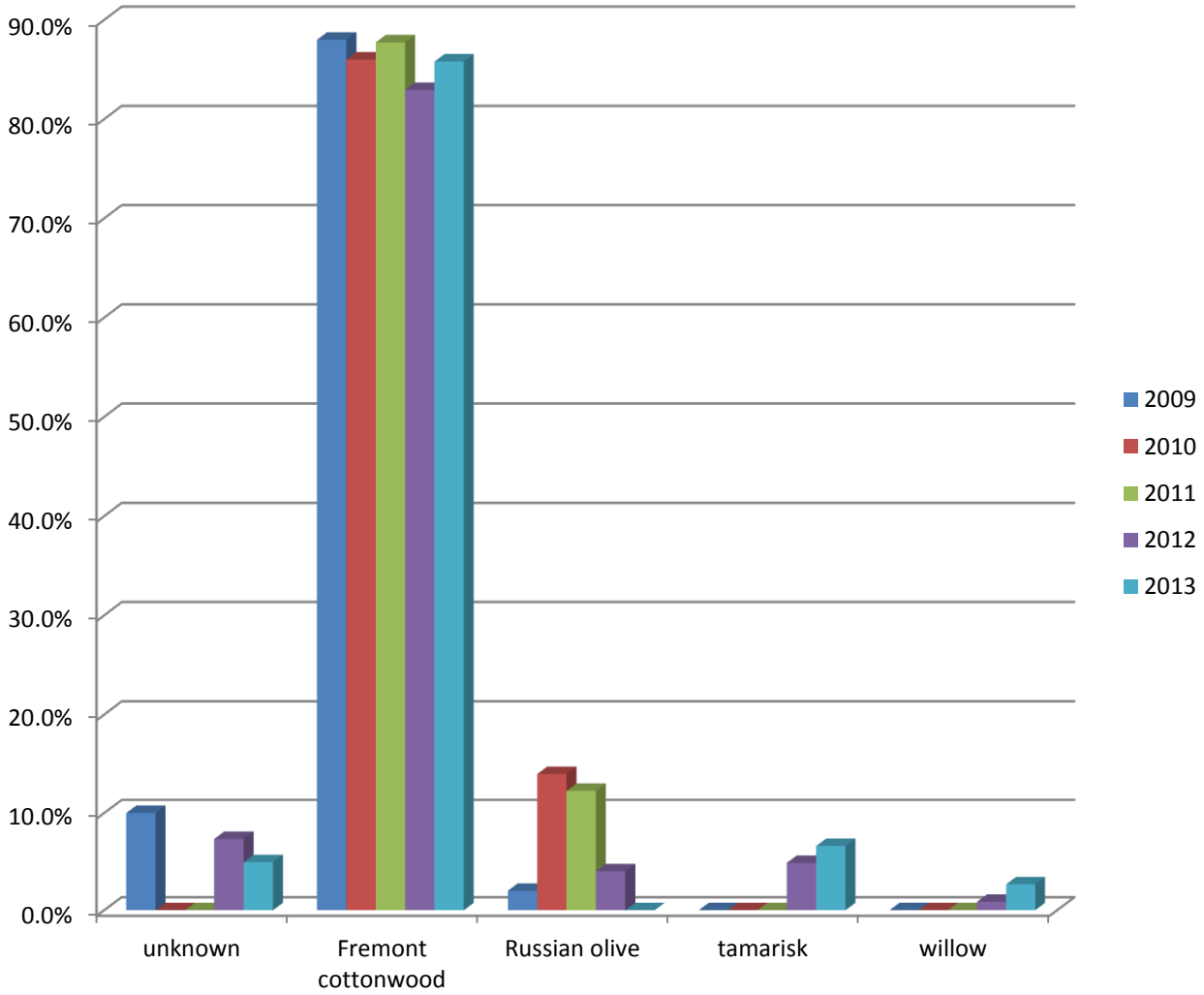
Species	Year	Transect Number				Total
		TA-GREO14	TA-GREO15	TA-GREO3	TA-UDWR-1	
Willow Flycatcher (cont.)	2010	2	0	0	0	2
	2012	4	2	0	0	6
	2013	4	6	0	1	11
Wilson's Warbler	2010	1	0	0	0	1
	2012	1	0	0	0	1
Wood Duck	2012	0	2	2	0	4
Yellow Warbler	2009	22	18	8	0	48
	2010	79	40	32	0	151
	2012	260	160	134	0	554
	2013	151	125	85	116	477
Yellow-breasted Chat	2009	11	5	10	0	26
	2010	26	14	38	0	78
	2012	43	34	71	0	148
	2013	28	24	44	43	139
Yellow-headed Blackbird	2010	0	0	5	0	5
	2012	1	0	7	0	8
	2013	11	0	0	1	12
Yellow-rumped Warbler	2010	3	2	2	0	7
	2012	0	4	3	0	7

Appendix C. Abundance estimation of plant species present in the overstory at point-count locations at Ouray NWR, 2009-2013.

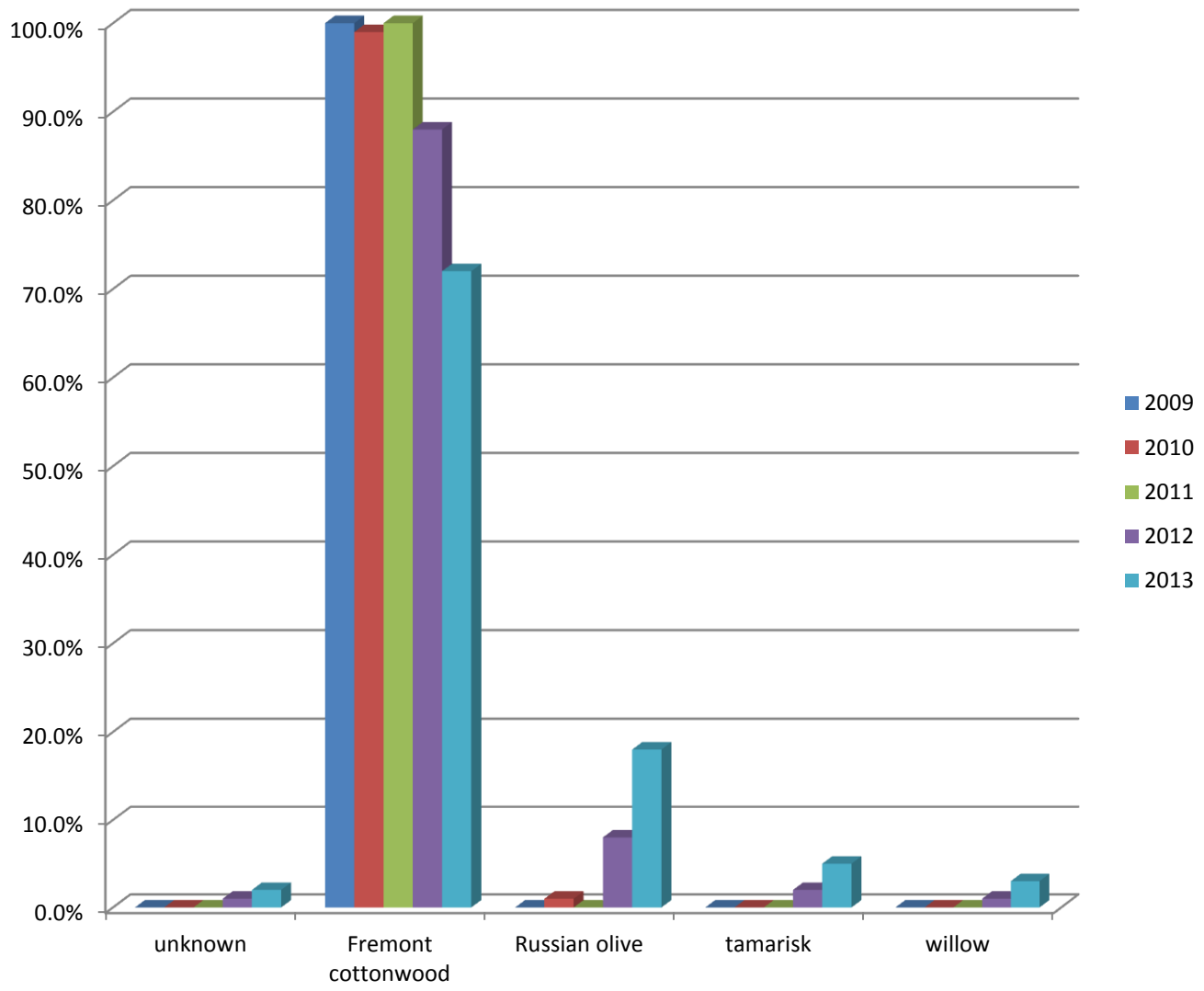
Transect Number	Year	unknown	Fremont cottonwood	Russian olive	tamarisk	willow
TA-GREO3	2009	10.0%	88.0%	2.0%	0.0%	0.0%
	2010	0.0%	86.0%	14.0%	0.0%	0.0%
	2011	0.0%	87.7%	12.3%	0.0%	0.0%
	2012	7.3%	82.9%	4.0%	4.9%	0.9%
	2013	4.9%	85.8%	0.0%	6.6%	2.7%
TA-GREO14	2009	0.0%	100.0%	0.0%	0.0%	0.0%
	2010	0.0%	99.0%	1.0%	0.0%	0.0%
	2011	0.0%	100.0%	0.0%	0.0%	0.0%
	2012	1.0%	88.0%	8.0%	2.0%	1.0%
	2013	2.0%	72.0%	18.0%	5.0%	3.0%
TA-GREO15	2009	3.6%	96.4%	0.0%	0.0%	0.0%
	2010	0.0%	94.6%	0.4%	0.0%	5.0%
	2011	0.0%	97.5%	2.5%	0.0%	0.0%
	2012	0.5%	79.7%	1.1%	1.6%	17.1%
	2013	0.8%	76.7%	2.7%	0.7%	19.1%

*Overstory cover estimations are for all plant species 5 meters and higher within a 50 meter radius of point-count locations

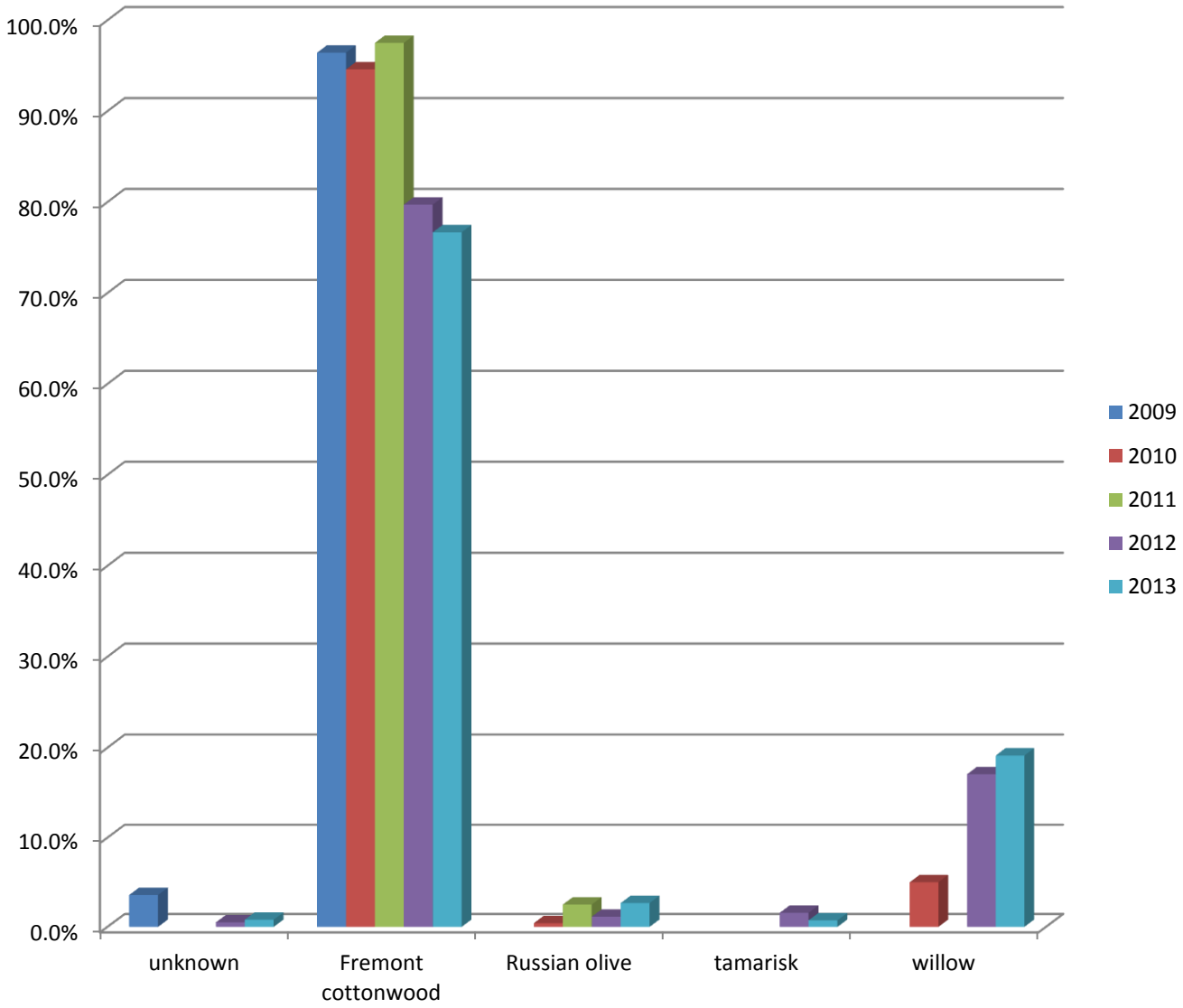
Appendix D. Abundance estimation of overstory species at Ouray National Wildlife Refuge transect #TA-GREO3, 2009-2013.



Appendix E. Abundance estimation of overstory species at Ouray National Wildlife Refuge transect #TA-GREO14, 2009-2013.



Appendix F. Abundance estimation of overstory species at Ouray National Wildlife Refuge transect #TA-GREO15, 2009-2013.

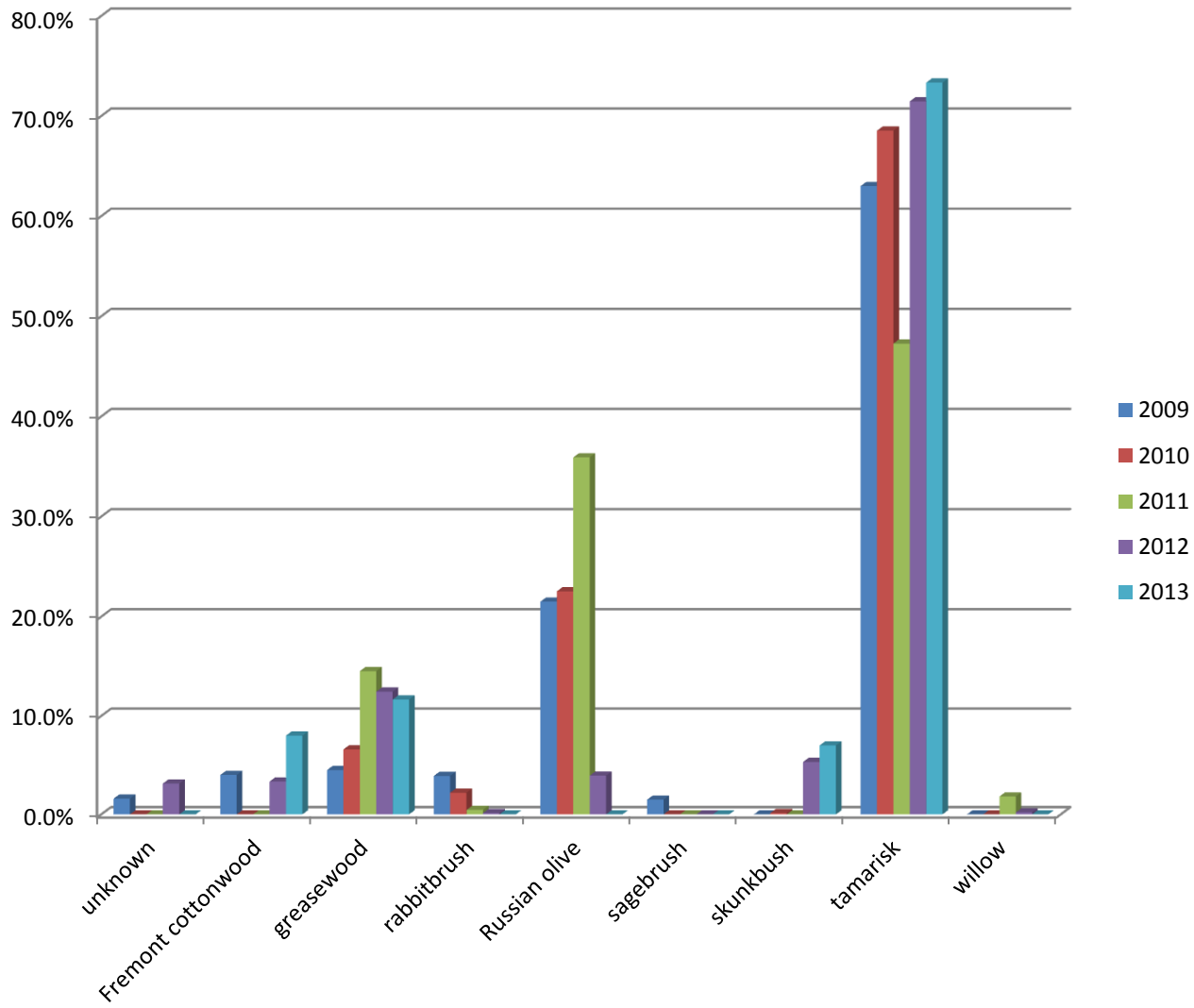


Appendix G. Abundance estimation of plant species present in the understory at point-count locations at Ouray NWR, 2009-2013.

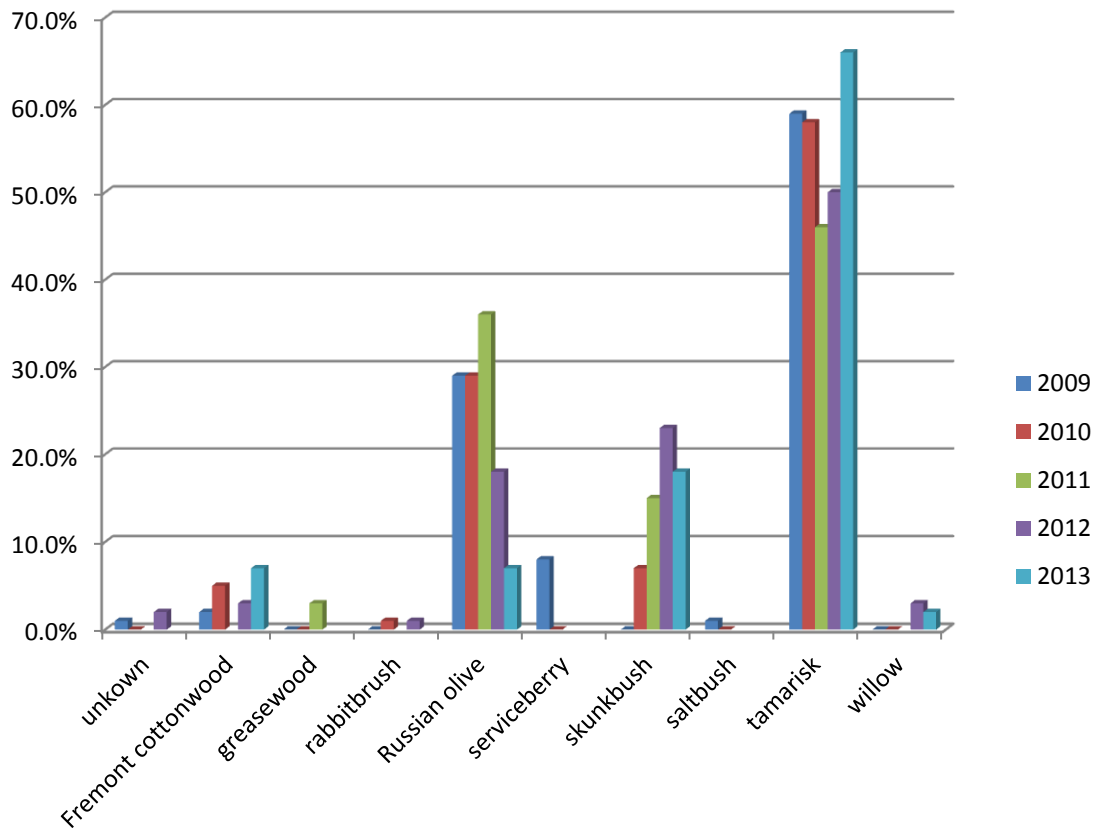
Transect Number	Year	unknown	Fremont cottonwood	greasewood	rabbitbrush	Russian olive	sagebrush	serviceberry	skunkbush	saltbush	tamarisk	willow
TA-GREO3	2009	1.6%	4.0%	4.5%	3.9%	21.5%	1.5%	0.0%	0.0%	0.0%	63.0%	0.0%
	2010	0.0%	0.0%	6.6%	2.2%	22.5%	0.0%	0.0%	0.1%	0.0%	68.5%	0.0%
	2011	0.0%	0.0%	14.5%	0.5%	35.9%	0.0%	0.0%	0.0%	0.0%	47.3%	1.8%
	2012	3.1%	3.3%	12.5%	0.1%	3.9%	0.0%	0.0%	5.3%	0.0%	71.5%	0.2%
	2013	0.0%	8.0%	11.7%	0.0%	0.0%	0.0%	0.0%	7.0%	0.0%	73.3%	0.0%
TA-GREO14	2009	1.0%	2.0%	0.0%	0.0%	29.0%	0.0%	8.0%	0.0%	1.0%	59.0%	0.0%
	2010	0.0%	5.0%	0.0%	1.0%	29.0%	0.0%	0.0%	7.0%	0.0%	58.0%	0.0%
	2011	0.0%	0.0%	3.0%	0.0%	36.0%	0.0%	0.0%	15.0%	0.0%	46.0%	0.0%
	2012	2.0%	3.0%	0.0%	1.0%	18.0%	0.0%	0.0%	23.0%	0.0%	50.0%	3.0%
	2013	0.0%	7.0%	0.0%	0.0%	7.0%	0.0%	0.0%	18.0%	0.0%	66.0%	2.0%
TA-GREO15	2009	10.0%	6.4%	0.0%	0.7%	15.0%	0.0%	0.0%	0.0%	0.0%	58.6%	9.3%
	2010	0.0%	0.6%	0.0%	5.0%	13.6%	0.0%	0.0%	7.3%	0.0%	39.1%	34.4%
	2011	0.0%	0.0%	0.0%	0.0%	19.6%	0.0%	0.0%	6.3%	0.0%	59.8%	14.4%
	2012	0.0%	2.0%	0.0%	0.4%	7.8%	0.0%	0.0%	11.3%	0.0%	59.1%	19.4%
	2013	0.0%	0.2%	0.0%	0.0%	9.1%	0.0%	0.0%	11.6%	0.0%	67.3%	11.8%

*Understory cover estimations are for all plant species below 5 meters high within a 50 meter radius of point-count locations

Appendix H. Abundance estimation of understory species at Ouray National Wildlife Refuge transect #TA-GREO3, 2009-2013.



Appendix I. Abundance estimation of understory species at Ouray National Wildlife Refuge transect #TA-GREO14, 2009-2013.



Appendix J. Abundance estimation of understory species at Ouray National Wildlife Refuge transect #TA-GREO15, 2009-2013.