Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

2010 Vegetation Monitoring Report

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

May 2011

Lower Colorado River Multi-Species Conservation Program Steering Committee Members

Federal Participant Group

Bureau of Reclamation
U.S. Fish and Wildlife Service
National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

Arizona Participant Group

Arizona Department of Water Resources
Arizona Electric Power Cooperative, Inc.
Arizona Game and Fish Department
Arizona Power Authority
Central Arizona Water Conservation District
Cibola Valley Irrigation and Drainage District
City of Bullhead City
City of Lake Havasu City
City of Mesa
City of Somerton
City of Yuma
Electrical District No. 3, Pinal County, Arizona
Golden Shores Water Conservation District
Mohave County Water Authority
Mohave Valley Irrigation and Drainage District
Mohave Water Conservation District
North Gila Valley Irrigation and Drainage District
Town of Fredonia
Town of Thatcher
Town of Wickenburg
Salt River Project Agricultural Improvement and Power District
Unit "B" Irrigation and Drainage District
Wellton-Mohawk Irrigation and Drainage District
Yuma County Water Users' Association
Yuma Irrigation District
Yuma Mesa Irrigation and Drainage District

Other Interested Parties Participant Group

QuadState Local Governments Authority
Desert Wildlife Unlimited

California Participant Group

California Department of Fish and Wildlife
City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
Southern California Edison Company
Southern California Public Power Authority
The Metropolitan Water District of Southern California

Nevada Participant Group

Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
Colorado River Commission Power Users
Basic Water Company

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
Chemehuevi Indian Tribe

Conservation Participant Group

Ducks Unlimited
Lower Colorado River RC&D Area, Inc.
The Nature Conservancy

Lower Colorado River Multi-Species Conservation Program

2010 Vegetation Monitoring Report

Prepared by:

BIO-WEST, Inc.

Lower Colorado River
Multi-Species Conservation Program
Bureau of Reclamation
Lower Colorado Region
Boulder City, Nevada
http://www.lcrmscp.gov

May 2011

BIO-WEST, Inc. 2011. 2010 Vegetation Monitoring Report. Prepared by BIO-WEST, Inc., for the Bureau of Reclamation, Lower Colorado River Multi-Species Conservation Program, Boulder City, Nevada.

TABLE OF CONTENTS

INTRODUCTION 1

FIELD METHODS 1
Vegetation Sampling 16
Rapid Plot Set Up 17
Intensive Plot Set Up 17
Overstory Tree Species 19
Intermediate Tree and Shrub Species 20
Ground Cover/Herbaceous Layer 20
Canopy Closure 21
Total Vegetation Volume (TVV) 21
Additional Collected Data 22

RESULTS 23
Beal Lake 24
Rapid Plots 24
Intensive Plots 24
Palo Verde Ecological Reserve (PVER) Phases 2–5 26
Phase 2 (PVER2) 26
Phase 3 (PVER3) 27
Phase 4 (PVER4) 28
Phase 5 (PVER5) 30
Cibola Valley Conservation Area (CVCA) Phases 1–5 31
Phase 1 (CVCA1) 31
Phase 2 (CVCA2) 32
Phase 3 (CVCA3) 33
Phase 4 East (CVCA4 E) 35
Phase 4 West (CVCA4 W) 36
Phase 5 (CVCA5) 37
Cibola National Wildlife Refuge (CNWR) 38
Cibola Nature Trail (CNT) 38
Cibola Crane's Roost (CCR) 39
Cibola Mass Planting (CMP) 40

DISCUSSION AND RECOMMENDATIONS 40
Conditions of Habitat Creation Sites 40

PHOTOS 43

REFERENCES 49

APPENDIX A: SUMMARY STATISTICS

List of Tables

Table 1. Distribution of plots for 2010 monitoring year. 16

List of Figures

Figure 1. Beal Lake Riparian Restoration Habitat Creation Site rapid and intensive plots. 2

Figure 2. Palo Verde Ecological Reserve Phase 2 rapid and intensive plots. 3

Figure 3. Palo Verde Ecological Reserve Phase 3 rapid and intensive plots. 4

Figure 4. Palo Verde Ecological Reserve Phase 4 rapid and intensive plots. 5

Figure 5. Palo Verde Ecological Reserve Phase 5 rapid and intensive plots. 6

Figure 6. Cibola Valley Conservation Area Phase 1 rapid and intensive plots. 7

Figure 7. Cibola Valley Conservation Area Phase 2 rapid and intensive plots. 8

Figure 8. Cibola Valley Conservation Area Phase 3 rapid and intensive plots. 9

Figure 9. Cibola Valley Conservation Area Phase 4 East rapid and intensive plots. 10

Figure 10. Cibola Valley Conservation Area Phase 4 West rapid and intensive plots. 11

Figure 11. Cibola Valley Conservation Area Phase 5 rapid and intensive plots. 12

Figure 12. Cibola National Wildlife Refuge Crane's Roost rapid and intensive plots. 13

Figure 13. Cibola National Wildlife Refuge Mass Planting rapid and intensive plots. 14

Figure 14. Cibola National Wildlife Refuge Nature Trail rapid and intensive plots. 15

Figure 15. Intensive plot layout. 18

List of Photos

Photo 1. The density of screwbean mesquite within Beal Lake. 43

Photo 2. Size and density of quailbush within CCR. 43

Photo 3. Density of desertbroom and mesquite within CNT. 44

Photo 4. Bare alkaline areas surrounded by fivehorn smotherweed within CCR. 45

Photo 5. Lack of weedy species within western half of CVCA4 E. 46

Photo 6. Weed control measures within CCR. 47

Photo 7. Horseweed and prickly lettuce infestation within CVCA4 W. 48

APPENDIX A: SUMMARY STATISTICS

List of Tables

Table A1. Mean density of each target tree species per rapid plot. A-1

Table A2. Mean density of all target tree species per rapid plot. A-2

Table A3. Mean density of each target overstory tree species per intensive plot. A-2

Table A4. Mean density of all target overstory tree species per intensive plot. A-3

Table A5. Mean density of all target intermediate tree and shrub species (8–12 centimeters) per intensive plot. . . . . A- 3

Table A6. Mean density of all intermediate tree species (8–12 centimeters) per intensive plot. . . . . A- 4

Table A7. Mean density of each target tree species within each size class per intensive plot. A-5

Table A8. Mean density of each target intermediate tree and shrub species per intensive plot. A-9

Table A9. Mean density of each nontarget intermediate tree and shrub species per intensive plot. A-10

Table A10. Mean height of each target intermediate tree and shrub species per intensive plot. A-11

Table A11. Mean height of all target intermediate tree and shrub species per intensive plot. A-11

Table A12. Mean crown closure percentage per intensive plot. A-12

Table A13. Total vegetation volume (TVV) per intensive plot in cubic meters. A-12

Table A14. Mean percent cover of each herbaceous and shrub species per intensive plot. A-13

Table A15. Mean percent cover of all herbaceous species per intensive plot. A-16

Table A16. Mean percent cover of all shrub species per intensive plot. A-16

Table A17. Mean percent cover of leaf litter, rock/gravel, and bare ground per intensive plot. A-17

List of Figures

Figure A1. The number of each rapid plot target tree species per hectare. A-18

Figure A2. The estimated number of each target tree species per phase. A-19

Figure A3. The number of all rapid plot target tree species per hectare. A-20

Figure A4. The estimated number of all rapid plot target tree species per phase. A-21

Figure A5. The number of each intensive plot target overstory tree species per hectare. A-22

Figure A6. The estimated number of each intensive plot target overstory tree species per phase. A-23

Figure A7. The number of all intensive plot target overstory tree species per hectare. . A-24

Figure A8. The estimated number of all intensive plot target overstory tree species per phase. A-25

Figure A9. The number of each intensive plot target intermediate tree and shrub species per hectare. A-26

Figure A10. The estimated number of each intensive plot target intermediate tree and shrub species per phase. A-27

Figure A11. The number of all intensive plot target intermediate tree and shrub species per hectare. A-28

Figure A12. The estimated number of all intensive plot target intermediate tree and shrub species per phase. A-29

Figure A13. The number of each intensive plot target intermediate tree and shrub species within each size class per hectare. A-30

Figure A14. The estimated number of each intensive plot target intermediate tree and shrub species within each size class per phase. A-31

Figure A15. The mean density of each intensive plot target intermediate tree and shrub species per size class. A-32

Figure A16. The number of all intensive plot (nontarget and target) intermediate tree and shrub species per hectare. A-33

Figure A17. The estimated number of all intensive plot (nontarget and target) intermediate tree and shrub species per phase. A-34

Figure A18. The mean height of each target overstory tree species per intensive plot. . . A-35

Figure A19. The mean height of all target overstory tree species per intensive plot. A-36

Figure A20. The mean height of each target intermediate tree and shrub species per intensive plot. A-37

Figure A21. The mean height of all intermediate tree and shrub species per intensive plot. A-38

Figure A22. The mean percent crown closure per intensive plot. A-39

INTRODUCTION

In 2010 BIO-WEST, Inc. (BIO-WEST) was contracted by the U.S. Bureau of Reclamation (Reclamation) to set up and monitor permanent vegetation plots within Lower Colorado River Multi-Species Conservation Program (LCR MSCP) habitat creation sites. The LCR MSCP was designed to create habitat supporting the conservation of 26 LCR MSCP-covered and evaluated species important to the Lower Colorado River ecosystem. According to the *Lower Colorado River Habitat Conservation Plan* (HCP) (LCR MSCP 2004), approximately 8,100 acres of habitat will be created to reach this goal. Included in the HCP is a long-term monitoring strategy designed to follow the progression of each LCR MSCP habitat creation site goal over time and ensure that goals are reached.

Monitoring data collected by BIO-WEST can be used to characterize habitat composition, structure, and functionality. These data can also be used to identify potential problems within the LCR MSCP habitat creation sites, such as weed infestation and plant stress. Additionally, data obtained during the current monitoring year can be compared with previous years' data to detect changes in vegetation community structure and provide annual benchmark levels with which to determine the progression of each target LCR MSCP habitat creation site.

Using several components of common forestry and vegetation monitoring protocols, data are collected within several parameters and strata to capture a "complete picture" (from ground cover to canopy) of the vegetation composition within each habitat type and at each LCR MSCP habitat creation site. Following multiple years of data collection, trends observed will be used to formulate an adaptive management strategy for each LCR MSCP habitat creation site.

FIELD METHODS

The 2010 Lower Colorado River vegetation monitoring occurred at four different LCR MSCP habitat creation sites and was performed in varying time frames during four separate field events. A detailed field methodology was provided by Reclamation staff in the Lower Colorado River 2010 vegetation monitoring scope of work (Reclamation 2010). This methodology outlined the sampling plot design as well as data collection protocols. During the first event (September 14–24, 2010), BIO-WEST's field crew established field protocol by ground truthing the methodology at the Beal Lake Riparian Restoration Habitat Creation Site (Beal Lake) (Figure 1) and the Palo Verde Ecological Reserve (PVER) Phases 2–5 (Figures 2, 3, 4, and 5). During the second event (September 29–October 8, 2010), the field crew completed monitoring at PVER and then moved on to the Cibola Valley Conservation Area (CVCA) Phases 1–5 (Figures 6, 7, 8, 9, 10, and 11). The third event (October 17–27, 2010) was spent collecting data solely at CVCA. During the fourth event (November 3–9, 2010), the field crew completed work at CVCA and then moved on to Cibola National Wildlife Refuge Unit #1 (CNWR) (Figures 12, 13, and 14). When the crew completed field work for CNWR, two individuals returned to Beal Lake to finish the remaining monitoring for the season.

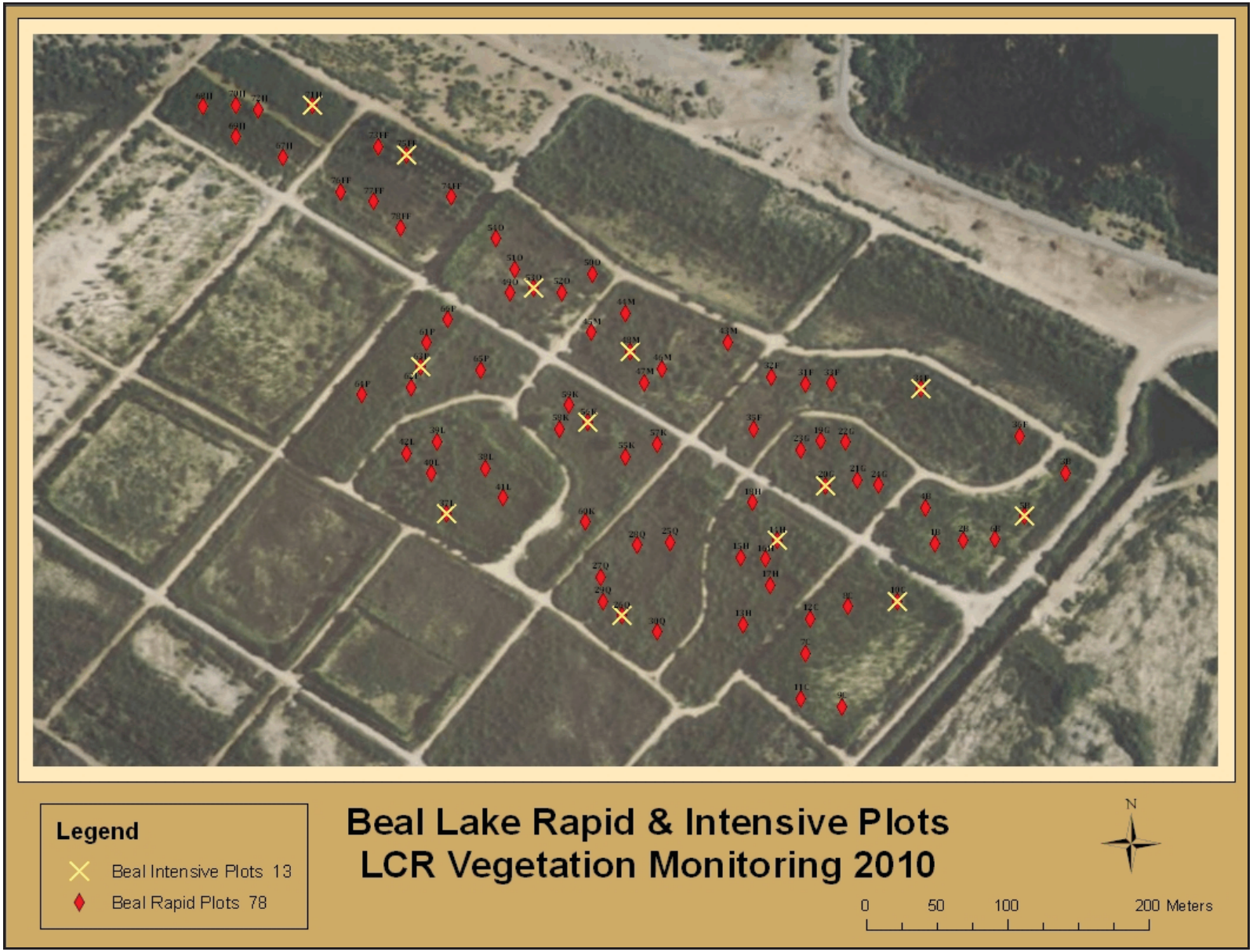

Figure 1. **Beal Lake Riparian Restoration Habitat Creation Site rapid and intensive plots.**

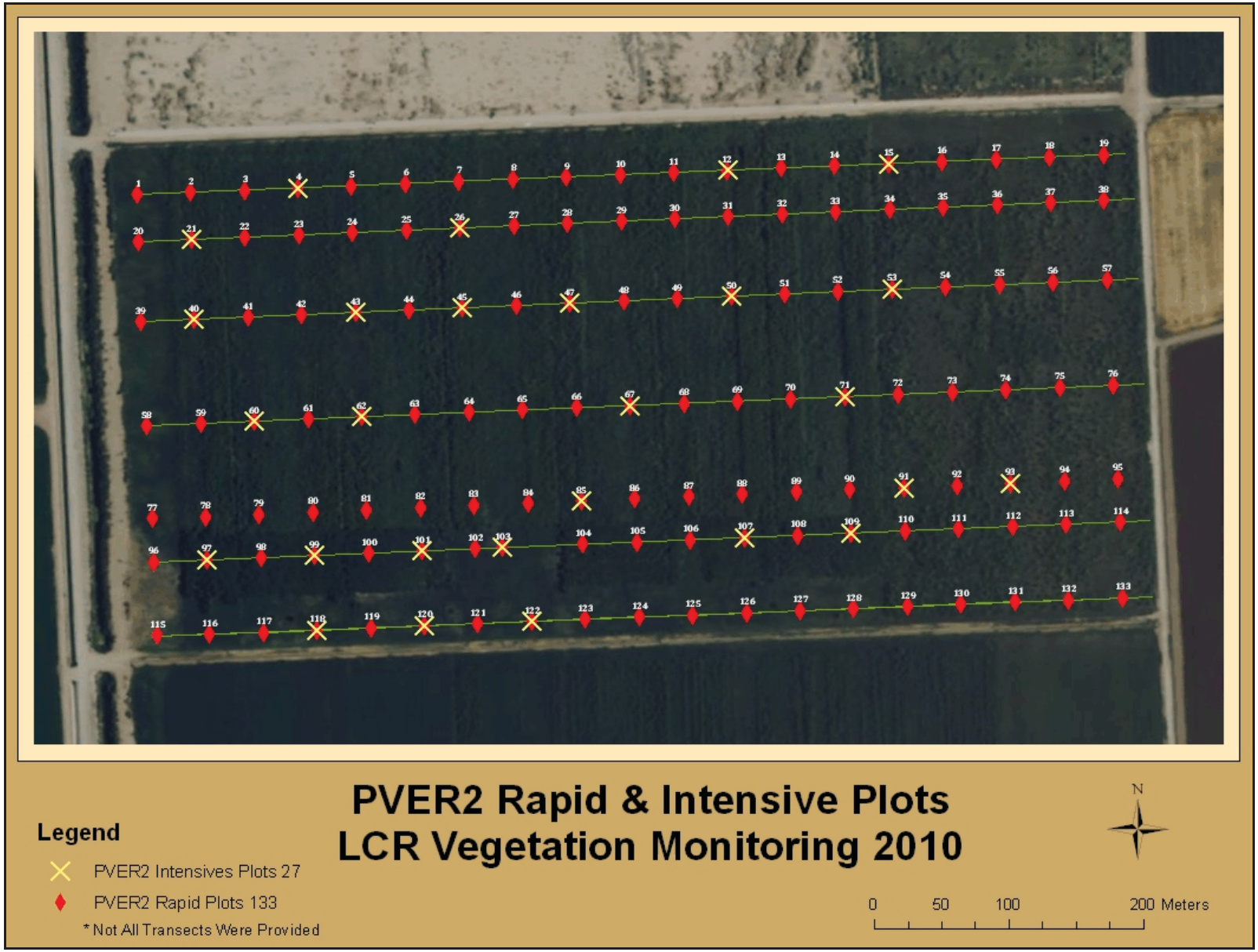

Figure 2. **Palo Verde Ecological Reserve Phase 2 rapid and intensive plots.**

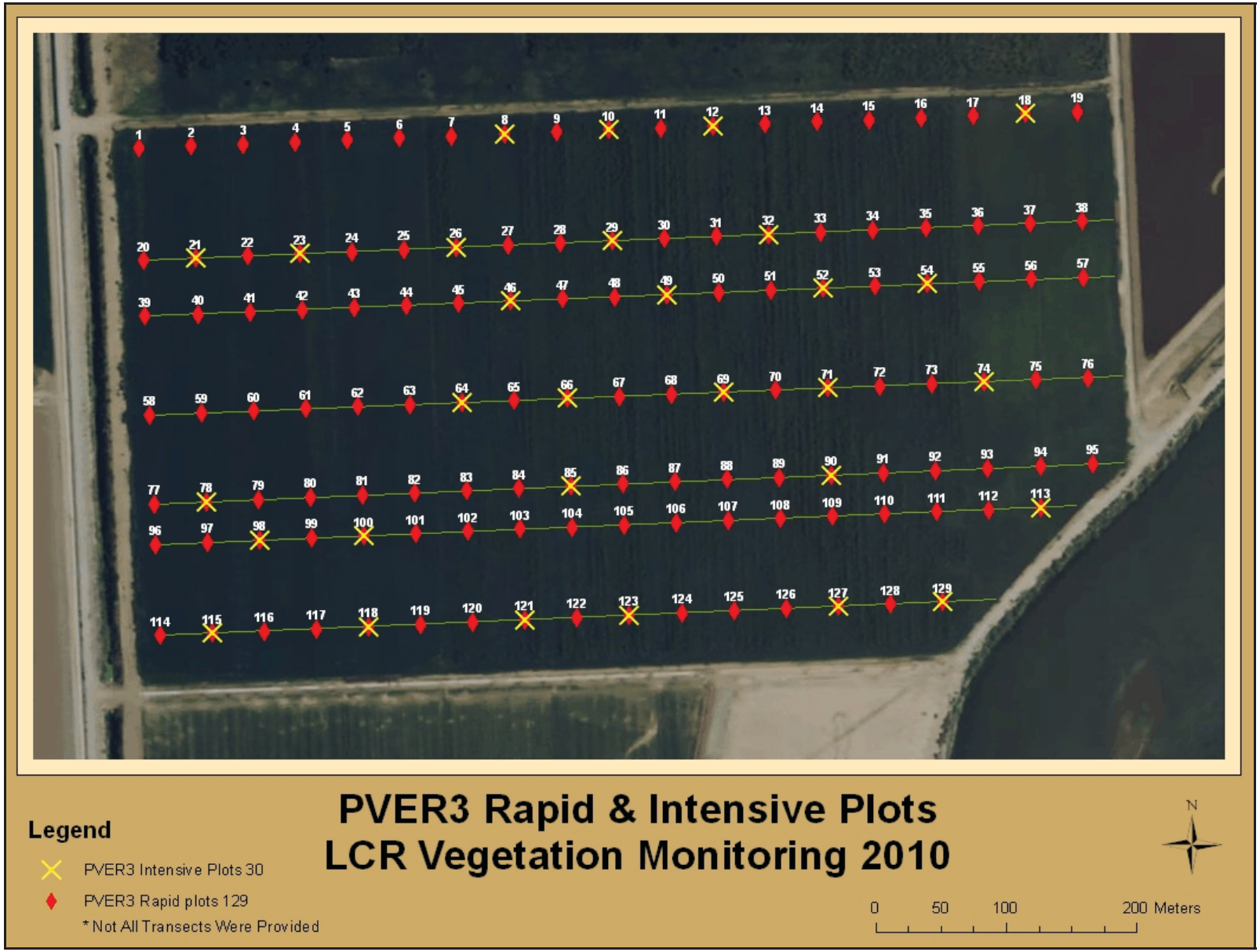

Figure 3. **Palo Verde Ecological Reserve Phase 3 rapid and intensive plots.**

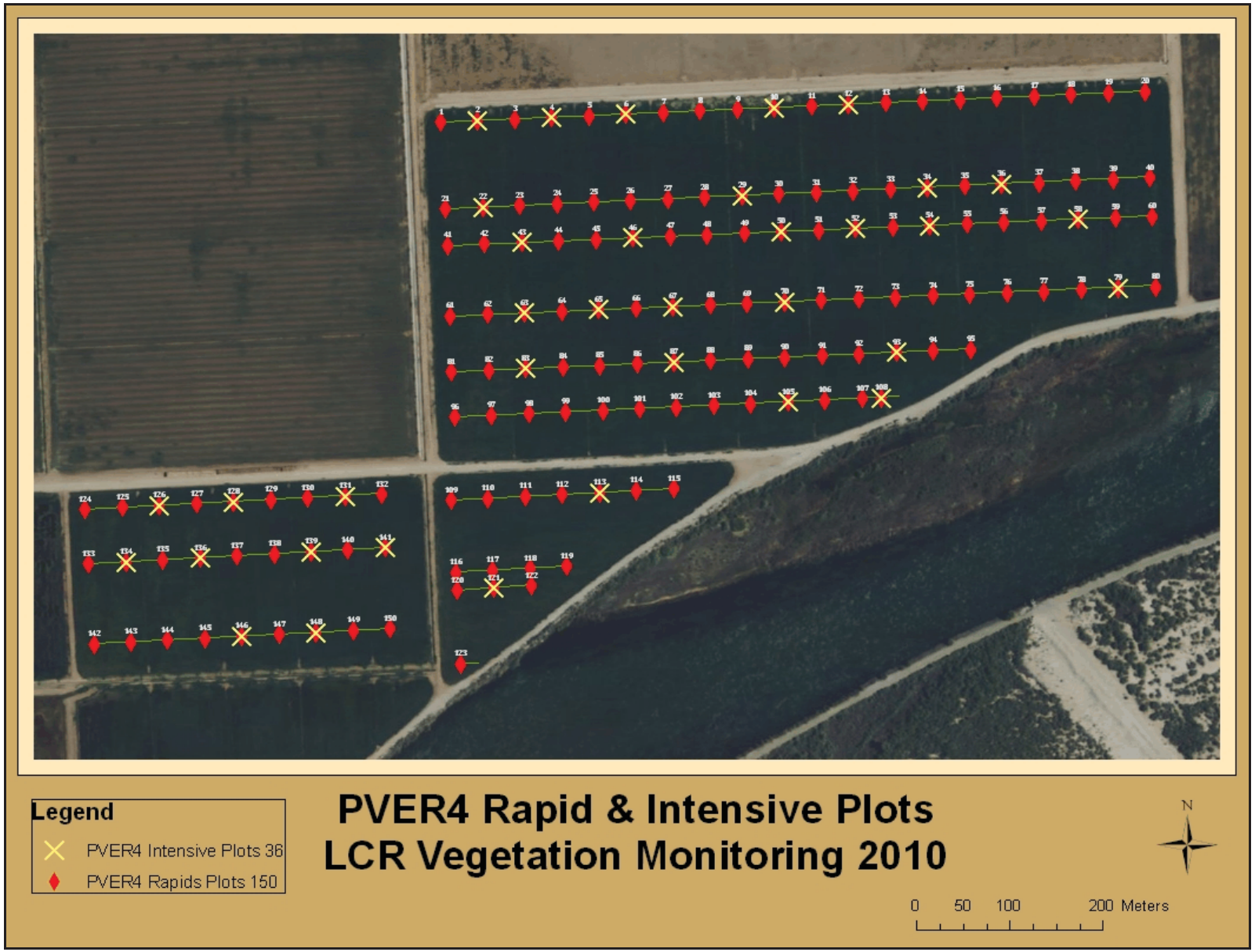

Figure 4. **Palo Verde Ecological Reserve Phase 4 rapid and intensive plots.**

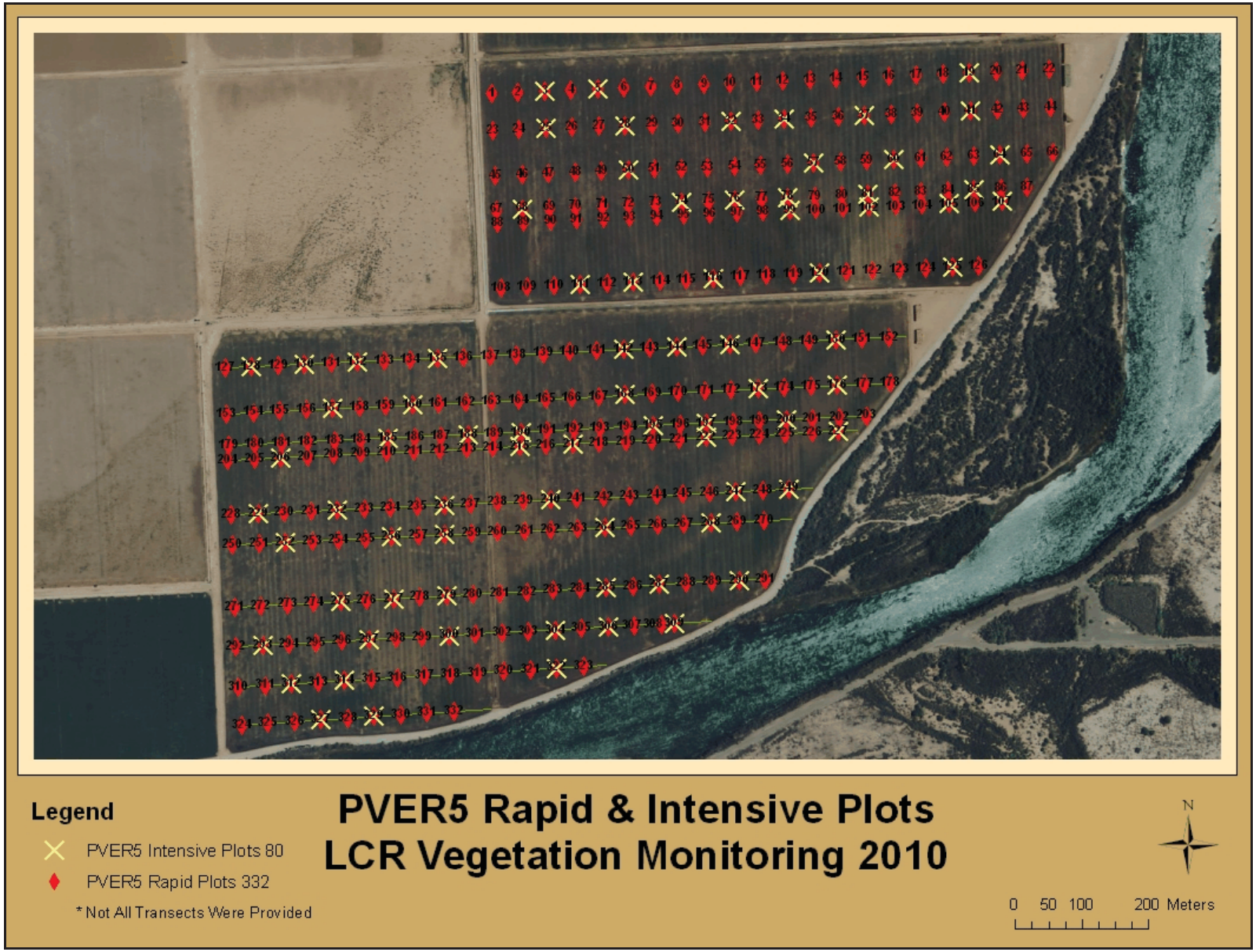

Figure 5. **Palo Verde Ecological Reserve Phase 5 rapid and intensive plots.**

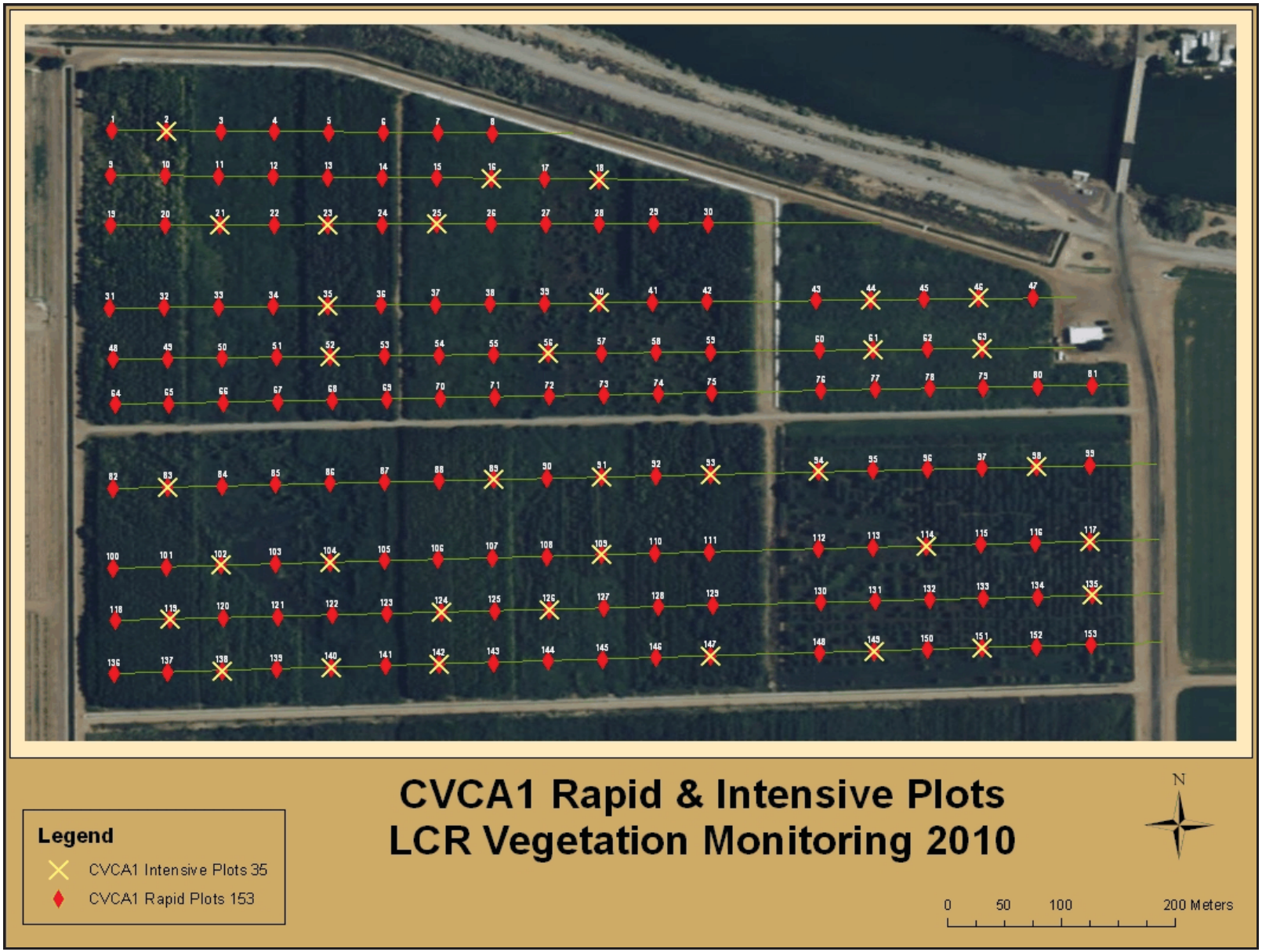

Figure 6. **Cibola Valley Conservation Area Phase 1 rapid and intensive plots.**

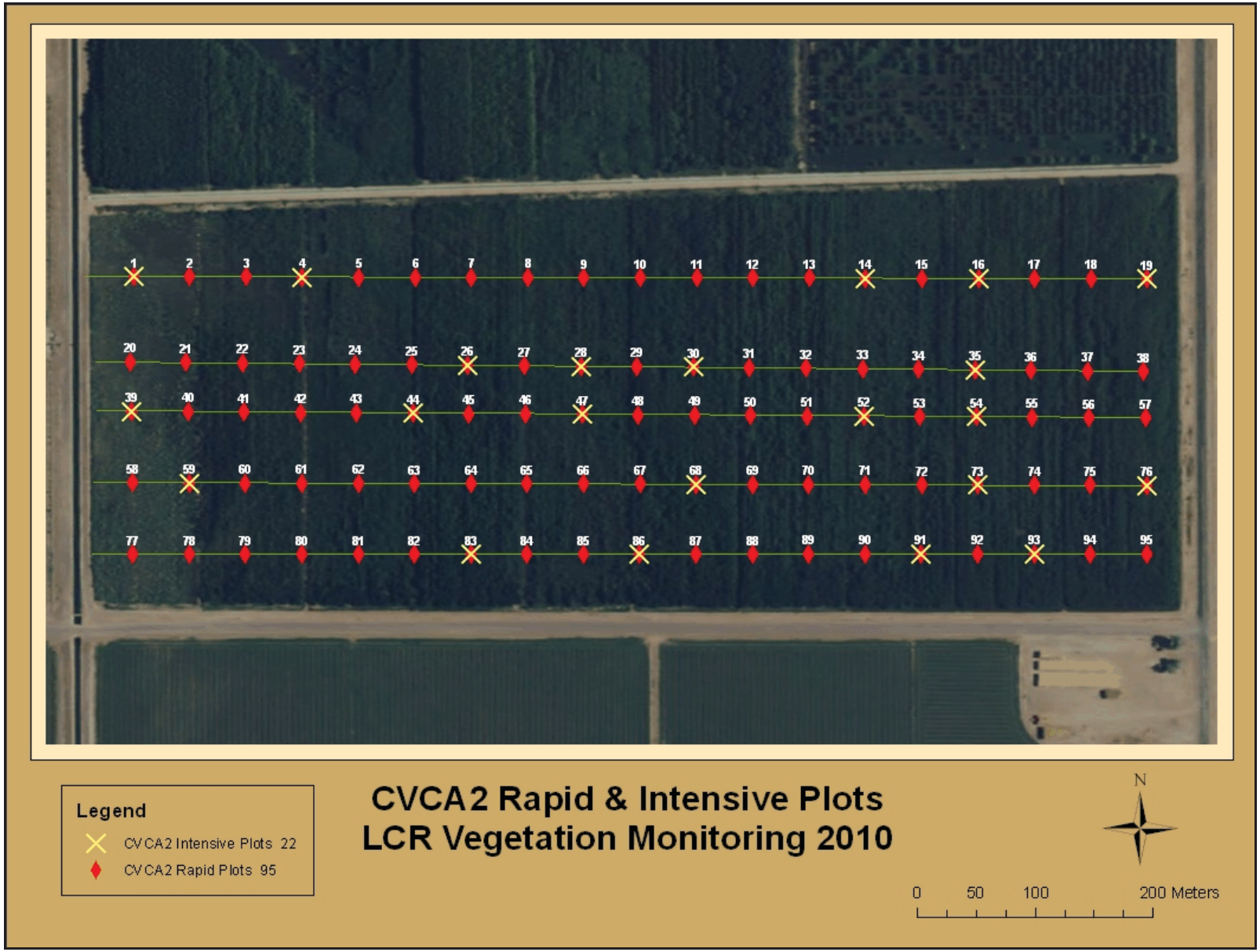

Figure 7. **Cibola Valley Conservation Area Phase 2 rapid and intensive plots.**

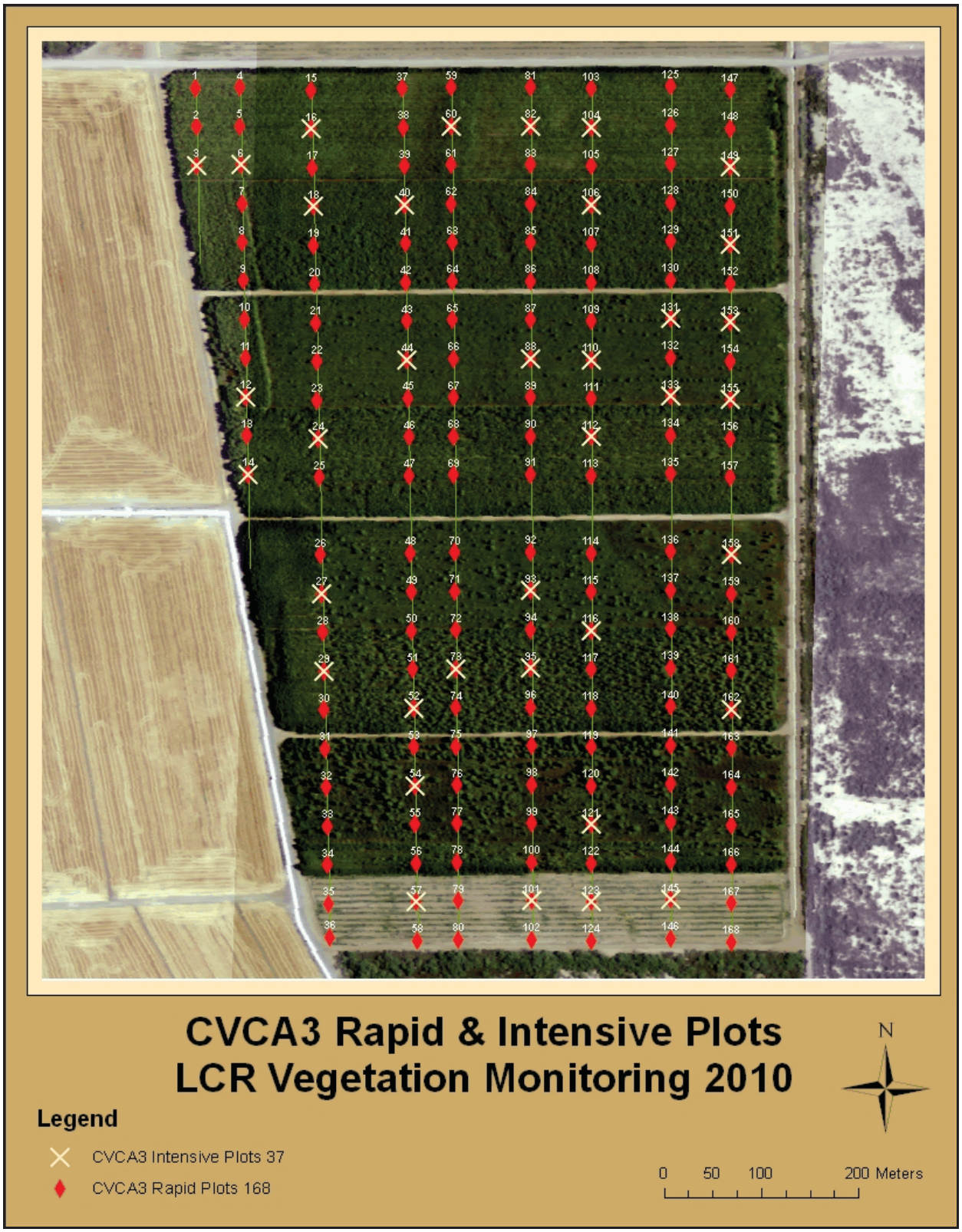

Figure 8. **Cibola Valley Conservation Area Phase 3 rapid and intensive plots.**

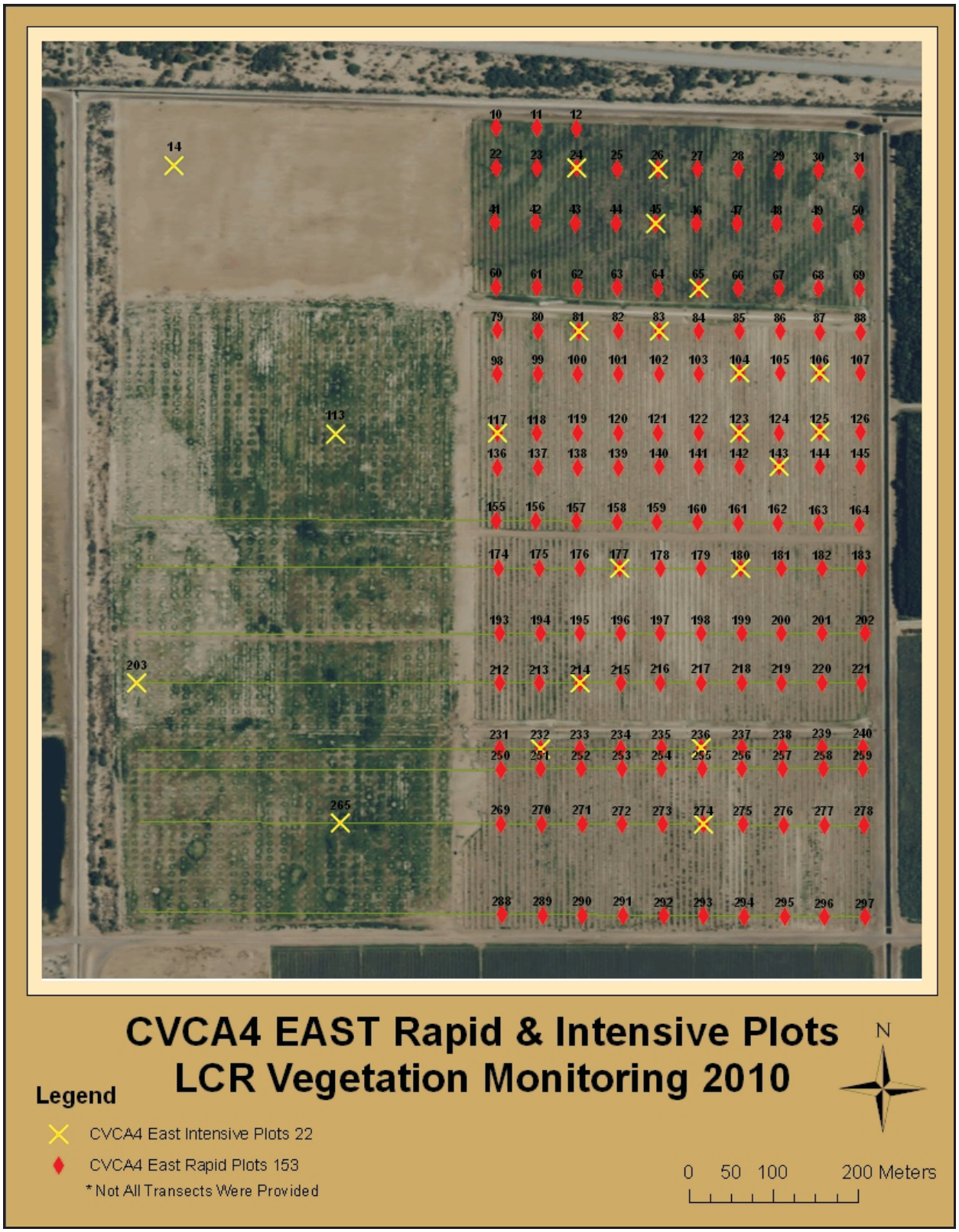

Figure 9. **Cibola Valley Conservation Area Phase 4 East rapid and intensive plots.**

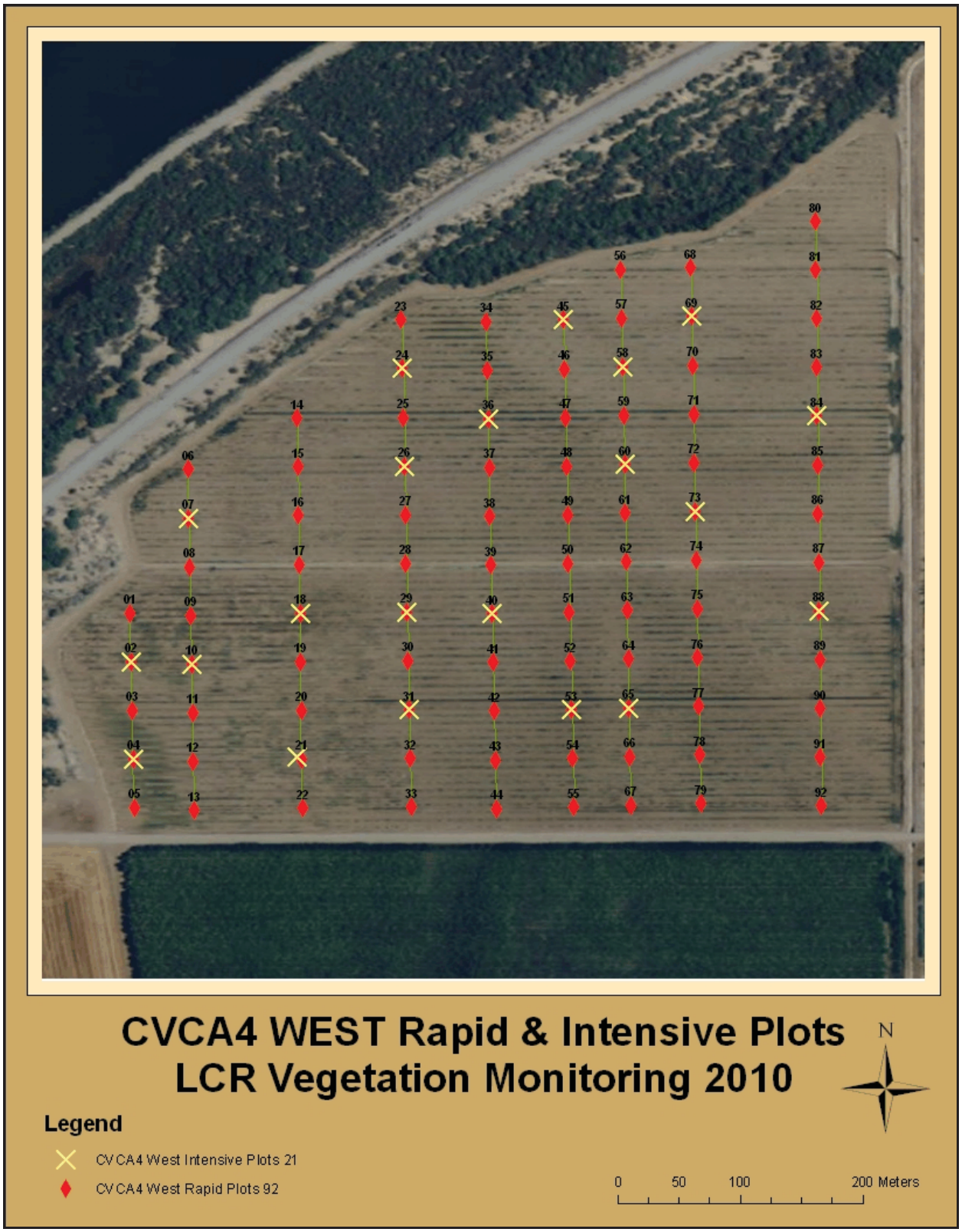

Figure 10. Cibola Valley Conservation Area Phase 4 West rapid and intensive plots.

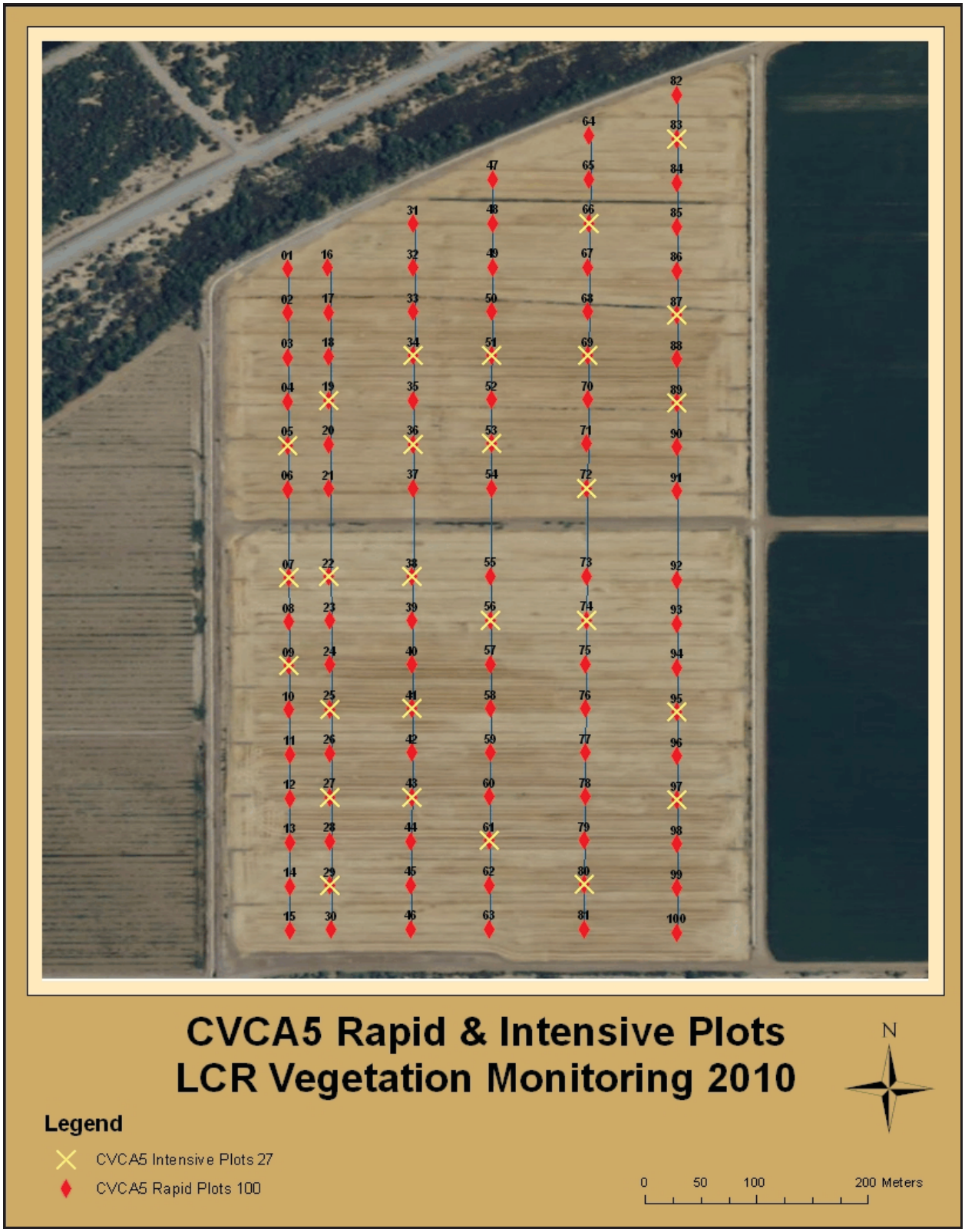

Figure 11. Cibola Valley Conservation Area Phase 5 rapid and intensive plots.

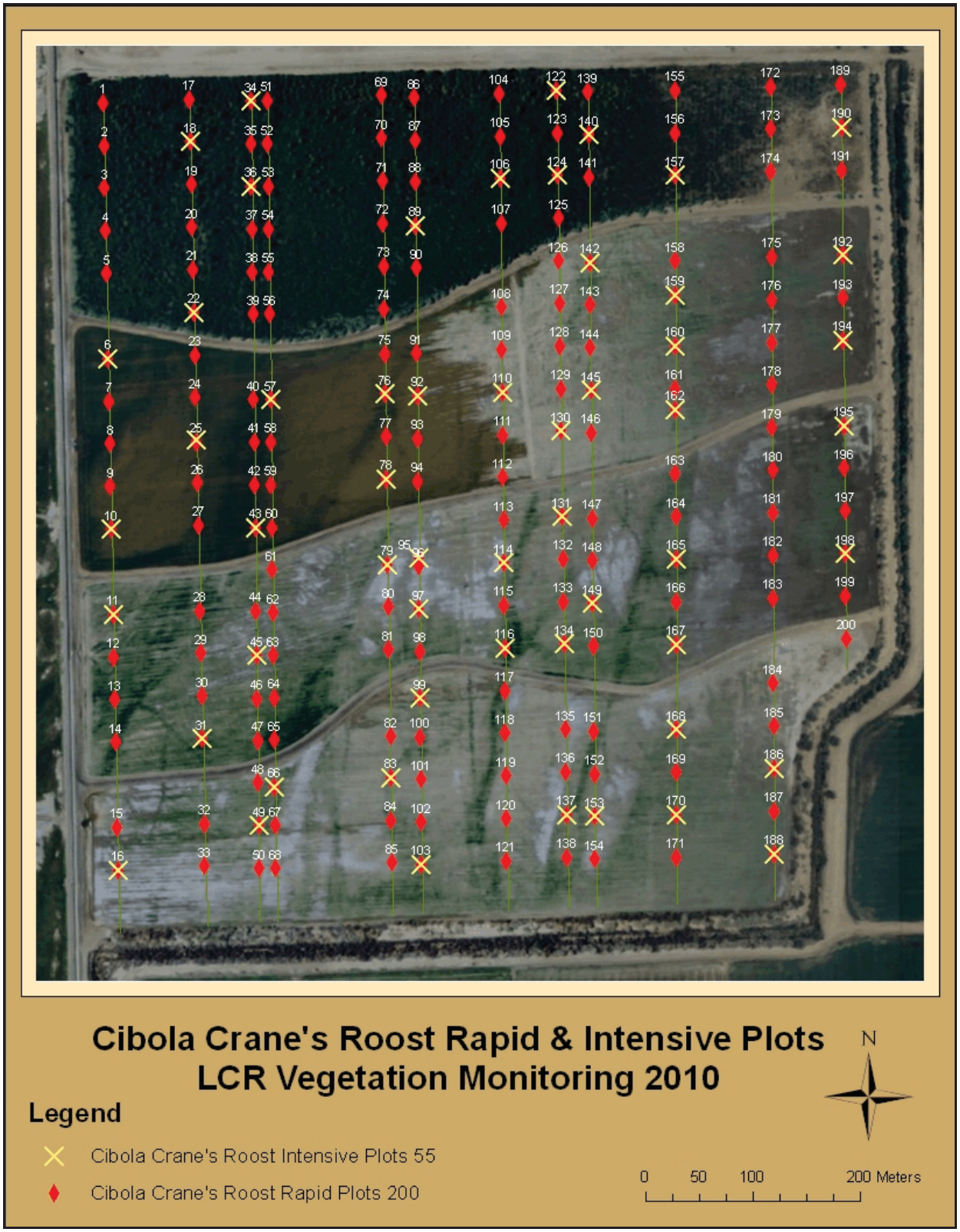

Figure 12. Cibola National Wildlife Refuge Crane's Roost rapid and intensive plots.

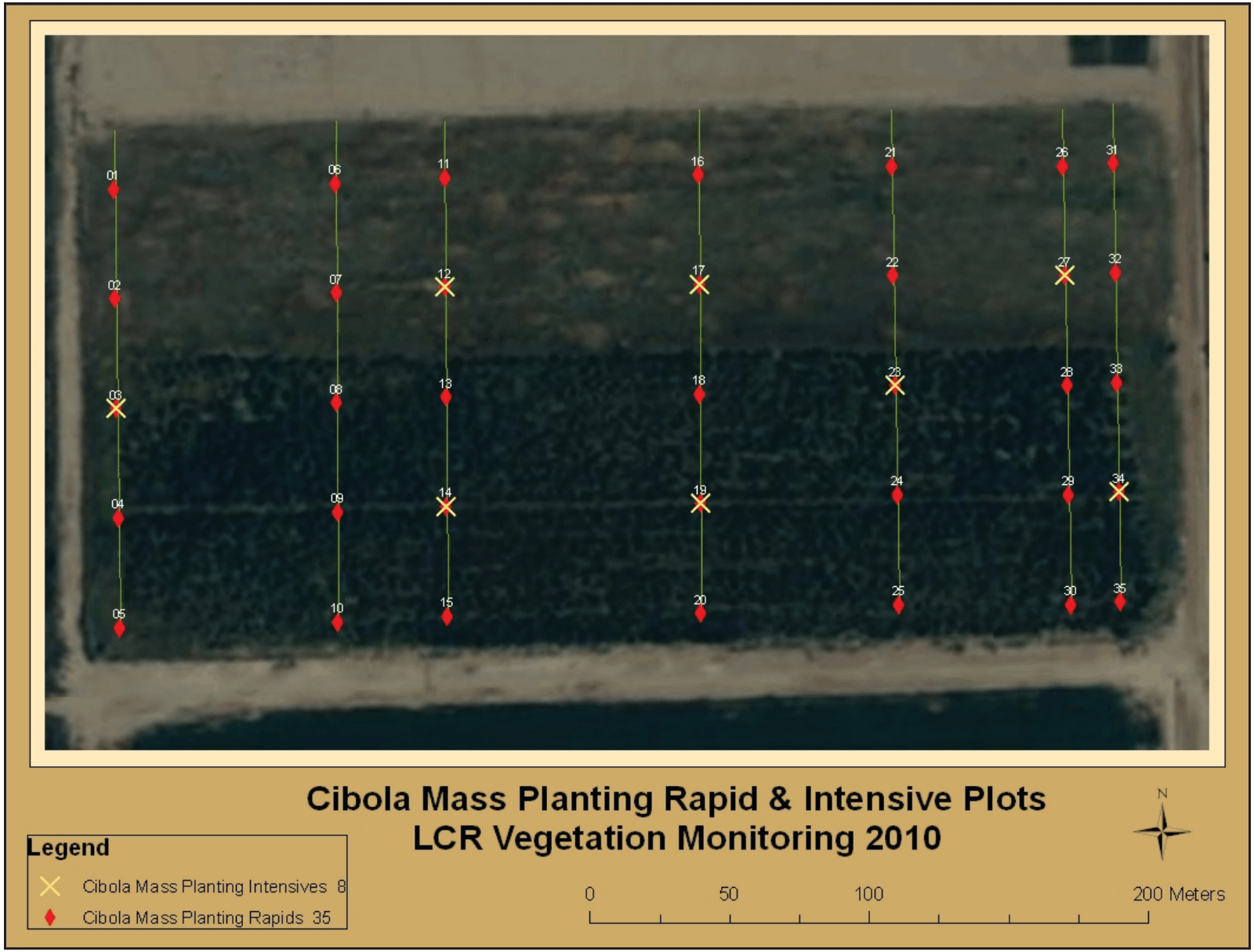

Figure 13. **Cibola National Wildlife Refuge Mass Planting rapid and intensive plots.**

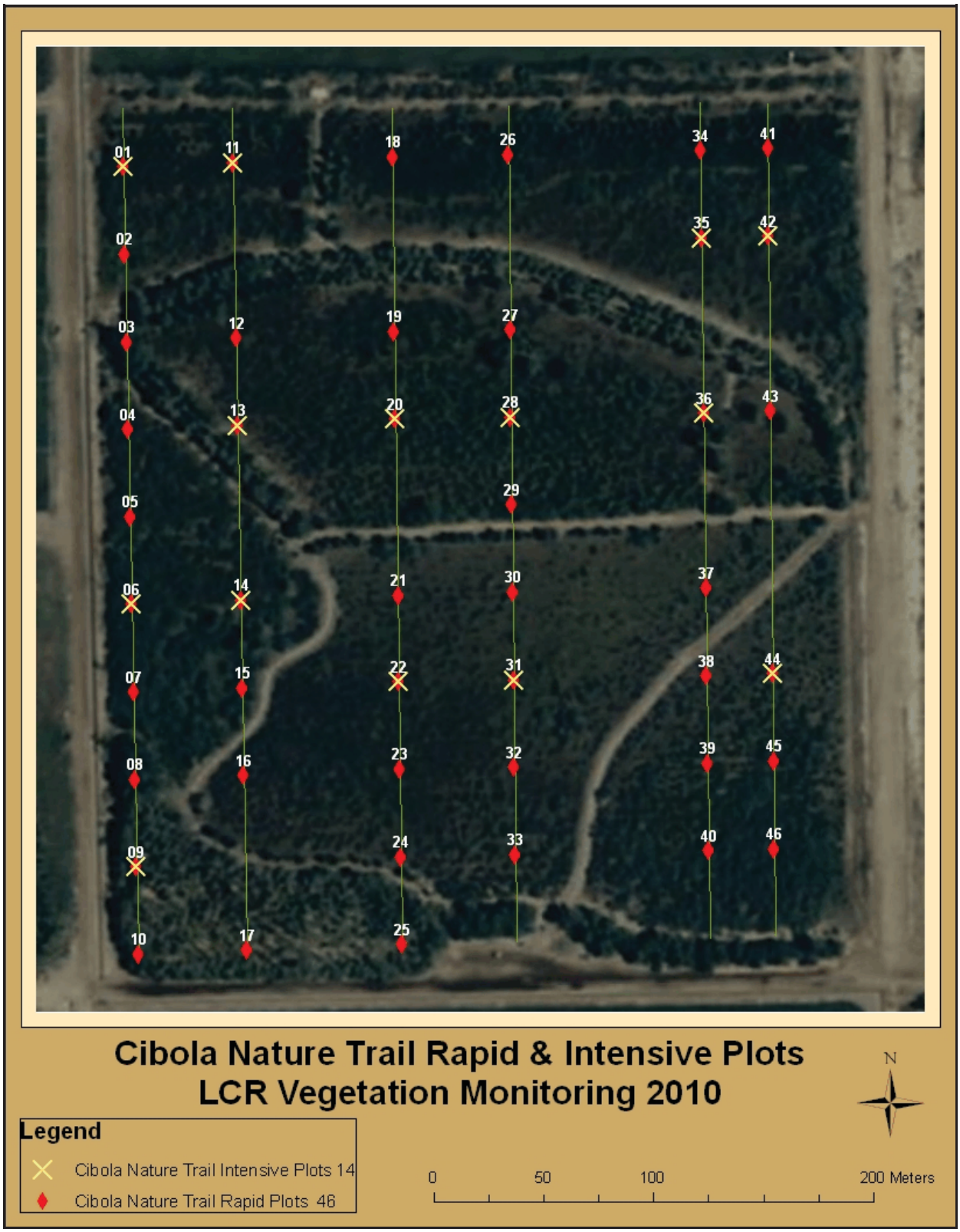

Figure 14. Cibola National Wildlife Refuge Nature Trail rapid and intensive plots.

Two teams of three field biologists each performed field work based on the methodology outlined in the statement of work for all intensive plots. Varying combinations of these same teams also collected data within rapid plots. Because of the number of rapid plots and the intensive subplot dimensions, which differed from rapid plot dimensions, bias on the part of those crew members who surveyed the same rapid and intensive plots was eliminated.

In 2010 Reclamation provided shapefiles for 427 center points for intensive plots. Subsequently, BIO-WEST installed and monitored 427 new intensive plots at the corresponding center point locations. BIO-WEST also evaluated 1,864 rapid plots using rapid plot centerpoints (2,008) from given shapefiles (excluding 144 rapid plots not monitored in CVCA Phase 4 East [CVCA4 E] that were located in a grainfield). The number of plots at each location is shown in Table 1.

Table 1. Distribution of plots for 2010 monitoring year. Intensive plot quantities were calculated based on percent of total acreage of each phase. A total of 427 intensive plots and 1,864 rapid plots was evaluated for 2010 vegetation monitoring.

SITE	ACRES	INTENSIVE PLOTS	RAPID PLOTS
Beal Lake	26	13	78
PVER2	72	27	133
PVER3	80	30	129
PVER4	97	36	150
PVER5	210	80	332
CVCA1	91	35	153
CVCA2	71	22	95
CVCA3	103	37	168
CVCA4 East	91	22	153
CVCA4 West	58	21	92
CVCA5	71	27	100
CNWR CNT	36	14	46
CNWR CCR	147	55	200
CNWR CMP	20	8	35
Totals	**1,172**	**427**	**1,864**

Vegetation Sampling

Plot center points were randomly preselected within each phase, or field in the case of Beal Lake. The plot centers were placed by randomly locating a starting point within 20 meters (m) of a phase edge and creating plot centers every 40 m on transects placed across a habitat gradient. These points represented rapid plot center points. A random subset of the rapid plot center points was selected for installing intensive monitoring plots (Reclamation 2010).

Shapefiles of these rapid plot and intensive plot center points, along with transects, were provided by Reclamation staff. BIO-WEST staff then numbered rapid plot center points starting at the northwest corner of each phase with the ascending order following the horizontal or vertical orientation of that phase's transects. The intensive plot center points were then spatially matched with the corresponding, numbered rapid plot center point and assigned the same number. These numbers correspond to the plot ID numbers found on datasheets and within the database.

Rapid Plot Set Up

Center points used for rapid assessments of the density of target tree species (Fremont cottonwood [*Populus fremontii*], Goodding's willow [*Salix gooddingii*], coyote willow [*Salix exigua*], honey mesquite [*Prosopis glandulosa*], and screwbean mesquite [*Prosopis pubescens*]) were provided and GPS coordinates were generated in ArcMap for each center point. These X and Y coordinates were used to navigate to the center of each rapid plot, which was temporarily flagged. Field biologists then used a precut 5-m rope to establish visual boundaries, within which they counted and recorded the number of each target species present. When it was observed that the density of brush regularly inhibited the placement of reference flagging along the 5-m border of many rapid plots, a circular, spatial (GPS) buffer was created in ArcMap and loaded into GPS units to increase the accuracy of tree estimations. These spatial points were used throughout all phases of the project as needed. All flagging was removed after data were collected. In subsequent years these same coordinates can be used to navigate to rapid plots using submeter-accurate GPS units. Rapid plot corners were also generated in ArcMap, and their corresponding coordinates provided.

Intensive Plot Set Up

Rebar was installed at each intensive plot center point, along with an aluminum survey cap stamped with the date, plot number, and GPS coordinates. Once an intensive plot was established, it represented a permanent location that would be monitored annually to determine changes in the vegetation community over time. Intensive plots were laid across the gradient of the planting design (except at Beal Lake where all plots were placed with the long edge in the southeast to northwest direction). In compliance with methodology, intensive plots were created as nested plots of three sizes including one primary plot (10x40 m divided into four 10x10-m quadrants), one secondary plot (5x15 m), four tertiary plots (0.5x2 m), and four transects radiating from the center of all primary plots in each cardinal direction (Figure 15).

After evaluating the time it took to implement intensive plot set up using standard survey equipment (e.g., compasses and measuring tapes), it was determined that spatial (GPS) reference was needed for all points of data collection to expedite plot boundary determination. These data collection points were created in ArcMap, imported into PathFinder, and then loaded onto GPS units as background files, which were used for navigation. This process was ground truthed

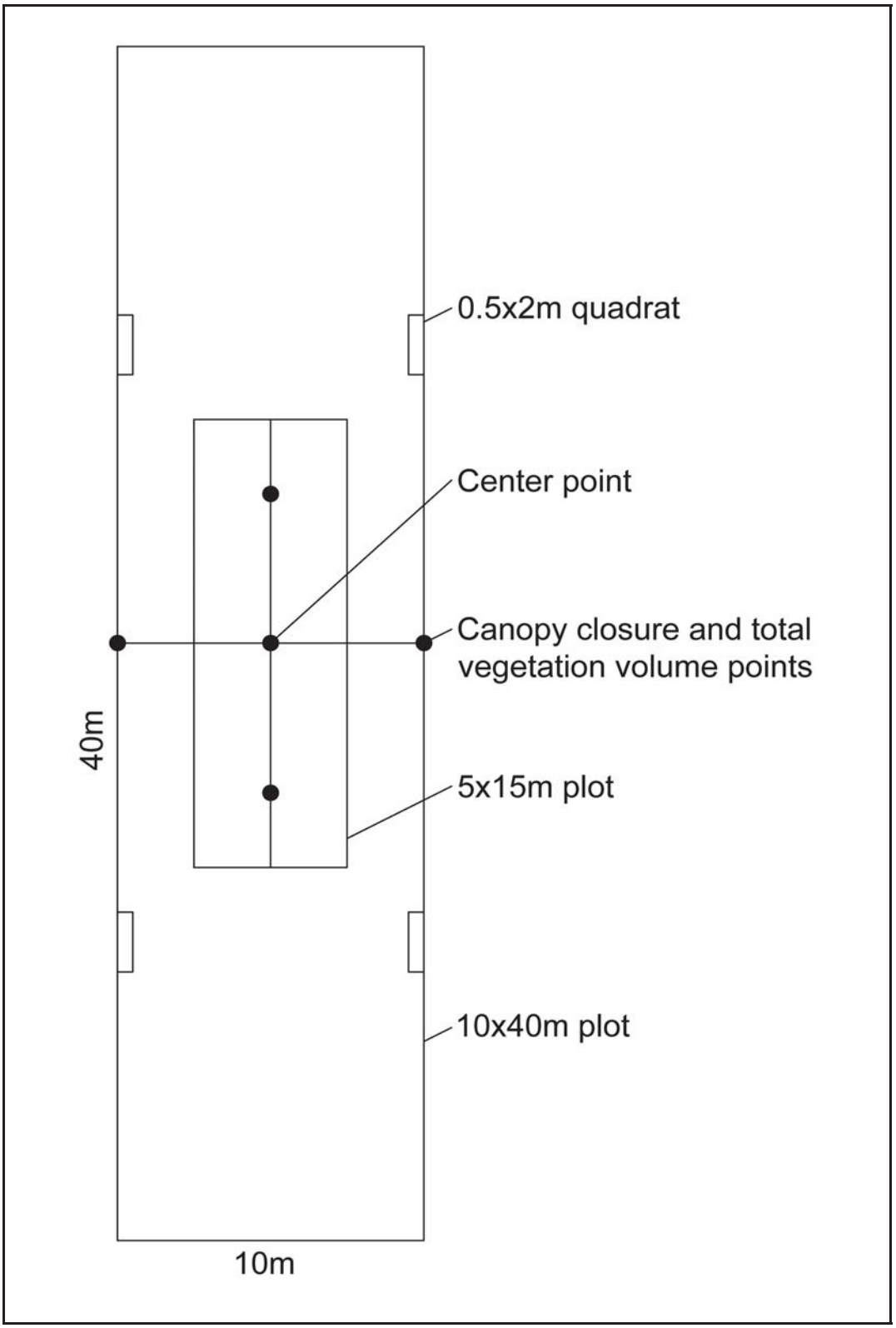

Figure 15. Intensive plot layout.

before implementation. Flagging was then used to mark the reference points on the ground while monitoring. These reference points (shapefiles) will also be available for use in subsequent years, which will increase the repeatability and accuracy of future monitoring.

Transect start and end points were permanently marked with flagged rebar within each phase (although it was observed that much of the flagging was removed by animals as early as the next day). The lower right and upper left corners of each primary plot were also permanently marked with flagged rebar. Secondary plots (5x15 m) were nested in the center of primary plots (10x40 m) and tertiary plots (0.5x2 m) were placed within the primary plot along the long edges but outside of the secondary plot. Compass bearings were included for each transect in the provided shapefiles and the long edge of intensive plot borders (reference points) were aligned with the same bearing within ArcMap for each phase.

Overstory Tree Species

Within the primary plot (10x40 m), overstory tree species with a diameter at breast height (DBH) ≥ 12 centimeters (cm) were monitored. Tree species, height, and DBH were recorded in metric with tree height collected in tenths of a meter and DBH collected in tenths of a centimeter.

The DBH was taken at a point 4.5 feet (ft) above the ground (Avery 1975). The DBH measurements were made with a tree caliper in most instances; a diameter tape was only used when DBH exceeded tree caliper dimensions (20 cm).

The measurement of DBH on irregular trees (when swellings, bumps, depressions, or branches occurred at DBH) was taken just above or below the irregularity at a point where it ceased to affect normal stem form (Avery 1975). Although stems or trunks that branch below DBH are sometimes considered two separate trees, in this study this type of branching led to the measurement of the largest, or main, stem of the tree, as well as the recording of the smaller additional stems. Stems that branched close to DBH were measured below the branch irregularity (if this measurement could be made 3 ft above ground) and recorded as a single stem measurement. For stems that branched lower than this point (< 3 ft), a measurement of the largest stem at DBH was recorded in the main data column, additional stems were counted, and an average DBH and number of stems were recorded.

The true measurements of five trees within each primary intensive plot were taken and remaining trees were compared with those measured to expedite monitoring time. Tree height was measured with a 7.5-m survey rod. The 2-m level was then observed on the body of the technician holding the survey rod and was lifted to that point, creating a 9.5-m measurement. Height of all trees > 9.5 m was estimated.

Honey mesquite and screwbean mesquite species in the primary plot were monitored if their height was > 1.4 m. Crown diameters (two measurements taken perpendicular to each other

from tip to tip of the longest branches) were recorded for all mesquite species (*Prosopis* spp.) in the > 1.4-m category that met height criteria.

The location within the secondary plot (left or right) and its relativity to the center point were also recorded for all species. A tally of all dead snags (no species noted) was estimated in the following size categories: 12–20 cm, 20–40 cm, and > 40 cm DBH. Very few snags were recorded since mortality was very low across habitat creation sites.

Intermediate Tree and Shrub Species

Within the secondary plot (5x15 m), intermediate target tree species (Fremont cottonwood, Goodding's willow, and coyote willow) with a DBH 8–12 cm were evaluated. If a tree's DBH was 8–12 cm, species, height, and DBH data were recorded. Measurements were collected in tenths of a metric unit. The tree species with a DBH of < 8 cm were placed into one of two size classes (≤ 2.5 cm and 2.51–7.99 cm). The number of each species in each size class was then tallied and recorded.

Honey mesquite and screwbean mesquite species in the secondary plot were monitored if their height was < 1.4 m. Crown diameter was recorded for all mesquite species in this category that met the height criteria (individuals > 1.4 m were recorded in overstory data).

Height and crown diameter of additional intermediate tree and shrub species—which include baccharis species (*Baccharis* sp.), saltbush species (*Atriplex* sp.), arrowweed (*Pluchea sericea*), and tamarisk species (*Tamarix* sp.)—within the secondary plot with heights ≥ 1.4 m were recorded. Starting in CVCA Phase 5 (CVCA5) and continuing through CNWR and Beal Lake, when additional intermediate numbers were excessive (> 30), foliar cover was estimated within the subplot and a stem count was recorded to provide density estimations. These stem count estimates were not included in the data analysis. Individuals < 1.4 m were tallied and recorded by species.

Target tree species within the secondary plot were monitored for inclusion in the first-year size class if the phase was planted in 2010.

Ground Cover/Herbaceous Layer

Ground and foliar cover data were collected within the four tertiary plots placed along the long edge of the primary plots (centered at the 5-m and 15-m marks so that the entire tertiary plot is within the primary plot) (see Figure 1).

Foliar and ground cover were estimated by using PVC quadrants to "frame" the tertiary plots and technicians were instructed to visualize the aerial coverage of all annuals, perennials, and small shrubs not included in intermediate tree and shrub classes as a picture within this frame. All foliage was visually condensed to minimize open space and the contents of those areas were

recorded within the following cover classes: 1 = 0–1%, 2 = 1–2%, 3 = 2–5%, 4 = 5–10%, 5 = 10–25%, 6 = 25–50%, 7 = 50–75%, 8 = 75–95%, 9 = > 95%.

Foliar cover and ground cover were treated as separate categories on the datasheet. Cover within each category equaled 100%.

Intermediate tree and shrub species found within the tertiary plots were not recorded unless they fell within the < 1.4-m category, where they were then considered a sapling or small shrub and, therefore, foliar cover.

Dead tree and/or large shrub species were recorded as present/dead within foliar cover. All dead annuals, perennials, and shrubs were recorded in one cover class assignment labeled "Dead Veg" within groundcover.

The following categories represent nonvegetated groundcover: leaf litter, rock/gravel, and bare ground. These categories were recorded in the following cover classes: 1 = 0–1%, 2 = 1–2%, 3 = 2–5%, 4 = 5–10%, 5 = 10–25%, 6 = 25–50%, 7 = 50–75%, 8 = 75–95%, 9 = > 95%.

Canopy Closure

The percent canopy closure was measured at five different locations within each secondary subplot. These locations were at the center point and end of each 5-m transect, laid in the four cardinal directions from center. Data were taken using a spherical densiometer attached to a 1.2-m-long PVC pipe and the number of dots covered by canopy and open sky were recorded. In this case dots were considered intersections of lines on the densiometer. Using a methodology similar to a sighting tube, there were a total of 37 intersections. Sighting canopy closure over cross hairs (or line intersections) can be more precise than sighting canopy over imagined dots within each square on the densiometer. The total number of intersections covered by canopy was multiplied by a factor of 2.702 to obtain the percent crown closure.

Total Vegetation Volume (TVV)

Total vegetation volume (TVV) from canopy top to ground level was monitored along the cardinal transects established for canopy closure and at the center point of each intensive plot. At each position a 7.5-m survey rod was extended through the canopy and data were recorded by species based on all vegetation that came within a tenth of a meter to the survey rod. At every tenth of a meter section, a "hit" was recorded when a species fell within that proximity of the rod. A maximum number of 10 hits per meter was collected. If more than one species was present within proximity to the rod, "hits" were assigned based on percent composition (visual estimation of species dominance) of each species present, so that the 10-hits-per-m mark was never exceeded.

The TVV was measured with a 7.5-m survey rod. The 2-m level was then observed on the body of the technician holding the survey rod and lifted to that point, creating a 9.5-m measurement, and hits were recorded to that level. The TVV for all trees > 9.5 m was visually estimated.

Additional Collected Data

When an intensive or rapid plot's boundaries fell within 5 m of a road, phase/check boundary, or boundary of another plot, the entire plot was moved in 1-m increments in the direction away from the unmonitorable area until a 5-m buffer was established. If it was necessary to move the intensive plot to the nearest rapid plot that did not contain a monitoring obstacle, the intensive plot's number was changed to that of the new rapid plot it corresponded with. These points were moved both manually in the field and spatially in ArcMap. No intensive or rapid plots were eliminated during this process.

Determining whether a plant was inside or outside of a plot depended on the plot border. Plants along plot borders 1 and 2 (border 1 is the first short border a researcher encounters along the transect moving from transect start to transect end) were considered within the plot and data were recorded. Plants along plot borders 3 and 4 (border 3 is the second short border a researcher encounters along the transect moving from transect start to transect end) were considered outside of the plot and no data were recorded.

Additional variables recorded on the datasheet included the distance to nearest standing water (excluding irrigation) and open space (≥ 6 m). Gap widths were visually estimated in the field and placed in one of the following width categories: 6–9 m, 9–12 m, or > 12 m. If there was any question as to whether these standing water and canopy gap distances were > 30 m in the field, the data entry was left blank. The distances were then confirmed using aerial imagery and GIS and the correct distance was entered in the project database. For each intensive plot, all additional plant species found within the primary plot that weren't recorded in the secondary or tertiary plots were recorded as present on the datasheet.

At least three photos were taken at each intensive plot. All photos were taken directly north (0˚) of the center point at 10 m. The first photo is of the 7.5-m survey rod with flagging at the 3-m and 6-m marks. The second photo is of the density board facing the camera. The third photo is a "blank" with nothing but vegetation visible. If the rod or the density board was not visible at 10 m, the photographer walked toward the center point until he/she was able to see either item and take another picture. Any variation on distance from center point and angle due to visibility were recorded on the datasheet. Photo numbers, compass bearing, photographer, date, and time of day were also recorded for each plot.

A herbarium collection was created by pressing representative plant specimens for all plant species found within intensive plots at each LCR MSCP habitat creation site. Each representative specimen within the plant press includes an index card with species information (scientific and common names), date, location, plot number, collector's name, at least two

associated species, and GPS coordinates. At least one specimen of every observed species from every LCR MSCP habitat creation site is included in this collection, and whether the specimen is from a rapid or intensive plot is noted.

RESULTS

The following data were summarized according to Reclamation's requested analyses. Summary statistics are tabulated and graphed in Appendix A and discussed below.

Rapid plot data for the four habitat creation sites and LCR MSCP habitat creation sites were analyzed by calculating the mean density of each target species per rapid plot, as well as the mean density of all target species per rapid plot. The data were also reported in terms of the density of each target species per phase and the density of all target species per hectare. In addition, the estimated number of trees per phase was extrapolated using the sample size and size of each phase (or site in the case of Beal Lake).

Overstory data were analyzed in terms of mean density of qualifying target overstory tree species (target species with a DBH of ≥ 12.0 cm) per intensive plot and mean density of all target tree species per intensive plot. They were also reported in terms of mean density of target overstory species per phase and mean density of all qualifying overstory tree species per phase. In addition, the mean height of each qualifying target species and the mean height of all target species were reported per intensive plot. The mean height per phase was extrapolated.

Intermediate- and shrub-layer data were collected according to the following categories: target species with a DBH 8.0–12.0 cm; target tree species within the size class of a first-year planting, DBH ≤ 2.5 cm, 2.51–7.99 cm, and < 1.4 m (honey mesquite and screwbean mesquite); and additional nontarget species. The first category was analyzed for mean density of each target species per intensive plot, mean density of all target species per intensive plot, and mean density of each target species per phase. The second category was analyzed for mean density by target species within each size class per intensive plot and per phase. The last category was analyzed for mean density by target species per intensive plot and per phase, as well as mean density of all target species per intensive plot and per phase. Finally, all intermediate- and shrub-layer data were combined and analyzed for total mean density per intensive plot and per phase.

Table A13 in Appendix A reports the calculated TVV within each intensive plot. The TVV was calculated using the following equation: TVV = H/10p, where H represents the total number of vegetation hits recorded over all meter layers (see previously described methods) and p is the number of meter layers measured multiplied by the number of sampling locations within an intensive plot (seven meter layers surveyed multiplied by five sampling points within the intensive plot) (Mills et al. 1991). The resulting TVV is reported in cubic meters (m^3) of vegetation.

Ground cover data were analyzed using the median value of each cover class within which a species was recorded. Ground cover classes are defined in the methods section of this document. According to the methodology, the following were determined: (1) mean cover percentages using the median cover values for herbaceous and shrub species per intensive plot and per phase; (2) mean percent cover for all herbaceous species per intensive plot; (3) mean percent cover for all shrub species per intensive plot; and (4) mean percent cover for leaf litter, rock/gravel, and bare ground per intensive plot.

The mean percent ground cover of all herbaceous and shrub species per intensive plot is reported in Appendix A, Table A14.

Beal Lake

Rapid Plots

The mean density of target tree species per rapid plot and phase at Beal Lake varies among species (Appendix A, Table A1 and Figures A1 and A2). The tree species with the lowest mean densities at all rapid plots throughout Beal Lake are Goodding's willow and coyote willow. The majority of the rapid plots at this LCR MSCP habitat creation site do not contain any of the three species. The species with the highest mean density in rapid plots is Fremont cottonwood. Due to the planting scheme at Beal Lake, there are no rapid plots with high densities of multiple species. In other words, if Fremont cottonwood is present in high numbers, there are either no other target species in the plot or few individuals of other species occur in the plot.

Intensive Plots

Of 13 intensive monitoring plots at Beal Lake, 11 contain qualifying overstory tree species (Appendix A, Table A3). The species with the highest mean density per intensive plot is screwbean mesquite. Fremont cottonwood is present but in low densities of 1.85 trees per intensive plot. There are no qualifying Goodding's willow or coyote willow in the intensive plots at Beal Lake. The mean density of all species throughout the monitored fields is > 4,000 trees per hectare (Appendix A, Figure A8).

The mean height of each qualifying overstory species per plot and the mean height of all overstory tree species per plot are represented in Appendix A, Figure A18. Mean Fremont cottonwood heights at Beal Lake range from 7.5–12.0 m. Several plots do not contain qualifying Fremont cottonwood. As mentioned in the density summaries, there are no qualifying overstory willow species at Beal Lake in intensive plots. The mean heights of screwbean mesquite are 3.96–6.43 m. The mean heights for overstory tree species at Beal Lake are between 3.78–12.0 m. The majority of monitoring plots at Beal Lake are located within mature planting areas as evidenced by the mean height data. The lack of qualifying willow species is likely due to coyote willow growth and a lack of Goodding's willow general composition at Beal Lake.

There are very few qualifying target intermediate-layer tree species at Beal Lake (Appendix A, Table A5). Of 13 intensive plots 6 contain intermediate- and shrub-layer trees, which are all Fremont cottonwood. The mean density of Fremont cottonwood is 3.83 trees per plot. Within Beal Lake there are > 3,000 Fremont cottonwood trees per hectare and an estimated 4,000 total target trees within the site (Appendix A, Figures A9 and A12).

Mean density by species for each size class in intensive plots at Beal Lake is reported in Appendix A, Table A6 and Figures A13 and A14. Within the 2.51- to 7.99-cm size class, Fremont cottonwood has the highest mean density with 8.77 trees per intensive plot. Fremont cottonwood, Goodding's willow, and coyote willow occur in the ≤ 2.5-cm size class. Fremont cottonwood has the highest mean density at 1.62 trees per intensive plot. The highest mean density of coyote willow is 2.0 trees per intensive plot. The highest mean density of Goodding's willow is 1.92 trees per intensive plot. There are no first-year plantings at Beal Lake. Within the < 1.4-m size class, one plot contains screwbean mesquite. There are > 200 target trees per hectare in the ≤ 2.5-cm size class. Fremont cottonwood has the highest site density in the 2.5- to 7.99-cm size class with > 1,000 trees per hectare.

Table A9 in Appendix A represents the mean density of nontarget/additional species found per intensive plot, as well as the mean density of all additional species found per intensive plot. Two species were noted in Beal Lake plots, desertbroom (*Baccharis sarothroides*) and arrowweed. Arrowweed had the highest per-plot density at 6.29 trees. There are > 900 arrowweed plants per hectare, and > 12,000 plants are estimated within the entire site. Field observations of arrowweed indicate that it readily colonizes open space within Beal Lake fields.

The mean height of target intermediate tree species (DBH 8.00–11.99 cm) at Beal Lake shows that Fremont cottonwood has a mean height of 8.02 m and honey mesquite has a mean height of 1.20 m.

Beal Lake plots have a mean canopy closure of 78.82%. Of the 13 plots, 6 have mean canopy closure values of > 90%. One plot at Beal Lake has a mean canopy closure value of 4%. Monitored plots show wide variability in canopy closure, likely a result of fields with less mature vegetation and fields with extremely dense vegetation.

The TVV within plots at Beal Lake (Appendix A, Table A13) range from 0.02–0.30 m^3. The majority of the plots have at least 0.10 m^3 of TVV. The mean TVV per plot is 0.13 m^3.

Vegetative ground cover at Beal Lake is sparse throughout many of the plots. Bermudagrass (*Cynodon dactylon*) is the species with the highest mean cover at 85%. The mean cover of all herbaceous species per plot is 31.33%. There were few shrubs represented in the ground cover with a mean cover of 0.38%. Aside from Bermudagrass, the highest ground covers are leaf litter at 53.89% and bare ground at 39.63%.

Palo Verde Ecological Reserve (PVER) Phases 2–5

Phase 2 (PVER2)

Rapid Plots

The mean densities of target tree species per rapid plot at PVER Phase 2 (PVER2) are highest among willow species (Appendix A, Table A1). The majority of rapid plots at this phase contain Goodding's willow or coyote willow. Several rapid plots in the phase have an excess of 300 coyote willow per plot. Mean densities of Goodding's willow are higher than mean densities of other target species, although not as dense as coyote willow. There are no screwbean mesquite represented in rapid plots at PVER2. The mean densities of all tree species per rapid plot tend to reflect coyote willow presence. The mean density of target trees within PVER2 is 15,100 trees per hectare, translating to an estimated 440,000 trees throughout the phase (Appendix A, Figures A3 and A4).

Intensive Plots

Within PVER2 intensive plots, Fremont cottonwood and Goodding's willow are the species representing overstory tree species. Densities of Fremont cottonwood are higher than Goodding's willow throughout the intensive plots. Mean density of overstory tree species is 5.48 per intensive plot. Several intensive plots contain a single qualifying individual; however, the mean density is too low to be represented in the calculation. In other words, significant figures in the mean density report a zero value. This is seen frequently throughout the overstory data.

The mean height of overstory species is represented in Appendix A, Figure A18. The mean Fremont cottonwood height is 10.30 m, while the mean height of Goodding's willow is 7.57 m. As previously mentioned, these are the two species with qualifying trees in the overstory. As a result, the mean height of all overstory species is 9.29 m.

Intermediate tree densities within the size classes are represented in Appendix A, Figures A14 and A15. Coyote willow has the highest densities in both primary size classes at the PVER2 intensive plots. The highest coyote willow density in the ≤ 2.5-cm size class is at PVER2, with a mean density of 125.63 trees per intensive plot. The mean density of coyote willow in the 2.51- to 7.99-cm size class is the highest in PVER2 at 16.30 trees per plot. Coyote willow densities per phase are > 100 trees per hectare in each size class. There are > 487,000 estimated coyote willow in the ≤ 2.5-cm size class within PVER2 and > 11,000 estimated Goodding's willow. These high densities were also evident in the rapid plot data for this phase.

Of the nontarget intermediate tree and shrub species (Appendix A, Table A9), desertbroom is the only species recorded in monitored intensive plots within PVER2. Densities are low with < 1 plant per plot.

Target species' intermediate heights are represented in Appendix A, Figure A20. As with the overstory data, Fremont cottonwood and Goodding's willow are the two species represented. The mean height of intermediate Fremont cottonwood per plot is 8.99 m and the mean height for Goodding's willow in this parameter is 6.85 m. The mean height of both species is 7.77 m.

The mean percent of crown closure is represented in Appendix A, Figure A22. The PVER2 has a mean crown closure of 79.92%. The high crown closure percentage, in spite of the lack of overstory species, is likely the result of the high densities of overstory and intermediate Fremont cottonwood and Goodding's willow.

The mean TVV per plot for PVER2 is 0.21 m^3 (Appendix A, Table A13). The TVV differed greatly between plots, as well as within plots.

Ground cover statistics are represented in Appendix A, Tables A15–A18. The primary vegetative ground cover species at PVER2 is Bermudagrass with a mean cover of 35.52%. The other species represented are an unknown sedge (*Cyperus* sp.) and alfalfa (*Medicago sativa*). The total vegetative ground cover per plot is < 60.0%. The mean cover of all species per plot is 23.03%. There are no shrub species within the ground cover plots in this phase. Leaf litter is the only nonvegetative cover represented, with a mean cover of 24.01%.

Phase 3 (PVER3)

Rapid Plots

Mean density of target tree species per rapid plot at PVER Phase 3 (PVER3) again reflect higher densities among willow than other species monitored (Appendix A, Table A1). While Goodding's willow and coyote willow densities remain high, Fremont cottonwood density is also high throughout this phase. Honey mesquite does not occur in the plots or is present in low numbers. The highest densities of Fremont cottonwood tend to be found in rapid plots where no willows are present.

Intensive Plots

The mean densities of target overstory tree species per intensive plot are reported in Appendix A, Table A3. Fremont cottonwood and honey mesquite are the two species with qualifying overstories in this phase. The mean density of Fremont cottonwood is 2.89 trees per intensive plot. The mean density of honey mesquite is reported as zero due to the small sample size. The mean density of Fremont cottonwood in the phase is > 100 trees per hectare. Given the high density of this species, it is not surprising that the estimated number of Fremont cottonwood is > 2,187 individuals. The density of all overstory species is relatively low, factoring in the extremely low density of honey mesquite and the low density of Fremont cottonwood (Appendix A, Figure A6). The high estimate of Fremont cottonwood is reflective of the estimate of total target overstory trees in the phase (Appendix A, Figure A8).

The per-plot mean densities of target intermediate tree species are reported in Appendix A, Table A5. Once again the high density of Fremont cottonwood (Appendix A, Figure A9) is evident with > 500 individuals per hectare. Each of the other species represented in PVER3 is < 50 individuals per hectare. There are estimated to be > 17,500 Fremont cottonwood in all of PVER3 (Appendix A, Figure A10), with < 500 each of the willow species and honey mesquite. The mean density of all species per hectare is < 600, although nearly 18,000 target intermediate tree species are estimated for this phase.

There are four species represented in the intermediate size class data: Fremont cottonwood, Goodding's willow, coyote willow, and honey mesquite. Fremont cottonwood has the highest density among the 2.5- to 7.99-cm size classes. Coyote willow has the highest density among ≤ 2.5-cm trees with 41.69 trees per plot. This translates to > 5,000 coyote willow per hectare (Appendix A, Figure A13) and nearly 200,000 of this size within the phase (Appendix A, Figure A14). The total estimated number of all target trees in these size classes is approximately 250,000 throughout the phase.

The mean heights of target overstory and intermediate tree species are reported in Appendix A, Figures A18–A21. As expected, Fremont cottonwood is the tallest in both strata. The mean height of Goodding's willow in the intermediate tree category is slightly less than Fremont cottonwood. The mean height of all overstory tree species is > 8.0 m. Interestingly, the mean height of all intermediate tree species is < 1 m shorter than the mean height of overstory tree species.

The mean of crown closure for PVER3 is just over 60% (Appendix A, Figure A22). While Fremont cottonwood has the highest density of overstory species, it does not appear to be very dense within plots. The overstory Fremont cottonwood and intermediate Goodding's willow likely provide some cover without completely closing the canopy. The TVV (Appendix A, Table A13) for PVER3 is 0.23 m^3.

Within PVER3 the species with the highest ground cover percentage is alfalfa at 40.82% (Appendix A, Table A14). Many plots within PVER3 have 100% vegetative ground cover, which generally consists of nonnative species. The exception is a small percentage of quailbush (*Atriplex lentiformis*). The mean cover of all herbaceous species is 31.15%. Of the nonvegetative cover, the mean cover of leaf litter is 12.43%. There was no rock/gravel or bare ground cover recorded in this phase.

Phase 4 (PVER4)

Rapid Plots

The mean target tree density per rapid plot at PVER Phase 4 (PVER4) is generally lower than those in the previous two phases of the LCR MSCP habitat creation site (Appendix A, Table A1). Eleven of the 150 rapid plots at PVER4 contain Fremont cottonwood. Within these plots, Fremont cottonwood densities are comparable to Goodding's willow densities throughout the

phase. Coyote willow has the highest rapid plot densities with 9.09 trees per plot. The mean density of all species per rapid plot is 22.42 (Appendix A, Table A2). The mean density of species per hectare at PVER4 is < 1,000 trees for each of the four species sampled in the rapid plots. There are no species in this phase with extreme high density values such as those previously noted. The mean density of target tree species within the rapid plots is > 2,242 trees per hectare. There are an estimated 88,111 trees throughout the phase.

Intensive Plots

Honey mesquite is the one species represented in the overstory data at PVER4 (Appendix A, Figure A5). The mean density of honey mesquite within the phase is 9.03 trees per hectare. There are an estimated 354 trees within the phase. Given that this is the only overstory species, these numbers are also representative of the mean densities within the phase for intensive plots monitored.

Within the target intermediate tree data, Fremont cottonwood and Goodding's willow are the species represented. The density of Fremont cottonwood is 1.18 trees per plot, and Goodding's willow is 0.73 tree per plot. This results in < 100 of each species per hectare (Appendix A, Figure A9) and fewer than 2,000 of each species estimated throughout the phase (Appendix A, Figure A10). In the ≤ 2.5-cm size class, coyote willow has the highest mean density at 1,737 trees per hectare. In the 2.5- to 7.99-cm size class, Goodding's willow has the highest density with 689 trees per hectare. There are 30 coyote willow per hectare in the larger size class (Appendix A, Figure A13). Of the nontarget intermediate tree species, quailbush and willow baccharis (*Baccharis salicina*) were found within the monitored intensive plots with sample sizes of < 10 each (Appendix A, Table A9). There are an estimated 3,722 intermediate tree and shrub species (encompassing all intermediate data categories) throughout PVER4.

With honey mesquite as the one qualifying overstory tree species at PVER4, the mean height of all overstory tree species is 2.0 m. The mean height of all target intermediate tree species is 7.0 m (Appendix A, Figure A21).

The mean crown closure at PVER4 is 64.83% (Appendix A, Figure A22). The TVV per plot is 0.24 m^3 (Appendix A, Table A13).

Vegetative ground cover in this phase consists of Bermudagrass, an unknown sedge, and alfalfa. Both Bermudagrass and alfalfa have mean coverages of approximately 40.0% (Appendix A, Table A14). The unknown sedge is a minor component with a mean coverage of 1.94% per plot. Averaging all ground cover species, there is a mean herbaceous cover of 39.38%. Leaf litter is the only nonvegetative cover and has a mean of 2.78% (Appendix A, Table A17).

Phase 5 (PVER5)

Rapid Plots

The PVER Phase 5 (PVER5) is a newly planted phase. Mean densities of target tree species per rapid plot in this phase are generally low in comparison with other phases at this LCR MSCP habitat creation site (Appendix A, Table A1). The species with the highest per-plot densities and most frequent occurrence is Goodding's willow. Both Fremont cottonwood and coyote willow are present throughout the rapid plots in similar densities. Densities are not high in any one plot as seen in the more mature phases. The mean density of all target tree species is 16.47 trees per rapid plot (Appendix A, Table A2). There are no mesquite species in the rapid plot data for this phase. The mean density of rapid plot trees is 1,647 trees per hectare with an estimated 139,968 trees occurring throughout the entire phase.

Intensive Plots

Because PVER5 was planted this year, there are no overstory data and all trees in this phase occur in the first-year planting category. Goodding's willow is the most commonly reported species in the phase. The species with the highest mean density in the phase is Goodding's willow with 1,295 trees per hectare (Appendix A, Figure A13). Honey mesquite also occurs in the phase, although the sample size is too small to be represented in mean density data. There are an estimated 110,075 Goodding's willow, 49,583 Fremont cottonwood, and 18,275 coyote willow throughout the phase. This results in an estimate of 177,933 trees representing all data categories for this phase (Appendix A, Figure A17).

Since all species in PVER5 were planted this year, each is considered immature. As such, the mean height of all overstory trees in the phase is < 1.4 m (Appendix A, Figure A19). It is not surprising then that the mean crown closure is < 5.0% (Appendix A, Figure A22). The TVV for this phase is 0.25 m^3 (Appendix A, Table A13).

The PVER5 ground cover was planted at construction and, therefore, has the most diverse species composition of all PVER phases. The unknown sedge has the highest ground cover at 97.50% per plot. Alfalfa is present in the phase with a mean cover of 49.91%. The majority of the species present are native, although few invasive species, such as alfalfa and Bermudagrass, are colonizing the phase (Appendix A, Table A14). The mean cover of herbaceous species is 33.63% (Appendix A, Table A15). Of the nonvegetative cover types, the mean cover of leaf litter is 0.01% per plot and the mean cover of bare ground is 1.16% per plot (Appendix A, Table A17).

Cibola Valley Conservation Area (CVCA) Phases 1–5

Phase 1 (CVCA1)

Rapid Plots

Coyote willow was documented extensively in CVCA Phase 1 (CVCA1). The species has the highest mean density of the rapid plots by a large margin (Appendix A, Table A1). Where plots contain coyote willow, mean densities of the species are in excess of 103 trees per plot. The next highest mean per rapid plot is Fremont cottonwood. While Goodding's willow is present in CVCA1 rapid plots, its extent is significantly less than coyote willow. Almost no mesquite species are present in the rapid plots, and this is reflected by the species' mean densities. Within the phase, the mean density of rapid plot target species is 11,907 trees per hectare; throughout the phase there are an estimated 438,161 trees (Appendix A, Figures A1 and A2).

Intensive Plots

Within CVCA1 Fremont cottonwood has the highest overstory mean densities at 4.51 trees per intensive plot (Appendix A, Table A3). Goodding's willow and honey mesquite are present in low densities in the overstory throughout the phase, which is otherwise dominated by Fremont cottonwood (Appendix A, Figure A6). The mean density of overstory tree species within CVCA1 is 5.40 trees per plot (Appendix A, Table A4).

The CVCA1 tree species include Fremont cottonwood, honey mesquite, and Goodding's willow. The mean height of Goodding's willow per plot is between 9 and 10 m (Appendix A, Figure A18). However, six plots within CVCA1 contain Goodding's willow. The mean overstory tree height (Appendix A, Figure A19) at CVCA1 is > 10 m per plot, which is the greatest mean height of all LCR MSCP habitat creation site phases.

At CVCA1 coyote willow has the highest mean density in the ≤ 2.5-cm size class with 88.20 trees per intensive plot (Appendix A, Table A7). Additionally, within the 2.51- to 7.99-cm size class, coyote willow has the highest mean density with 11.00 trees per intensive plot. Fremont cottonwood is represented in the ≤ 2.5-cm and 2.51- to 7.99-cm size classes with means ranging from 0.46- to 3.32-cm trees per plot, respectively. Throughout the phase, species composition and age are reflected by the density of coyote willow in the ≤ 2.5-cm size class (Appendix A, Figure A14). Honey mesquite is found throughout the phase; however, the sample sizes are too small to be represented in the mean density results.

Target intermediate tree and shrub species represented at CVCA1 include Fremont cottonwood, Goodding's willow, and coyote willow. Fremont cottonwood has the largest mean density (Appendix A, Table A8) at 4.65 trees per intensive plot. The intermediate willow species, especially coyote willow, are less dense throughout the phase (Appendix A, Figure A10). However, CVCA1 is the one phase that contains coyote willow as an intermediate tree or shrub species.

At CVCA1 the target intermediate tree and shrub species have the tallest mean height per intensive plot of any CVCA phase (Appendix A, Figure A20). Goodding's willow has a mean height > 9.0 m (Appendix A, Figure A20) at CVCA1 and appears to be well represented throughout the phase (Appendix A, Figure A10).

Nontarget intermediate tree and shrub species do not occur in CVCA1 within the monitored plots with the exception of tamarisk species, which have a mean density of 0.77 tree and shrub per plot (Appendix A, Table A9).

CVCA1 has a high mean crown closure of 89.32%. This is likely due to the high mean densities of Fremont cottonwood and willow species across all categories.

The mean TVV at CVCA1 is 0.13 m^3 per plot (Appendix A, Table A13).

Herbaceous species ground cover is relatively low per intensive plot at CVCA1, with a total mean cover of 17.53% (Appendix A, Table A15). Sedge species have the highest mean herbaceous cover per plot in the phase at 34.91% (Appendix A, Table A14). The other two most prominent ground cover species are Bermudagrass, with a mean cover of 34.91% per plot, and horseweed (*Conyza canadensis*), with a mean cover of 26.38% per plot. No shrub species are included in the ground cover at CVCA1. Mean cover of leaf litter is relatively high in the phase at 56.48%. Other nonvegetative ground cover at CVCA1 consists of bare ground with a mean cover of 1.48%.

Phase 2 (CVCA2)

Rapid Plots

Within CVCA Phase 2 (CVCA2) the mean densities of target tree species (Appendix A, Table A1) show coyote willow as the species with the highest density within rapid plots. Only one plot in the phase contains honey mesquite. No screwbean mesquite were monitored in rapid plots in this phase. Goodding's willow density is low at 7.97 trees per plot. Goodding's willow was often absent from monitored plots. The majority of CVCA2 plots contain Fremont cottonwood at a density of 5.85 trees per plot. The mean density of coyote willow is 49.14 trees per plot. This translates to a density of 4,913.68 trees per hectare and an estimated population of > 141,000 trees within the phase (Appendix A, Figures A1 and A2).

Intensive Plots

All five target species are represented in the overstory data for CVCA2, although in low densities. The densities of Fremont cottonwood and Goodding's willow in this phase are < 30 trees per hectare (Appendix A, Figure A5). While all target species are present, coyote willow, honey mesquite, and screwbean mesquite sample sizes are too low to be represented in mean calculations. The estimated number of Fremont cottonwood is < 800 trees per phase and Goodding's willow is 97 trees per phase. The mean density of all overstory is extremely low at 0.86 tree per plot (Appendix A, Table A4).

Similar to the overstory data, per-plot densities of target intermediate tree species are low (Appendix A, Table A5). Fremont cottonwood has a density of 4.47 trees per plot and Goodding's willow has a density of 0.33 tree per plot. There are no other target species represented in this data category. The density per hectare is reported in Appendix A, Figure A9 and the estimated number of trees per phase is reported in Appendix A, Figure A10. Mean per-plot densities of target species within the size classes are also low (Appendix A, Table A7). Coyote willow has the highest per-plot density in the ≤ 2.5-cm size class with 17.23 trees per plot; Goodding's willow has the highest density in the larger size class with 10.77 trees per plot. Coyote willow has the highest density of the phase with 2,297 trees per hectare in the ≤ 2.5-cm size class (Appendix A, Figure A13). There are an estimated 80,000 coyote willow in the smaller size class within CVCA2. The mean density of all intermediate tree and shrub species at CVCA2 is nearly 200,000 (Appendix A, Figure A17).

The mean height of CVCA2 overstory tree species is presented in Appendix A, Figure A18. The data indicate that large trees occur within this phase. The mean height of overstory Fremont cottonwood is nearly 10.0 m, and Goodding's willow are taller with a mean height of 11.0 m. The mean height of all overstory species is just under 10.0 m (Appendix A, Figure A18). Mean heights of target intermediate tree species are generally high for the category with Fremont cottonwood height at just over 9.0 m and Goodding's willow height slightly less (Appendix A, Figure A20).

The mean crown closure is 82.98%, reflective of the large overstory and intermediate tree species (Appendix A, Figure A22). The TVV for CVCA2 is 0.16 m^3 per plot.

There is little vegetative ground cover at CVCA2; vegetative ground cover consists entirely of invasive species (Appendix A, Table A14). The highest percentage per plot is horseweed with a mean cover of 23.31%. Nonvegetative cover percentages are high in this phase (Appendix A, Table A17). Leaf litter covers 57.99% per plot, and bare ground covers 6.18% per plot.

Phase 3 (CVCA3)

Rapid Plots

Within CVCA Phase 3 (CVCA3) the mean density of target tree species again shows coyote willow as the species with the highest density per rapid plot. Fremont cottonwood, Goodding's willow, and honey mesquite are also present in the plots (Appendix A, Table A1). The mean density of coyote willow is 55.39 trees per rapid plot. There are few honey mesquite present with a mean density of 0.21 tree per rapid plot. The mean density of coyote willow in the phase is 5,538.69 trees per hectare (Appendix A, Figure A1). The estimated number of coyote willow within the phase is 230,963 trees (Appendix A, Figure A2). The target tree mean density is 8,017 trees per hectare (Appendix A, Figure A3).

Intensive Plots

Three target species are present in the overstory: Fremont cottonwood, Goodding's willow, and honey mesquite. However, there is only one Goodding's willow sample within intensive plots in the phase. With a sample size that small, the mean density is presented as 0.00 tree per intensive plot. Mean densities are < 2.0 trees per plot for both Fremont cottonwood and honey mesquite (Appendix A, Table A3). Overstory species within the phase include Fremont cottonwood and honey mesquite with mean densities of 27.03 and 32.43 trees per hectare, respectively. The estimated number of trees in the phase is 1,127 Fremont cottonwood and 1,352 honey mesquite (Appendix A, Figure A6).

The same three species are represented in the target intermediate tree data. With a sample size of five trees, the mean density of Goodding's willow is 0.42 tree per plot. Fremont cottonwood has the highest density with 4.25 trees per plot. There is one mesquite in the rapid plots, resulting in a mean per-plot density of zero (Appendix A, Table A8). Coyote willow has the highest density within the ≤ 2.5-cm size class with 28.81 trees per plot. The mean density of Fremont cottonwood is highest within the 2.5- to 7.99-cm size class with 12.35 trees per plot. One honey mesquite was sampled within the size class data. All six nontarget species sampled were present in this phase (Appendix A, Table A9). Mean densities of nontarget species were all < 1 tree per plot. The mean density of all intermediate tree species at CVCA3 is > 7,000 trees per hectare (Appendix A, Figure A16). Considering all intermediate- and shrub-layer species, there are estimated to be > 300,000 intermediate tree and shrub species within the phase (Appendix A, Figure A17).

The mean height of Fremont cottonwood is < 9.0 m, while the mean height of Goodding's willow is > 7.0 m. Honey mesquite has a mean height of just over 2.0 m (Appendix A, Figure A18). The mean heights of Fremont cottonwood and Goodding's willow in the target intermediate data are comparable to those of the overstory trees, indicating these species have grown quickly in CVCA3 (Appendix A, Figure A20).

The mean crown closure at CVCA3 is < 70.0% per plot (Appendix A, Figure A22), indicating that overstory and intermediate target tree species are providing some cover within the plots. The TVV is 0.15 m^3 per plot (Appendix A, Table A13).

Within the vegetative ground cover, there are several species with low mean cover (< 15.0%). Two species, horseweed and an unknown sedge, have mean covers of 12.58% and 32.74% per plot, respectively (Appendix A, Table A14). The vegetative ground cover in this phase primarily consists of nonnative species. The mean cover of herbaceous species is 24.85% per plot with only 9.0% shrub cover per plot (Appendix A, Tables A15 and A16). Leaf litter was 36.53% per plot and bare ground cover was 12.35% per plot (Appendix A, Table A17).

Phase 4 East (CVCA4 E)

Rapid Plots

Mean densities of target tree species at CVCA4 E reflect the planting scheme of the phase (Appendix A, Table A1). There are few Fremont cottonwood present and no Goodding's willow, coyote willow, or screwbean mesquite in any CVCA4 E rapid plots. With primarily one species in all plots, mean tree density corresponds with honey mesquite mean density. The mean density of target tree species is 1.93 trees per rapid plot (Appendix A, Table A2).

Intensive Plots

The planting scheme of CVCA4 E is also represented in the intensive plots. Honey mesquite is the only target overstory tree species present, with a mean density of 5.04 trees per intensive plot (Appendix A, Table A3).

With a small mean height of 1.88 m (Appendix A, Figure A18), the honey mesquite plantings are indicative of younger overstory trees at CVCA4 E. The mean density of honey mesquite per hectare and per plot within intensive plots is 155.0 and 5.0, respectively.

The < 1.4-m size class is the only size class represented in CVCA4 E, and consists of honey mesquite. Honey mesquite has a mean density of 0.004 tree per plot (Appendix A, Table A7). Honey mesquite is also the only target intermediate tree and shrub species (8.0–12.0 cm) present at CVCA4 E. Honey mesquite mean density in this category is 1.0 tree per phase (Appendix A, Figure A14). The per-plot mean height of honey mesquite in CVCA4 E is 1.24 m.

Nontarget intermediate tree and shrub species at CVCA4 E include quailbush, desertbroom, and tamarisk species. Quailbush has the greatest mean density at 1.18 trees per plot (Appendix A, Table A9). Desertbroom and tamarisk species are sparse throughout the phase, with very low mean densities per plot.

Mean crown closure percentage per plot for CVCA4 E is very small, reflecting the sparse, young honey mesquite planting scheme (Appendix A, Figure A22).

In addition, mean TVV for CVCA4 E is very low at 0.08 m^3 per plot (Appendix A, Table A13).

Ground cover is composed of a wide variety of herbaceous species at CVCA4 E, most likely due to the lack of overstory and intermediate species. Bermudagrass has a mean per-plot cover of just under 50% (Appendix A, Table A14). Other common ground cover species at CVCA4 E are common sunflower (*Helianthus annuus*), with 37.50% mean cover per plot, and prickly Russian thistle (*Salsola iberica*), with 32.50% mean cover per plot. The mean cover of all herbaceous species at CVCA4 E is 22.09% per plot (Appendix A, Table A15). The herbaceous cover in this phase consists of some weedy species that may need control. Mean cover of ground cover shrub species is 18.17% per plot (Appendix A, Table A16). Finally, nonvegetative cover in this phase

consists of leaf litter, at just 0.77% mean cover per plot, and bare ground, at 49.70% mean cover per plot (Appendix A, Table A17).

Phase 4 West (CVCA4 W)

Rapid Plots

With the exception of one plot, the only species present at CVCA Phase 4 West (CVCA4 W) is honey mesquite; one Fremont cottonwood was found in CVCA4W_061. Fremont cottonwood has a mean density of 0.01 tree per rapid plot (Appendix A, Figure A1). The mean density for honey mesquite is 3.08 trees per rapid plot.

Intensive Plots

Within CVCA4 W mean densities and heights of intensive plot target tree species are similar to those in CVCA4 E (Appendix A, Figures A18–A21). The only target species present in overstory and intermediate trees is honey mesquite. Mean densities and heights for this species indicate that younger honey mesquite trees occur throughout the phase, which is consistent with the planting scheme.

Quailbush and tamarisk species are the two nontarget intermediate tree and shrub species located in CVCA4 W. Quailbush has the greatest mean at 2.68 trees per plot (Appendix A, Table A9), while the mean density of tamarisk species is 1.84 trees per plot.

Although not as low as CVCA4 E, the mean crown closure percentage per plot at CVCA4 W is still relatively low at 16.73% (Appendix A, Figure A22). This is to be expected of younger trees with underdeveloped crowns.

The TVV at CVCA4 W is also fairly low at 0.17 m^3 per plot (Appendix A, Table A13).

Herbaceous ground cover at CVCA4 W is predominately sedge species with a mean cover of 28.72% per plot (Appendix A, Table A14). Nutgrass (*Cyperus rotundus*) is the second most dominate herbaceous species, with a mean cover of 17.50% per plot. A portion of ground cover at CVCA4 W is composed of quailbush, a shrub species, with a mean cover of 15.88% per plot. The ground cover species in this phase can be weedy and may require management. The mean cover of all herbaceous species at CVCA4 W is 15.08% per plot (Appendix A, Table A15). The mean cover of shrub species within the ground cover is 16.15% per plot (Appendix A, Table A16). Nonvegetative ground cover comprises primarily bare ground at a mean cover of 43.73% per plot, while leaf litter makes up just 2.20% per plot (Appendix A, Table A17).

Phase 5 (CVCA5)

Rapid Plots

The CVCA5 is a newly planted phase. Of the 100 rapid plots in this phase, 3 contain screwbean mesquite. The mean density of honey mesquite is 5.25 trees per rapid plot, while the mean density of screwbean mesquite is 0.10 tree per rapid plot (Appendix A, Table A1). With three plots containing additional species, mean tree densities per plot generally reflect honey mesquite density.

Intensive Plots

In CVCA5 honey mesquite appears to be very dense as an overstory species, with a mean density of 12.59 trees per intensive plot (Appendix A, Table A4). Also, honey mesquite has the greatest estimated density per phase of any overstory species (Appendix A, Figure A6). This could be due to the planting scheme of the phase.

Mean densities and heights of target intermediate tree species are similar in to those of the previous two CVCA phases (Appendix A, Table A11 and Figures A19 and A20).

Two nontarget intermediate species are present at CVCA5. Quailbush has the greatest mean density at 0.89 individual per intensive plot (Appendix A, Table A9) and tamarisk species have a low mean density of 0.15 individual per intensive plot.

Mean crown closure for CVCA5 is very low at 0.68% per intensive plot (Appendix A, Table A12). Because this is a first-year planted phase, there are no trees mature enough to provide canopy closure.

At CVCA5, TVV is also very low with a mean of 0.03 m^3 per plot (Appendix A, Table A13). This could also be explained by the planting scheme of the new phase.

While the collection of herbaceous ground cover species at CVCA5 is diverse, the mean percent cover for each species is low. The greatest mean cover is 21.38% per plot for quailbush, a shrub species that occurs within herbaceous ground cover (Appendix A, Table A14). Other dominant herbaceous species include carelessweed (*Amaranthus palmeri*), Bermudagrass, and lateflowering goosefoot (*Chenopodium striatum*). The varied and weedy understory is most likely due to the newness of the phase; as target tree and shrub species establish, the undesirable species could diminish. The mean cover of all CVCA5 herbaceous species is 7.94% per plot (Appendix A, Table A15). The mean cover of shrub species within the ground cover is 14.61% per plot (Appendix A, Table A16). Bare ground is the only nonvegetative ground cover component in CVCA5 with a mean cover of 60.07% per plot.

Cibola National Wildlife Refuge (CNWR)

Cibola Nature Trail (CNT)

Rapid Plots

Rapid plots surveyed within Cibola Nature Trail (CNT) vary in tree compositions and densities. Overall, CNT has the lowest density per hectare and per phase compared with the other two CNWR phases (Appendix A, Figures A3 and A4). The target species with the highest mean density is by far Goodding's willow at 4.46 trees per rapid plot. Honey mesquite and screwbean mesquite had similar mean densities with 1.09 and 0.93 tree(s) per rapid plot, respectively. For all other target species' mean density values, see Appendix A, Table A1. Similar trends can be seen in tree density per hectare data with honey mesquite (109 trees per hectare) and screwbean mesquite (93 trees per hectare) showing similar mean densities. Goodding's willow has the highest mean density per hectare at 446 trees with an estimated count of 6,507 individuals within CNT (Appendix A, Figures A1 and A2). Coyote willow averages the lowest mean densities per hectare at 50 trees with an estimated 730 individuals within the phase. The mean density of all rapid plot target tree species is 7.80 trees per plot (Appendix A, Table A2).

Intensive Plots

The mean densities of target overstory tree species at CNT show variation in target tree presence within plots (Appendix A, Table A3). None of the five target species are consistently present within intensive plots, although all five species are present in the phase. In intensive plots where Fremont cottonwood occurs, it is found in mean densities of 2.07 trees per plot. Honey mesquite has the highest per-plot mean density at 3.00 trees per plot where it occurs. There are no overstory coyote willow within intensive plots at CNT. Honey mesquite has the highest number of qualifying trees per hectare (42), and is estimated as having 1,096 trees within the phase (Appendix A, Figures A5 and A6). The mean density of all intensive plot target overstory species is 7.21 target species per plot (Appendix A, Table A4).

Plots containing overstory Fremont cottonwood at CNT have a mean height of 12.50 m, with one plot containing trees with a mean height of 16.33 m. The species with the second highest mean height is Goodding's willow at 9.38 m per plot. Mean per-plot overstory tree height within CNT is 7.93 m (Appendix A, Figure A19). The presence and growth habit of honey mesquite in this location likely contribute to the species' lower mean height of 5.79 m.

The mean density for target intermediate tree species within intensive plots at CNT is 4.0 trees per plot (Appendix A, Table A5). The species with the highest mean density per hectare is Goodding's willow at 105 trees (Appendix A, Figure A9). These data, along with supporting rapid plot data, suggest that CNT has an abundance of Goodding's willow but many of the individuals are not large enough to qualify as overstory trees.

Figure A15 in Appendix A shows the mean density of target species for each size class at CNWR. Goodding's willow is the most commonly represented species with the highest mean

density in the ≤ 2.5-cm size class at 1.64 trees per plot. Within the 2.51- to 7.99-cm size class, the greatest mean density of Goodding's willow is 3.64 trees per plot. At CNT there were no Fremont cottonwood recorded within the intensive plots for all size classes. Coyote willow, and Goodding's willow are found in varying densities and within the two primary size classes. Coyote willow has a per-hectare mean density of 76 trees in the ≤ 2.5-cm size class and 172 trees in the 2.51- to 7.99-cm size class. Goodding's willow per-hectare mean density is 219 trees in the ≤ 2.5-cm size class and 486 trees in the 2.51- to 7.99-cm size class.

Within the groundcover category, the species with the highest mean coverage at CNT is by far Johnson grass (*Sorghum halepense*) at 21.33%. Johnson grass is the only species recorded with a mean > 6% in the CNT monitoring plots (Appendix A, Table A14).

Cibola Crane's Roost (CCR)

Rapid Plots

Within Cibola Crane's Roost (CCR), mean densities of target tree species within rapid plots show that Goodding's willow has the highest per-plot mean densities (6.21 trees per plot) (Appendix A, Table A1). Species presence is variable throughout the phase, but Goodding's willow is found most consistently. Mean density for target tree species within CCR is 13.35 trees per rapid plot (Appendix A, Table A2).

Intensive Plots

Fremont cottonwood and honey mesquite are the two species within CCR with overstory trees. Target overstory species mean density is 3.09 trees per plot across the phase (Appendix A, Table A4). Overstory Fremont cottonwood at the CCR phase have a mean height of 12.50 m (Appendix A, Figure A18). Mean heights for overstory tree species in CCR is 5.09 m due to the presence of honey mesquite.

The highest mean density for intermediate Goodding's willow is in the ≤ 2.5-cm size class at 6.47 trees per plot. Of the nontarget species within CCR, tamarisk is the most common with a mean density of 0.98 tree per plot (Appendix A, Table A9).

Percent canopy closure within CCR plots is 29.34%. This sparse overstory is not only reflected in the crown closure data (Appendix A, Table A12 and Figure A22) but also in the herbaceous ground cover percentage data, which has a mean percent ground coverage of 42.88% (Appendix A, Table A15). The herbaceous ground cover percentage is higher with more species diversity at CCR than the other two CNWR phases.

Cibola Mass Planting (CMP)

Rapid Plots

Mean density for target species per rapid plot within Cibola Mass Planting (CMP) is 23.69 (Appendix A, Table A2). The species with the highest density is by far Fremont cottonwood with a mean density of 20.97 trees per plot. There were no coyote willow or screwbean mesquite recorded in any of the monitored rapid plots.

Intensive Plots

Overstory mean height of Fremont cottonwood within CMP is 9.31 m (Appendix A, Figure A18). These data reflect a visually observable size homogeny at this particular phase. The per-hectare and estimated per-phase numbers are higher overall for both overstory and intermediate Fremont cottonwood at CMP. The mean density of overstory Fremont cottonwood per hectare at CMP is 131 trees with an estimated 1,063 trees per phase. Intermediate Fremont cottonwood have a mean per-hectare of 550 trees with an estimated 4,455 trees per phase (Appendix A, Figures A9 and A10).

At CMP the most common intermediate species recorded is Fremont cottonwood; only four plots contain Goodding's willow. No other species are found within these size classes at the phase. The greatest mean densities of Fremont cottonwood are 13.00 trees per plot in the 2.51- to 7.99-cm size class and 4.88 trees per plot in the ≤ 2.5-cm size class.

DISCUSSION AND RECOMMENDATIONS

Conditions of Habitat Creation Sites

Rapid and intensive plots monitored within each LCR MSCP habitat creation site show an increase in tree density and height since conditions were observed during the 2009 field season. Subsequent years of monitoring using the 2010 methodology should provide data to quantify this observation. Overall, access is generally good for both rapid and intensive plots, although it became apparent during field work that some rapid and intensive plots were barely accessible and would require substantial effort to continue monitoring in the near future. Portions of Beal Lake continue to be thick with arrowweed in the most dense plots. The mean density of screwbean mesquite is high within some Beal Lake rapid and intensive plots with mostly juvenile trees established (BL_071_I, BL _075_I [Photo 1 (all photos are located at the end of this section)]). All plots within the northwest planting area of CCR are extremely dense due to a mixture of desertbroom, tamarisk species, mature quailbush, and mesquite species (Photo 2). A large portion of CNT, which contains the most mature trees within the habitat creation sites, has several areas that require substantial effort to monitor because desertbroom has grown as large as mature mesquite species in some instances, becoming an impenetrable wall (Photo 3). Access to these habitat creation sites took considerable effort including using machetes and clearing a path, which may create concerns about the accuracy of data collected because of altered vegetation.

Monitoring some LCR MSCP habitat creation sites and rapid and intensive plots will likely become more difficult over time as understory densities increase. Human disturbance is still low across habitat creation sites and none of the rapid or intensive plots monitored appeared disturbed.

Understory vegetation consisting of Bermudagrass and alfalfa continues to decrease in percent coverage from previous years because of shading in fields with the greatest canopy closure, such as CVCA1 and the southern portion of PVER2. As of 2010 no other ground cover has established to replace alfalfa and Bermudagrass in these locations.

General tree health within rapid and intensive plots appears good, with an overall low mortality rate. Plots in CVCA4 E (planted in 2009) and CVCA4 W show some honey mesquite mortality. It was observed that there is an abundance of nonnative species (e.g., horseweed and prickly lettuce [*Lactuca serriola*]) in CVCA4 E in the areas with the honey mesquite mortality. Additionally, there was some Fremont cottonwood mortality observed in the middle of the southernmost section of CCR. All other dead species within the plots monitored are scattered and regarded as incidental die back.

Nonnative ivyleaf morning-glory (*Ipomoea hederacea*) and tall morning-glory (*Ipomoea purpurea*) within all LCR MSCP habitat creation sites did not appear to impede target tree growth. Nonnative species appear in all habitat creation sites at varying levels of proliferation and aggression. Although many rapid and intensive plots have a strong nonnative ground cover component, not all habitat creation sites are of concern. Increased canopy cover and closure appear to shade out low-to-moderate infestations of undesirable nonnative species, which is projected to continue. Throughout all plots, scattered tamarisk species infestations are considered low in most cases, except for an unusually high occurrence in the middle of CCR, which was observed as being addressed by manual removal during monitoring. Other common nonnative species not considered of concern are Bermudagrass, alfalfa, jungle rice (*Echinochloa colona*), and Mexican spanglegrass (*Leptochloa uninerva*).

Beal Lake and CNWR habitat creation sites have the lowest incidence of weedy species. Arrowweed, while a native species, shows aggressive recruitment within many plots at Beal Lake, often dominating planted willow and Fremont cottonwood.

Plots monitored within the PVER habitat creation site show low-to-moderate weed disturbance with the exception of PVER5. Since this phase is the most recently planted (2010) of all habitat creation sites, it contains the largest diversity of weedy species because of its lack of overstory. The northwest corner of PVER3 has a moderate horseweed infestation. Palmer's amaranth is a nonnative annual scattered along access roads and edges of habitat creation site fields, but it occurs at a higher concentration on the east end of PVER4 (planted in 2009). The southern portion of CCR has many bare alkali areas, which are usually surrounded by fivehorn smotherweed (*Bassia hyssopifolia*) (Photo 4). Very low incidents of weedy species are found within the grain-planted western half of CVCA4 E (Photo 5). Many forms of weed control were

witnessed within the habitat creation sites, including manual removal in CVCA4 W and CCR in conjunction with discing in and around CCR192_I and CCR194_I (Photo 6).

Weed infestation is the highest at CVCA, especially in the western portion of CVCA2 where horseweed dominates plots and CVCA4 W where horseweed and prickly lettuce dominate mesquite plantings (Photo 7). The CVCA4 W also has well-established common purslane (*Portulaca oleracea*), which is problematic in cultivated fields and gardens because it can reroot after cultivation. The northern portion of CVCA3 has a moderate infestation of purple nutsedge (*Cyperus rotundus*), which in some intensive plots comprises a majority of the ground cover layer. Within these intensive plots purple nutsedge is tolerating a fairly closed canopy and seems resistant to shade.

PHOTOS

Photo 1. **The density of screwbean mesquite within Beal Lake.**

Photo 2. **Size and density of quailbush within CCR.**

Photo 3. Density of desertbroom and mesquite within CNT.

Photo 4. **Bare alkaline areas surrounded by fivehorn smotherweed within CCR.**

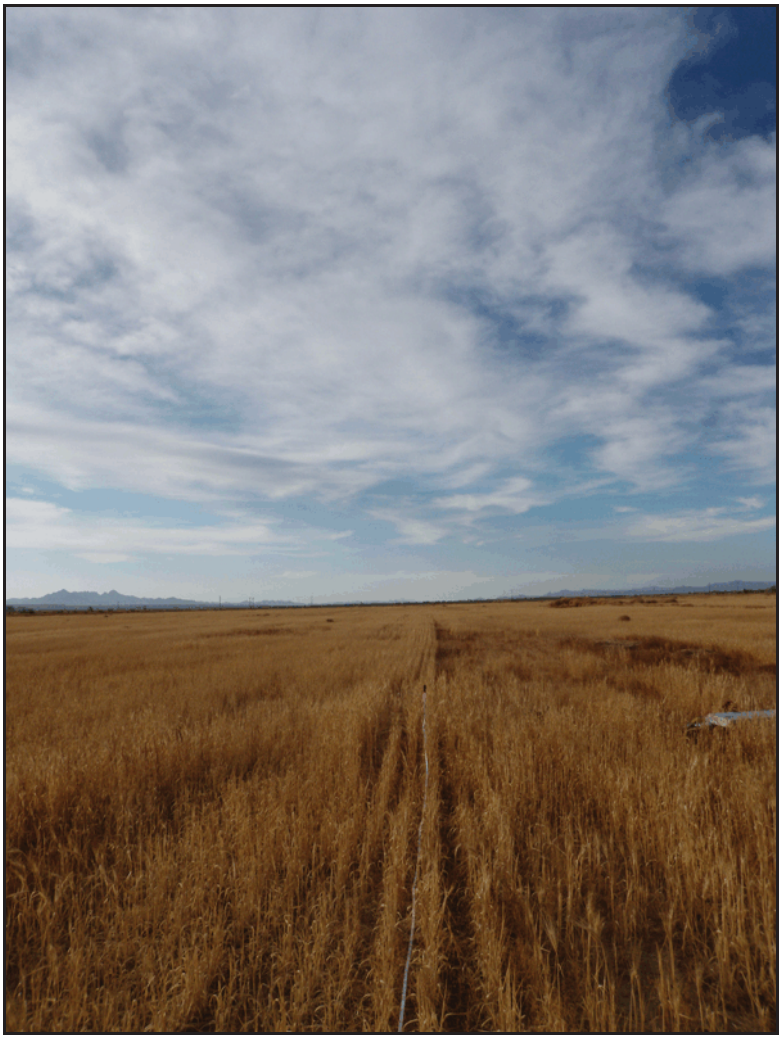

Photo 5. **Lack of weedy species within western half of CVCA4 E.**

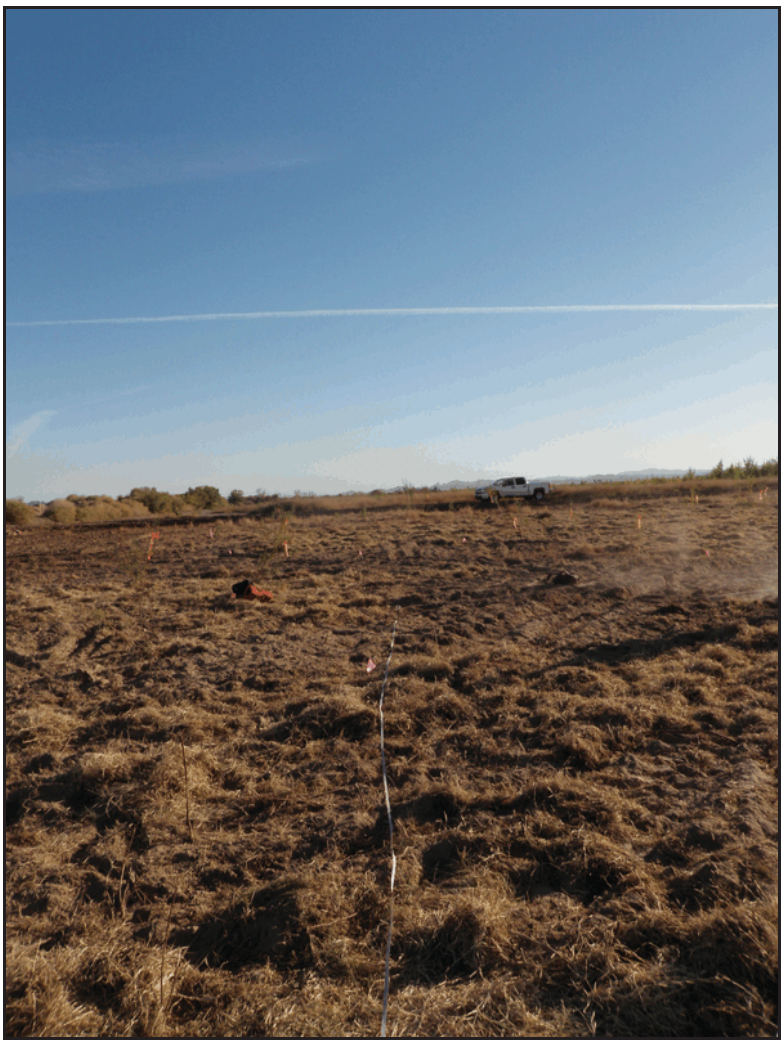

Photo 6. Weed control measures within CCR.

Photo 7. Horseweed and prickly lettuce infestation within CVCA4 W.

REFERENCES

Avery, T.E. 1975. Natural resources measurement. New York (NY): McGraw Hill. 331 p.

[LCR MSCP] Lower Colorado River Multi-Species Conservation Program. 2004. Lower Colorado River habitat conservation plan. Volume II. Final. December 17 (J&S 00450.00). Sacramento (CA): Lower Colorado River Multi-Species Recovery Program.

[Reclamation] U.S. Bureau of Reclamation. 2010. Vegetation Monitoring at Lower Colorado River Multi-species Conservation Program Habitat Creation and Restoration Demonstration Sites, 2010 Scope of Work. Las Vegas (NV): U.S. Bureau of Reclamation. 15 p.

Mills, G.S., Bunning, J.B., Jr., Bates, J.M. 1991. The Relationship between breeding bird density and vegetation volume. Wilson Bulletin. Volume 103, No. 3. 11 p.

APPENDIX A: SUMMARY STATISTICS

Table A1. Mean density of each target tree species per rapid plot.

SITE	PHASE	*Populus fremontii*			*Salix gooddingii*			*Salix exigua*			*Prosopis glandulosa*			*Prosopis pubescens*		
		N [a]	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
Beal Lake	N/A [b]	78	10.28	1.94	78	1.65	0.46	78	1.35	0.64	78	0.49	0.25	78	10.04	2.18
PVER	2	133	3.53	0.82	133	9.38	1.05	133	137.83	14.36	133	0.26	0.11	133	0.00	0.00
	3	129	7.30	0.83	129	9.50	2.51	129	14.78	2.36	129	0.60	0.10	129	0.03	0.02
	4	150	4.81	0.49	150	8.33	0.51	150	9.09	0.74	150	0.19	0.05	150	0.00	0.00
	5	332	4.23	0.32	332	10.92	0.52	332	1.00	0.12	332	0.31	0.13	332	0.01	0.00
CVCA	1	153	11.25	2.33	153	4.80	2.44	153	103.00	12.15	153	0.00	0.01	153	0.00	0.00
	2	95	5.85	0.79	95	7.97	1.09	95	49.14	7.33	95	0.02	0.01	95	0.00	0.00
	3	168	15.39	1.57	168	9.18	1.29	168	55.39	9.71	168	0.21	0.06	168	0.00	0.00
	4 East	153	0.02	0.01	153	0.00	0.00	153	0.00	0.00	153	1.92	0.13	153	0.00	0.00
	4 West	92	0.01	0.01	92	0.00	0.00	92	0.00	0.00	92	3.08	0.19	92	0.00	0.00
	5	100	0.00	0.00	100	0.00	0.00	100	0.00	0.00	100	5.25	0.26	100	0.10	0.06
Cibola NWR	Nature Trail	46	0.83	0.28	46	4.46	1.44	46	0.50	0.36	46	1.09	0.21	46	0.93	0.23
	Crane's Roost	200	3.07	0.48	200	6.21	0.62	200	3.36	0.92	200	0.59	0.11	200	0.14	0.04
	Mass Planting	35	20.97	2.55	35	2.57	0.65	35	0.00	0.00	35	0.14	0.07	35	0.00	0.00

[a] Sample size.
[b] Not applicable.

Table A2. Mean density of all target tree species per rapid plot.

SITE	PHASE	N [a]	MEAN	STANDARD ERROR
Beal Lake	N/A [b]	78	23.81	2.59
PVER	2	133	151.00	13.89
	3	129	32.22	3.22
	4	150	22.42	0.97
	5	332	16.47	0.59
CVCA	1	153	119.07	11.76
	2	95	62.98	6.79
	3	168	80.17	9.06
	4 East	153	1.93	0.13
	4 West	92	3.09	0.19
	5	100	5.35	0.25
Cibola NWR	Nature Trail	46	7.80	1.11
	Crane's Roost	200	13.35	1.11
	Mass Planting	35	23.69	2.38

[a] Sample size.
[b] Not applicable.

Table A3. Mean density of each target overstory tree species per intensive plot.

SITE	PHASE	*Populus fremontii*			*Salix gooddingii*			*Salix exigua*			*Prosopis glandulosa*			*Prosopis pubescens*		
		N [a]	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
Beal Lake	N/A [b]	13	1.85	0.62	13	0.00	0.00	13	0.00	0.00	13	3.54	2.27	13	7.23	3.06
PVER	2	27	4.85	1.84	27	0.63	0.29	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00
	3	30	2.89	0.86	30	0.00	0.00	30	0.00	0.00	30	0.00	0.00	30	0.00	0.00
	4	36	0.00	0.00	36	0.00	0.00	36	0.00	0.00	36	0.35	0.25	36	0.00	0.00
	5	80	0.00	0.00	80	0.00	0.00	80	0.00	0.00	80	0.06	0.33	80	0.00	0.00
CVCA	1	35	4.51	1.11	35	0.89	0.49	35	0.00	0.00	35	0.00	0.00	35	0.00	0.00
	2	22	0.73	0.26	22	0.14	0.64	22	0.00	0.00	22	0.00	0.00	22	0.00	0.00
	3	37	1.14	0.35	37	0.00	0.00	37	0.00	0.00	37	1.37	0.67	37	0.00	0.00
	4 East	22	0.00	0.00	22	0.00	0.00	22	0.00	0.00	22	5.04	4.49	22	0.00	0.00
	4 West	21	0.00	0.00	21	0.00	0.00	21	0.00	0.00	21	7.16	3.94	21	0.00	0.00
	5	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00	27	12.59	4.40	27	0.00	0.00
Cibola NWR	Nature Trail	14	2.07	1.28	14	0.50	0.37	14	0.00	0.00	14	3.00	0.73	14	1.64	0.73
	Crane's Roost	55	0.38	0.21	55	0.00	0.00	55	0.00	0.00	55	2.72	0.75	55	0.00	0.00
	Mass Planting	8	5.25	1.26	8	0.00	0.00	8	0.00	0.00	8	0.25	0.46	8	0.00	0.00

[a] Sample size.
[b] Not applicable.

Table A4. Mean density of all target overstory tree species per intensive plot.

SITE	E	N [a]	MEAN	STANDARD ERROR
Beal Lake	N/A [b]	13	12.62	5.95
PVER	2	27	5.48	2.14
	3	30	2.89	0.86
	4	36	0.35	0.25
	5	80	0.06	0.33
CVCA	1	35	5.40	1.60
	2	22	0.86	0.90
	3	37	2.51	1.02
	4 East	22	5.04	4.49
	4 West	21	7.16	3.94
	5	27	12.59	4.40
Cibola NWR	Nature Trail	14	7.21	3.11
	Crane's Roost	55	3.09	0.96
	Mass Planting	8	5.50	1.73

[a] Sample size.
[b] Not applicable.

Table A5. Mean density of all target intermediate tree and shrub species (8–12 centimeters) per intensive plot.

SITE	PHASE	N [a]	MEAN	STANDARD ERROR
Beal Lake	N/A[b]	13	4.00	1.66
PVER	2	27	8.05	2.86
	3	30	5.73	1.18
	4	36	1.91	0.79
	5	80	1.00	0.00
CVCA	1	35	5.90	1.99
	2	22	4.80	1.00
	3	37	4.75	1.50
	4 East	22	1.00	0.00
	4 West	21	1.00	0.00
	5	27	1.10	0.10
Cibola NWR	Nature Trail	14	4.00	3.06
	Crane's Roost	55	1.00	0.00
	Mass Planting	8	4.71	1.19

[a] Sample size.
[b] Not applicable.

Table A6. Mean density of all intermediate tree species (8–12 centimeters) per intensive plot.

SITE	PHASE	N [a]	MEAN	STANDARD ERROR
Beal Lake	N/A [b]	13	311.00	4.43
PVER	2	27	4357.00	0.90
	3	30	1674.00	0.05
	4	36	1000.00	0.18
	5	80	1322.00	0.29
CVCA	1	35	3792.00	0.37
	2	22	1,020.00	0.52
	3	37	2118.00	0.48
	4 East	22	113.03	0.29
	4 West	21	237.98	0.63
	5	27	89.03	0.18
Cibola NWR	Nature Trail	14	114.14	0.82
	Crane's Roost	55	998.00	0.39
	Mass Planting	8	211.50	0.85

[a] Sample size.
[b] Not applicable.

Table A7. Mean density of each target tree species within each size class per intensive plot.

SITE	PHASE	SPECIES	1ST YEAR PLANTING			≤ 2.5 CENTIMETERS			2.51–7.99 CENTIMETERS			< 1.4 METERS		
			N [a]	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
Beal Lake	N/A [b]	*Populus fremontii*	13	0.00	0.00	13	1.62	1.06	13	8.77	3.35	13	--	--
		Salex exigua	13	0.00	0.00	13	2.00	1.33	13	0.00	0.00	13	--	--
		Salex gooddingii	13	0.00	0.00	13	1.92	1.03	13	0.23	0.12	13	--	--
		Prosopis glandulosa	13	--	--	13	--	--	13	--	--	13	0.08	0.08
		Prosopis pubescens	13	--	--	13	--	--	13	--	--	13	1.54	1.54
PVER	2	*Populus fremontii*	27	0.00	0.00	27	0.44	0.22	27	1.44	0.62	27	--	--
		Salex exigua	27	0.00	0.00	27	125.63	32.13	27	16.30	4.68	27	--	--
		Salex gooddingii	27	0.00	0.00	27	2.93	1.42	27	7.41	2.10	27	--	--
		Prosopis glandulosa	27	--	--	27	--	--	27	--	--	27	0.15	0.15
		Prosopis pubescens	27	--	--	27	--	--	27	--	--	27	0.00	0.00
	3	*Populus fremontii*	30	0.00	0.00	30	1.55	1.02	30	2.84	1.13	30	--	--
		Salex exigua	30	0.00	0.00	30	41.68	17.76	30	0.84	0.35	30	--	--
		Salex gooddingii	30	0.00	0.00	30	1.97	0.91	30	1.00	0.43	30	--	--
		Prosopis glandulosa	30	--	--	30	--	--	30	--	--	30	0.08	0.08
		Prosopis pubescens	30	--	--	30	--	--	30	--	--	30	0.00	0.00
	4	*Populus fremontii*	36	0.00	0.00	36	0.64	0.21	36	3.17	0.78	36	--	--
		Salex exigua	36	0.00	0.00	36	13.03	2.11	36	0.22	0.12	36	--	--
		Salex gooddingii	36	0.00	0.00	36	4.47	0.70	36	5.17	1.21	36	--	--
		Prosopis glandulosa	36	--	--	36	--	--	36	--	--	36	0.00	0.00
		Prosopis pubescens	36	--	--	36	--	--	36	--	--	36	0.00	0.00

Table A7. Mean density of each target tree species within each size class per intensive plot (cont.).

SITE	PHASE	SPECIES	1ST YEAR PLANTING			≤ 2.5 CENTIMETERS			2.51–7.99 CENTIMETERS			< 1.4 METERS		
			N [a]	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
PVER (cont.)	5	*Populus fremontii*	80	4.38	0.55	80	0.00	0.00	80	0.00	0.00	80	--	--
		Salex exigua	80	1.61	0.32	80	0.00	0.00	80	0.00	0.00	80	--	--
		Salex gooddingii	80	9.71	0.74	80	0.00	0.00	80	0.00	0.00	80	--	--
		Prosopis glandulosa	80	--	--	80	--	--	80	--	--	80	0.04	0.02
		Prosopis pubescens	80	--	--	80	--	--	80	--	--	80	0.00	0.00
CVCA	1	*Populus fremontii*	35	0.00	0.00	35	0.46	0.21	35	3.23	1.00	35	--	--
		Salex exigua	35	0.00	0.00	35	88.20	20.79	35	11.00	3.55	35	--	--
		Salex gooddingii	35	0.00	0.00	35	0.23	0.11	35	1.09	0.70	35	--	--
		Prosopis glandulosa	35	--	--	35	--	--	35	--	--	35	0.00	0.00
		Prosopis pubescens	35	--	--	35	--	--	35	--	--	35	0.00	0.00
	2	*Populus fremontii*	22	0.00	0.00	22	0.23	0.09	22	2.86	0.72	22	--	--
		Salex exigua	22	0.00	0.00	22	17.23	4.84	22	8.14	2.82	22	--	--
		Salex gooddingii	22	0.00	0.00	22	1.55	0.39	22	10.77	2.57	22	--	--
		Prosopis glandulosa	22	--	--	22	--	--	22	--	--	22	0.00	0.00
		Prosopis pubescens	22	--	--	22	--	--	22	--	--	22	0.00	0.00
	3	*Populus fremontii*	37	0.00	0.00	37	0.38	0.17	37	12.35	3.03	37	--	0
		Salex exigua	37	0.00	0.00	37	28.81	8.93	37	4.11	2.92	37	--	0
		Salex gooddingii	37	0.00	0.00	37	1.59	0.49	37	6.68	2.03	37	--	0
		Prosopis glandulosa	37	--	0	37	--	0	37	--	0	37	0.03	0.28
		Prosopis pubescens	37	--	0	37	--	0	37	--	0	37	0.00	0.00

Table A7. Mean density of each target tree species within each size class per intensive plot (cont.).

SITE	PHASE	SPECIES	1ST YEAR PLANTING			≤ 2.5 CENTIMETERS			2.51–7.99 CENTIMETERS			< 1.4 METERS		
			N [a]	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
CVCA (cont.)	4E	*Populus fremontii*	22	0.00	0.00	22	0.00	0.00	22	0.00	0.00	22	--	--
		Salex exigua	22	0.00	0.00	22	0.00	0.00	22	0.00	0.00	22	--	--
		Salex gooddingii	22	0.00	0.00	22	0.00	0.00	22	0.00	0.00	22	--	--
		Prosopis glandulosa	22	--	--	22	--	--	22	--	--	22	0.00	0.08
		Prosopis pubescens	22	--	--	22	--	--	22	--	--	22	0.00	0.00
	4W	*Populus fremontii*	21	0.00	0.00	21	0.00	0.00	21	0.00	0.00	21	--	--
		Salex exigua	21	0.00	0.00	21	0.00	0.00	21	0.00	0.00	21	--	--
		Salex gooddingii	21	0.00	0.00	21	0.00	0.00	21	0.00	0.00	21	--	--
		Prosopis glandulosa	21	--	--	21	--	--	21	--	--	21	0.00	0.08
		Prosopis pubescens	21	--	--	21	--	--	21	--	--	21	0.00	0.00
	5	*Populus fremontii*	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00	27	--	--
		Salex exigua	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00	27	--	--
		Salex gooddingii	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00	27	--	--
		Prosopis glandulosa	27	--	--	27	--	--	27	--	--	27	0.00	0.08
		Prosopis pubescens	27	--	--	27	--	--	27	--	--	27	0.00	0.00
Cibola NWR	Nature Trail	*Populus fremontii*	14	0.00	0.00	14	0.00	0.00	14	0.00	0.00	14	--	--
		Salex exigua	14	0.00	0.00	14	0.57	0.40	14	1.29	0.87	14	--	--
		Salex gooddingii	14	0.00	0.00	14	1.64	1.21	14	3.64	2.02	14	--	--
		Prosopis glandulosa	14	--	--	14	--	--	14	--	--	14	0.08	0.08
		Prosopis pubescens	14	--	--	14	--	--	14	--	--	14	0.00	0.00

Table A7. Mean density of each target tree species within each size class per intensive plot (cont.).

SITE	PHASE	SPECIES	1ST YEAR PLANTING			≤ 2.5 CENTIMETERS			2.51–7.99 CENTIMETERS			< 1.4 METERS		
				Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
Cibola NWR (cont.)	Crane's Roost	*Populus fremontii*	55	0.00	0.00	55	0.00	0.99	55	0.23	0.10	55	--	--
		Salex exigua	55	0.00	0.00	55	5.74	2.62	55	0.18	0.17	55	--	--
		Salex gooddingii	55	0.00	0.00	55	6.47	1.19	55	0.89	0.58	55	--	--
		Prosopis glandulosa	55	--	--	55	--	--	55	--	--	55	0.02	0.02
		Prosopis pubescens	55	--	--	55	--	--	55	--	--	55	0.00	0.00
	Mass Planting	*Populus fremontii*	8	0.00	0.00	8	4.88	1.79	8	13.00	2.71	8	--	--
		Salex exigua	8	0.00	0.00	8	0.00	0.00	8	0.00	0.00	8	--	--
		Salex gooddingii	8	0.00	0.00	8	4.13	2.26	8	0.00	0.00	8	--	--
		Prosopis glandulosa	8	--	--	8	--	--	8	--	--	8	0.00	0.00
		Prosopis pubescens	8	--	--	8	--	--	8	--	--	8	0.00	0.00

[a] Sample size.
[b] Not applicable.

Table A8. Mean density of each target intermediate tree and shrub species per intensive plot.

SITE	PHASE	*Populus fremontii*			*Salix gooddingii*			*Salix exigua*			*Prosopis glandulosa*			*Prosopis pubescens*		
		N [a]	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
Beal Lake	N/A [b]	13	3.83	1.49	13	0.00	0.00	13	0.00	0.00	13	0.17	0.17	13	0.00	0.00
PVER	2	27	4.70	1.86	27	3.35	1.00	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00
	3	30	5.55	1.06	30	0.05	0.05	30	0.00	0.00	30	0.14	0.07	30	0.00	0.00
	4	36	1.18	0.48	36	0.73	0.30	36	0.00	0.00	36	0.00	0.00	36	0.00	0.00
	5	80	0.00	0.00	80	0.00	0.00	80	0.00	0.00	80	1.00	0.00	80	0.00	0.00
CVCA	1	35	4.65	1.25	35	1.15	0.67	35	0.10	0.07	35	0.00	0.00	35	0.00	0.00
	2	22	4.47	0.79	22	0.33	0.21	22	0.00	0.00	22	0.00	0.00	22	0.00	0.00
	3	37	4.25	1.13	37	0.42	0.29	37	0.00	0.00	37	0.08	0.08	37	0.00	0.00
	4 East	22	0.00	0.00	22	0.00	0.00	22	0.00	0.00	22	1.00	0.00	22	0.00	0.00
	4 West	21	0.00	0.00	21	0.00	0.00	21	0.00	0.00	21	1.00	0.00	21	0.00	0.00
	5	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00	27	1.10	0.10	27	0.00	0.00
Cibola NWR	Nature Trail	14	0.00	0.00	14	3.67	2.73	14	0.00	0.00	14	0.33	0.33	14	0.00	0.00
	Crane's Roost	55	0.00	--	55	0.00	--	55	0.00	--	55	1.00	--	55	0.00	--
	Mass Planting	8	4.71	1.19	8	0.00	0.00	8	0.00	0.00	8	0.00	0.00	8	0.00	0.00

[a] Sample size.
[b] Not applicable.

Table A9. Mean density of each nontarget intermediate tree and shrub species per intensive plot.

SITE	PLOT ID	*Atriplex lentiformis*			*Baccharis salicina*			*Baccharis sarothroides*			*Prosopis velutina*			*Pluchea sericea*			*Tamarix* sp.		
		N [a]	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
Beal Lake	N/A[b]	13	0.00	0.00	13	0.00	0.00	13	0.57	0.42	13	0.00	0.00	13	6.29	4.48	13	0.00	0.00
PVER	2	27	0.00	0.00	27	0.00	0.00	27	1.30	0.90	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00
	3	30	0.03	0.03	30	0.00	0.00	30	0.00	0.00	30	0.00	0.00	30	0.00	0.00	30	0.03	0.03
	4	36	0.22	0.15	36	0.25	0.11	36	0.00	0.00	36	0.00	0.00	36	0.00	0.00	36	0.00	0.00
	5	80	0.40	0.27	80	0.39	0.12	80	0.00	0.00	80	0.00	0.00	80	0.00	0.00	80	0.00	0.00
CVCA	1	35	0.00	0.00	35	0.00	0.00	35	0.00	0.00	35	0.00	0.00	35	0.00	0.00	35	0.77	0.37
	2	22	0.64	0.44	22	0.05	0.05	22	0.00	0.00	22	0.00	0.00	22	0.00	0.00	22	4.55	0.55
	3	37	0.54	0.28	37	0.35	0.25	37	0.03	0.03	37	0.03	0.03	37	0.24	0.24	37	0.57	0.19
	4 East	22	1.18	0.26	22	0.00	0.00	22	0.05	0.04	22	0.00	0.00	22	0.00	0.00	22	0.05	0.04
	4 West	21	2.68	0.33	21	0.00	0.00	21	0.00	0.00	21	0.00	0.00	21	0.00	0.00	21	1.84	0.54
	5	27	0.89	0.17	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00	27	0.15	0.07
Cibola NWR	Nature Trail	14	0.00	0.00	14	0.00	0.00	14	2.14	0.82	14	0.00	0.00	14	0.00	0.00	14	0.00	0.00
	Crane's Roost	55	0.11	0.06	55	0.00	0.00	55	0.05	0.04	55	0.00	0.00	55	0.04	0.02	55	0.98	0.36
	Mass Planting	8	0.00	0.00	8	0.00	0.00	8	1.88	0.88	8	0.00	0.00	8	0.00	0.00	8	0.63	0.42

[a] Sample size.
[b] Not applicable.

Table A10. Mean height of each target intermediate tree and shrub species per intensive plot.

SITE	PHASE	*Populus fremontii*			*Salix gooddingii*			*Salix exigua*			*Prosopis glandulosa*			*Prosopis pubescens*		
		N[a]	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error
Beal Lake	N/A[b]	13	8.02	0.43	13	–	–	13	–	–	13	1.20	–	13	–	–
PVER	2	27	8.99	0.29	27	6.85	0.43	27	–	–	27	–	–	27	–	–
	3	30	8.19	0.16	30	8.00	–	30	–	–	30	1.13	0.03	30	–	–
	4	36	7.33	0.33	36	6.88	0.31	36	–	–	36	–	–	36	–	–
	5	80	–	–	80	–	–	80	–	–	80	1.03	0.03	80	–	–
CVCA	1	35	10.51	0.19	35	9.32	0.77	35	6.20	0.20	35	–	–	35	–	–
	2	22	9.35	0.16	22	8.85	0.43	22	–	–	22	–	–	22	–	–
	3	37	8.65	0.15	37	7.53	0.17	37	–	–	37	1.20	–	37	–	–
	4 East	22	–	–	22	–	–	22	–	–	22	1.24	0.03	22	–	–
	4 West	21	–	–	21	–	–	21	–	–	21	1.24	0.03	21	–	–
	5	27	–	–	27	–	–	27	–	–	27	1.21	0.05	27	–	–
Cibola NWR	Nature Trail	14	–	–	14	8.19	0.63	14	–	–	14	3.00	0.41	14	–	–
	Crane's Roost	55	–	–	55	–	–	55	–	–	55	1.10	0.00	55	–	–
	Mass Planting	8	8.95	0.16	8	–	–	8	–	–	8	–	–	8	–	–

[a] Sample size.
[b] Not applicable.

Table A11. Mean height of all target intermediate tree and shrub species per intensive plot.

SITE	PHASE	N[a]	MEAN	STANDARD ERROR
Beal Lake	N/A[b]	13	7.04	1.04
PVER	2	27	7.77	0.36
	3	30	7.27	0.52
	4	36	7.10	0.23
	5	80	1.03	0.03
CVCA	1	35	9.87	0.36
	2	22	9.25	0.16
	3	37	7.82	0.58
	4 East	22	1.24	0.03
	4 West	21	1.24	0.03
	5	27	1.21	0.05
Cibola NWR	Nature Trail	14	6.46	1.79
	Crane's Roost	55	1.10	–
	Mass Planting	8	8.95	0.16

[a] Sample size.
[b] Not applicable.

Table A12. Mean crown closure percentage per intensive plot.

SITE	PHASE	N [a]	MEAN	STANDARD ERROR
Beal Lake	N/A [b]	65	78.82	7.36
PVER	2	135	79.92	5.90
	3	150	61.91	7.22
	4	180	64.83	5.14
	5	400	2.63	0.98
CVCA	1	175	89.32	1.27
	2	22	82.98	6.68
	3	185	66.37	3.29
	4 East	110	5.38	2.07
	4 West	105	16.73	4.72
	5	135	0.68	0.58
Cibola NWR	Nature Trail	70.00	82.68	4.98
	Crane's Roost	275	29.34	4.81
	Mass Planting	40	78.63	5.64

[a] Observations.
[b] Not applicable.

Table A13. Total vegetation volume (TVV) per intensive plot in cubic meters.

SITE	PHASE	N [a]	MEAN	STANDARD ERROR
Beal Lake	N/A[b]	65	0.13	0.02
PVER	2	135	0.21	0.02
	3	150	0.23	0.01
	4	180	0.24	0.01
	5	400	0.25	0.01
CVCA	1	175	0.13	0.01
	2	22	0.16	0.01
	3	185	0.15	0.01
	4 East	110	0.08	0.02
	4 West	105	0.17	0.03
	5	135	0.03	0.01
Cibola NWR	Nature Trail	70	0.21	0.03
	Crane's Roost	275	0.19	0.01
	Mass Planting	40	0.12	0.01

[a] Observations.
[b] Not applicable.

Table A14. Mean percent cover of each herbaceous and shrub species per intensive plot.

SITE	PHASE	SPECIES		MEAN	STANDARD ERROR
		Code	Scientific Name		
Beal Lake	N/A[a]	BOUGRA	*Bouteloua gracilis*	7.50	--
		CONCAN	*Conyza canadensis*	1.50	--
		CYNDAC	*Cynodon dactylon*	85.00	--
		PLUSER	*Pluchea sericea*	0.83	0.33
		TAMARIX	*Tamarix* sp.	0.50	--
PVER	2	CYNDAC	*Cynodon dactylon*	35.52	3.52
		CYPERUS SPP	*Cyperus* sp.	2.50	1.00
		MEDSAT	*Medicago sativa*	16.89	2.78
	3	ATRLEN	*Atriplex lentiformis*	3.50	--
		CONCAN	*Conyza canadensis*	21.88	21.04
		CYNDAC	*Cynodon dactylon*	30.02	2.68
		CYPERUS SPP	*Cyperus* sp.	5.75	3.34
		MEDSAT	*Medicago sativa*	40.82	2.45
	4	CYNDAC	*Cynodon dactylon*	41.44	2.49
		CYPERUS SPP	*Cyperus* sp.	1.94	0.50
		MEDSAT	*Medicago sativa*	47.67	8.13
	5	AMAPAL	*Amaranthus palmeri*	12.25	4.44
		BOTBAR	*Bothriochloa barbinodis*	17.50	--
		BOUGRA	*Bouteloua gracilis*	3.50	--
		CAREX	*Carex* sp.	97.50	--
		CONCAN	*Conyza canadensis*	17.50	--
		CYNDAC	*Cynodon dactylon*	35.51	3.89
		CYPERUS SPP	*Cyperus* sp.	23.77	1.77
		CYPROT	*Cyperus rotundus*	58.95	4.17
		ECHCOL	*Echinochloa colonum*	36.72	4.78
		ERAMEX	*Eragrostis mexicana* spp. *virescens*	31.05	2.45
		LOLPER	*Lolium perenne*	16.98	3.57
		MEDSAT	*Medicago sativa*	49.91	1.72
		PENCIL	*Pennisetum ciliare*	12.75	4.31
		QUILOB	*Quincula lobata*	17.50	
		SORHAL	*Sorgum halopense*	1.50	--
		SPOAIR	*Sporobolus airoides*	39.28	8.67

Table A14. Mean percent cover of each herbaceous and shrub species per intensive plot (cont.).

SITE	PHASE	SPECIES		MEAN	STANDARD ERROR
		Code	Scientific Name		
CVCA	1	AMAPAL	*Amaranthus palmeri*	3.50	--
		CALSEP	*Calystegia sepium*	7.82	1.61
		CONCAN	*Conyza canadensis*	26.38	6.99
		CYNDAC	*Cynodon dactylon*	27.93	3.87
		CYPERUS SPP	*Cyperus* sp.	34.91	7.88
		IPOPUR	*Ipomea purpurea*	4.33	1.11
		MEDSAT	*Medicago sativa*	14.10	3.45
		SORHAL	*Sorgum halopense*	17.50	--
	2	CONCAN	*Conyza canadensis*	23.31	5.31
		CYNDAC	*Cynodon dactylon*	22.88	8.06
		MEDSAT	*Medicago sativa*	10.30	6.80
	3	CALSEP	*Calystegia sepium*	0.50	0.00
		CONCAN	*Conyza canadensis*	12.58	3.47
		CYNDAC	*Cynodon dactylon*	37.74	6.81
		CYPERUS SPP	*Cyperus* sp.	32.74	2.17
		ECHCOL	*Echinochloa colonum*	7.50	--
		IPOPUR	*Ipomea purpurea*	13.26	1.77
		SALIBE	*Salsola iberica*	3.50	--
		TAMARIX	*Tamarix* sp.	9.00	8.50
	4 East	AMAPAL	*Amaranthus palmeri*	10.83	3.87
		ATRLEN	*Atriplex lentiformis*	18.93	5.08
		CALSEP	*Calystegia sepium*	1.50	--
		CONCAN	*Conyza canadensis*	9.28	2.03
		CYNDAC	*Cynodon dactylon*	47.21	4.73
		ECHCOL	*Echinochloa colonum*	3.50	--
		HELANN	*Helianthus annuus*	37.50	--
		HELCUR	*Heliotropium curassavicum*	7.50	--
		LEPUNI	*Leptochloa uninervia*	8.00	3.30
		POROLE	*Portulaca oleracea*	17.50	0.00
		SALIBE	*Salsola iberica*	32.50	15.00
		TAMARIX	*Tamarix* sp.	7.50	--
		UNK 7	unknown species	10.64	4.53

Table A14. Mean percent cover of each herbaceous and shrub species per intensive plot (cont.).

SITE	PHASE	SPECIES		MEAN	STANDARD ERROR
		Code	Scientific Name		
CVCA (cont.)	4 West	ATRLEN	*Atriplex lentiformis*	15.88	3.22
		CONCAN	*Conyza canadensis*	12.09	2.69
		CYPERUS SPP	*Cyperus* sp.	28.72	4.89
		CYPROT	*Cyperus rotundus*	17.50	--
		ECHCOL	*Echinochloa colonum*	11.90	3.43
		IPOPUR	*Ipomea purpurea*	5.50	2.00
		LACSER	*Lactuca serriola*	7.94	2.47
		LEPUNI	*Leptochloa uninervia*	11.79	2.02
	5	AMAPAL	*Amaranthus palmeri*	14.17	3.33
		ATRLEN	*Atriplex lentiformis*	21.38	6.94
		CHESTR	*Chenopodium strictum*	10.39	3.71
		CYNDAC	*Cynodon dactylon*	10.50	7.00
		ECHCOL	*Echinochloa colonum*	8.50	1.86
		LACSER	*Lactuca serriola*	3.50	--
		LEPUNI	*Leptochloa uninervia*	6.32	1.78
		POLARE	*Polygonum arenastrum*	6.50	1.90
		PROGLA	*Prosopis glandulosa*	4.50	1.60
		TAMARIX	*Tamarix* sp.	1.00	0.50
		TRIAES	*Triticum aestrivum*	5.75	4.58
Cibola NWR	Nature Trail	BACSAR	*Baccharid sarathroides*	1.25	0.25
		CYNDAC	*Cynodon dactylon*	3.50	0.00
		CYPERUS SPP	*Cyperus* sp.	5.50	2.00
		SORHAL	*Sorgum halopense*	21.33	4.18
	Crane's Roost	ATRLEN	*Atriplex lentiformis*	0.00	3.00
		CHEMUR	*Chenopodium strictum*	18.33	8.98
		CYNDAC	*Cynodon dactylon*	68.02	1.83
		HELANN	*Helianthus annuus*	32.05	5.58
		MEDSAT	*Medicago sativa*	20.55	1.74
		POROLE	*Portulaca oleracea*	24.19	5.46
		SALEXI	*Salix exigua*	2.30	0.49
		SALGOO	*Salix gooddingii*	6.50	1.00
		TAMARIX	*Tamarix* sp.	9.00	2.20
	Mass Planting	CYNDAC	*Cynodon dactylon*	29.25	5.98
		MEDSAT	*Medicago sativa*	3.50	--
		PLUSER	*Pluchea sericea*	1.50	--
		SORHAL	*Sorgum halopense*	17.50	4.47
		TAMARIX	*Tamarix* sp.	1.50	--

[a] Not applicable.

Table A15. Mean percent cover of all herbaceous species per intensive plot.

SITE	PHASE	MEAN	STANDARD ERROR
Beal Lake	N/A [a]	31.33	
PVER	2	23.03	3.38
	3	31.15	2.81
	4	39.38	2.70
	5	33.63	1.60
CVCA	1	17.53	2.45
	2	20.46	3.97
	3	24.85	2.44
	4 East	22.09	3.39
	4 West	15.08	2.12
	5	7.94	0.95
Cibola NWR	Nature Trail	14.93	3.18
	Crane's Roost	42.88	2.99
	Mass Planting	25.50	7.21

[a] Not applicable.

Table A16. Mean percent cover of all shrub species per intensive plot.

SITE	PHASE	MEAN	STANDARD ERROR
Beal Lake	N/A[a]	0.38	0.13
PVER	2	--	-
	3	3.50	-
	4	--	-
	5	--	-
CVCA	1	--	--
	2	--	--
	3	9.00	8.50
	4 East	18.17	5.52
	4 West	16.15	3.06
	5	14.61	3.99
Cibola NWR	Nature Trail	1.33	0.17
	Crane's Roost	7.49	2.00
	Mass Planting	1.50	0.00

[a] Not applicable.

Table A17. Mean percent cover of leaf litter, rock/gravel, and bare ground per intensive plot.

SITE	PHASE	LEAF LITTER		ROCK/GRAVEL			
		Mean	Standard Error	Mean	Standard Error	Mean	Error
Beal Lake	N/A [a]	53.89	8.13	0.00	0.00	39.63	8.90
PVER	2	24.01	6.15	0.00	0.00	0.00	0.00
	3	12.43	2.95	0.00	0.00	0.00	0.00
	4	2.78	0.94	0.00	0.00	0.00	0.00
	5	0.01	0.01	0.00	0.00	1.16	0.37
CVCA	1	56.48	4.08	0.00	0.00	1.48	0.48
	2	57.99	6.20	0.00	0.00	6.18	1.52
	3	36.53	4.13	0.00	0.00	12.35	3.71
	4E	0.77	0.47	0.00	0.00	49.70	4.88
	4W	2.20	0.69	0.00	0.00	43.73	4.12
	5	0.00	0.00	0.00	0.00	60.07	2.42
Cibola NWR	Nature Trail	24.57	5.97	0.06	0.06	6.01	2.34
	Crane's Roost	9.65	2.90	0.03	0.03	5.73	1.88
	Mass Planting	49.34	13.40	0.00	0.00	0.00	0.00

[a] Not applicable.

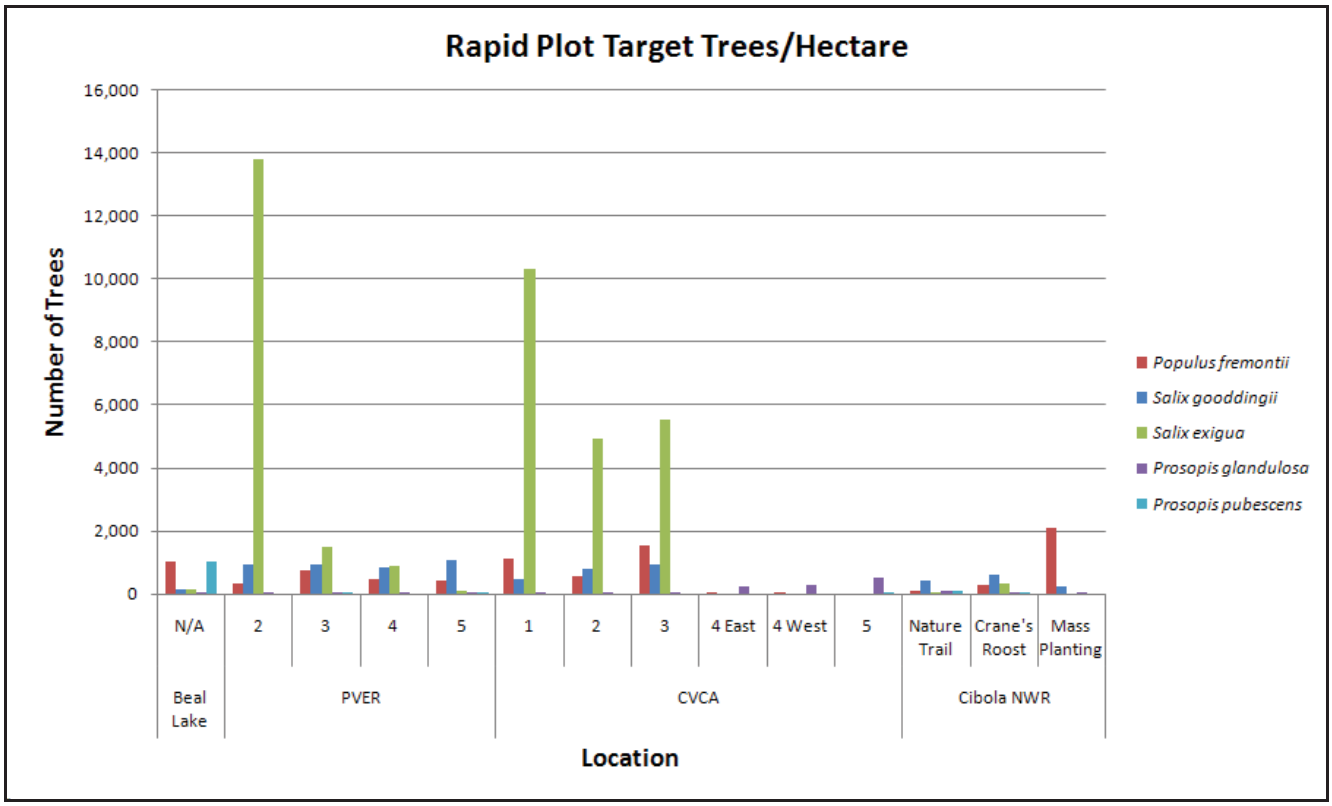

Figure A1. The number of each rapid plot target tree species per hectare.

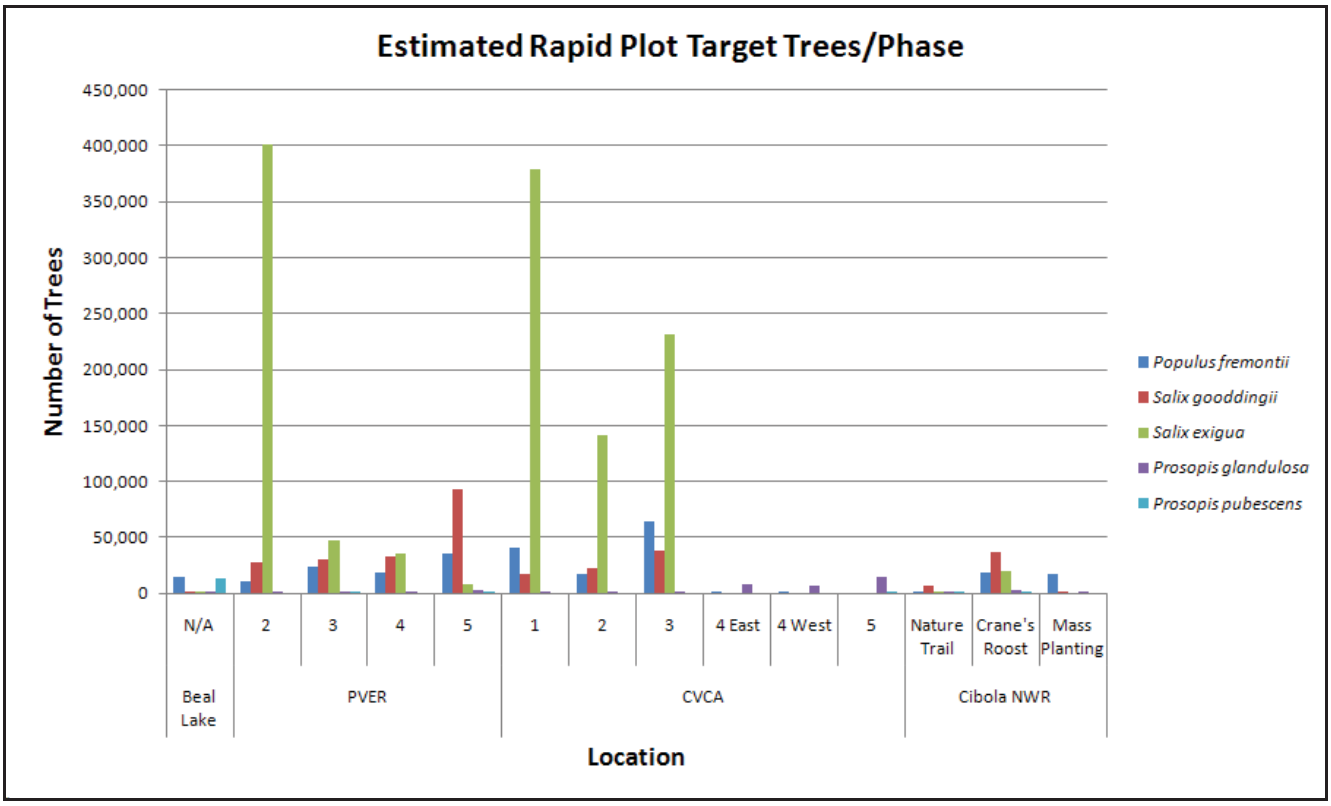

Figure A2. The estimated number of each target tree species per phase.

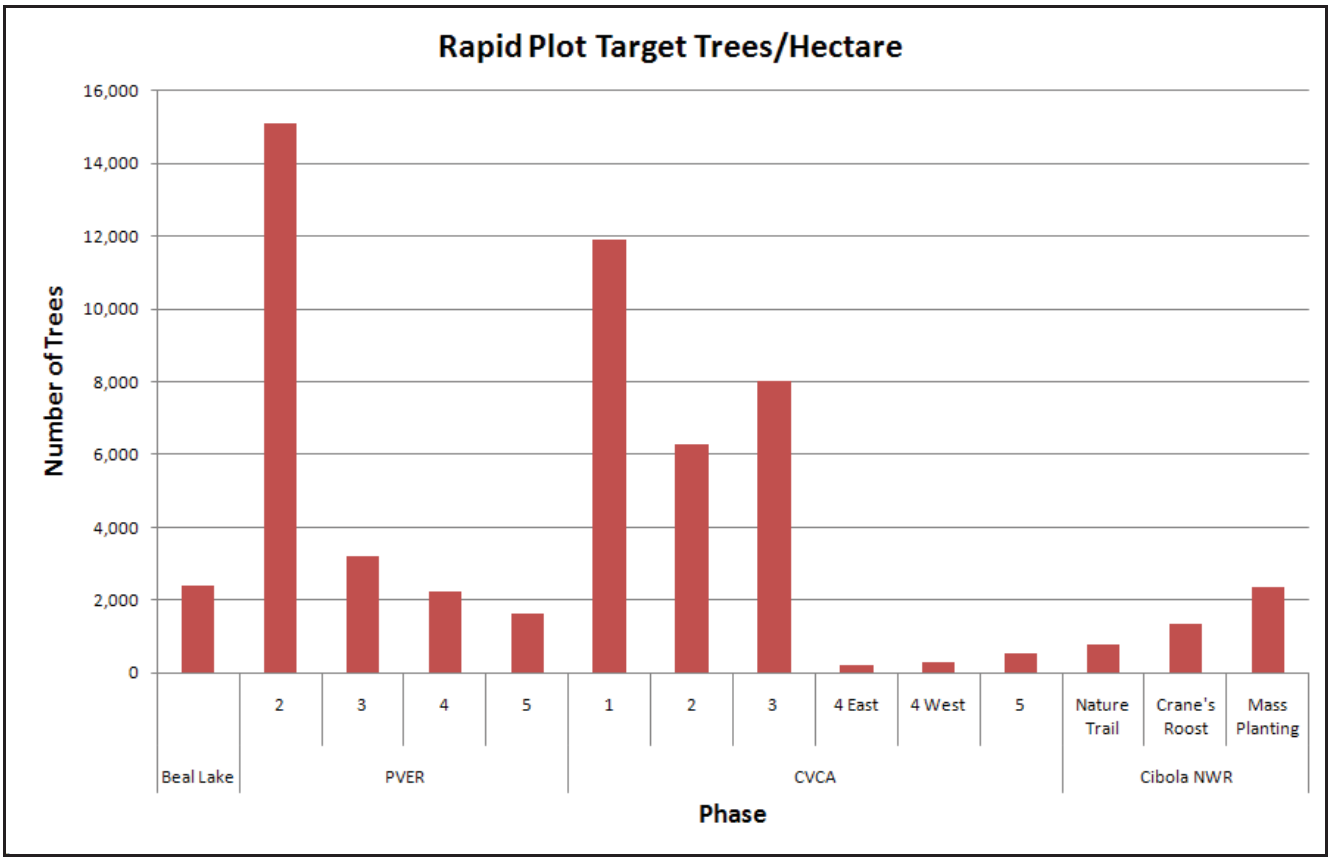

Figure A3. The number of all rapid plot target tree species per hectare.

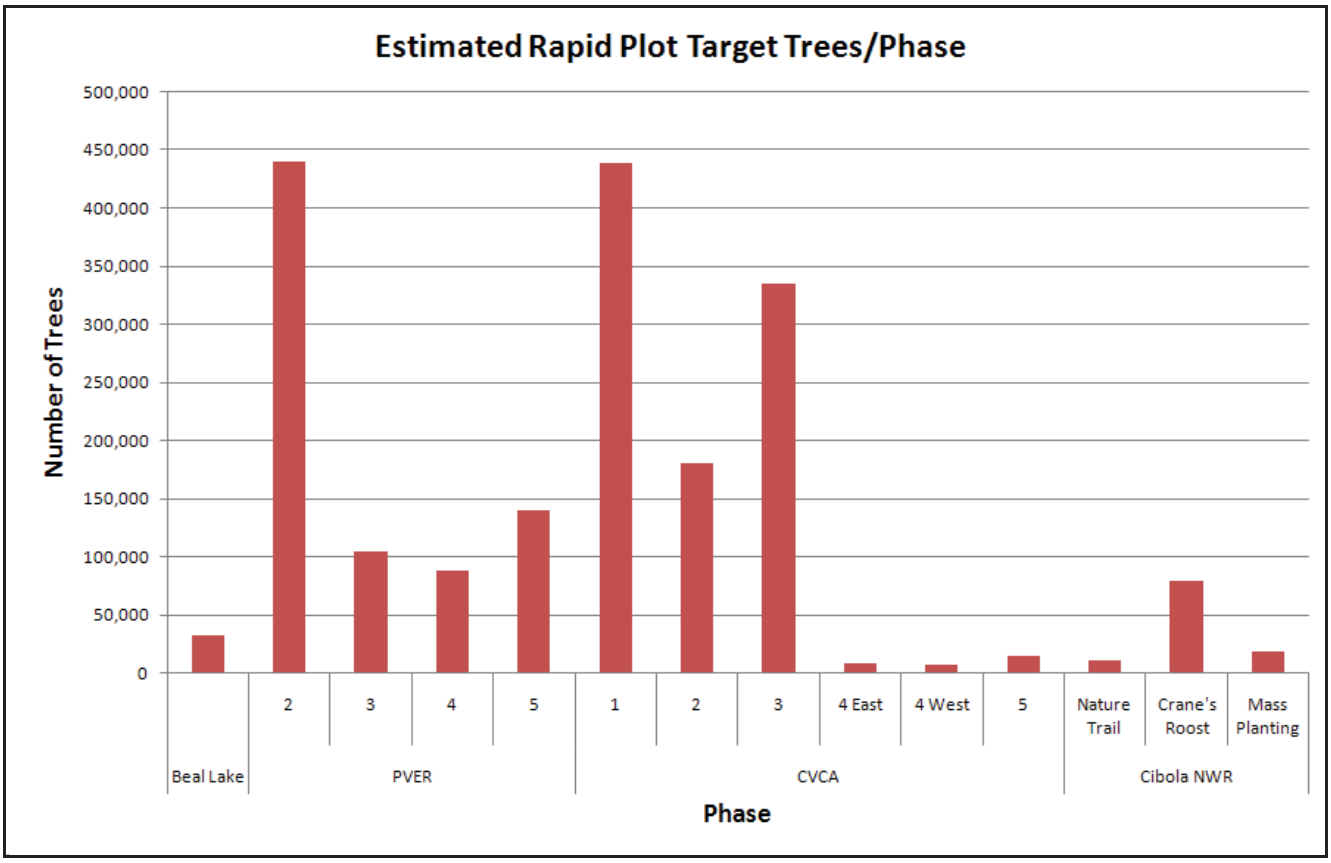

Figure A4. The estimated number of all rapid plot target tree species per phase.

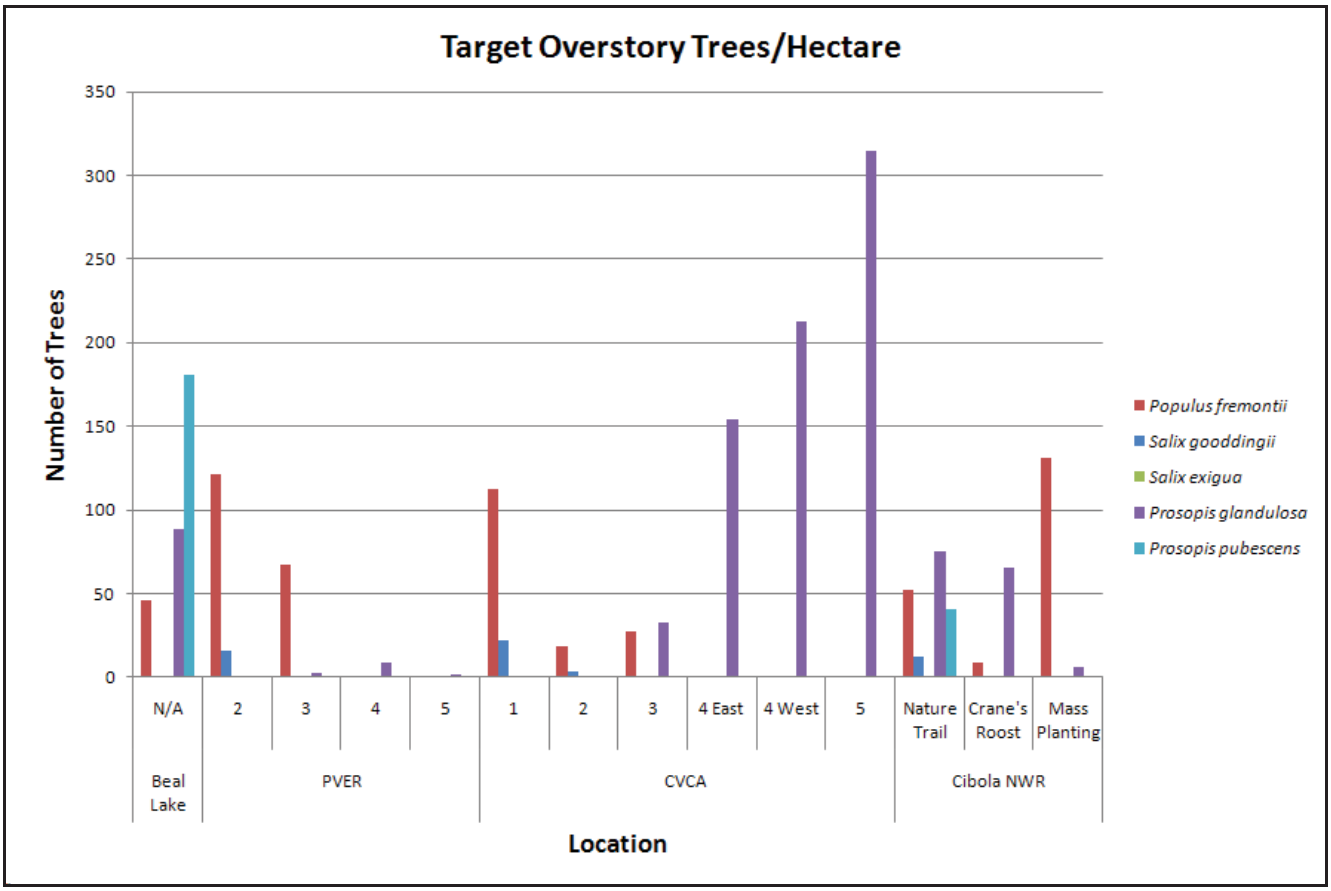

Figure A5. The number of each intensive plot target overstory tree species per hectare.

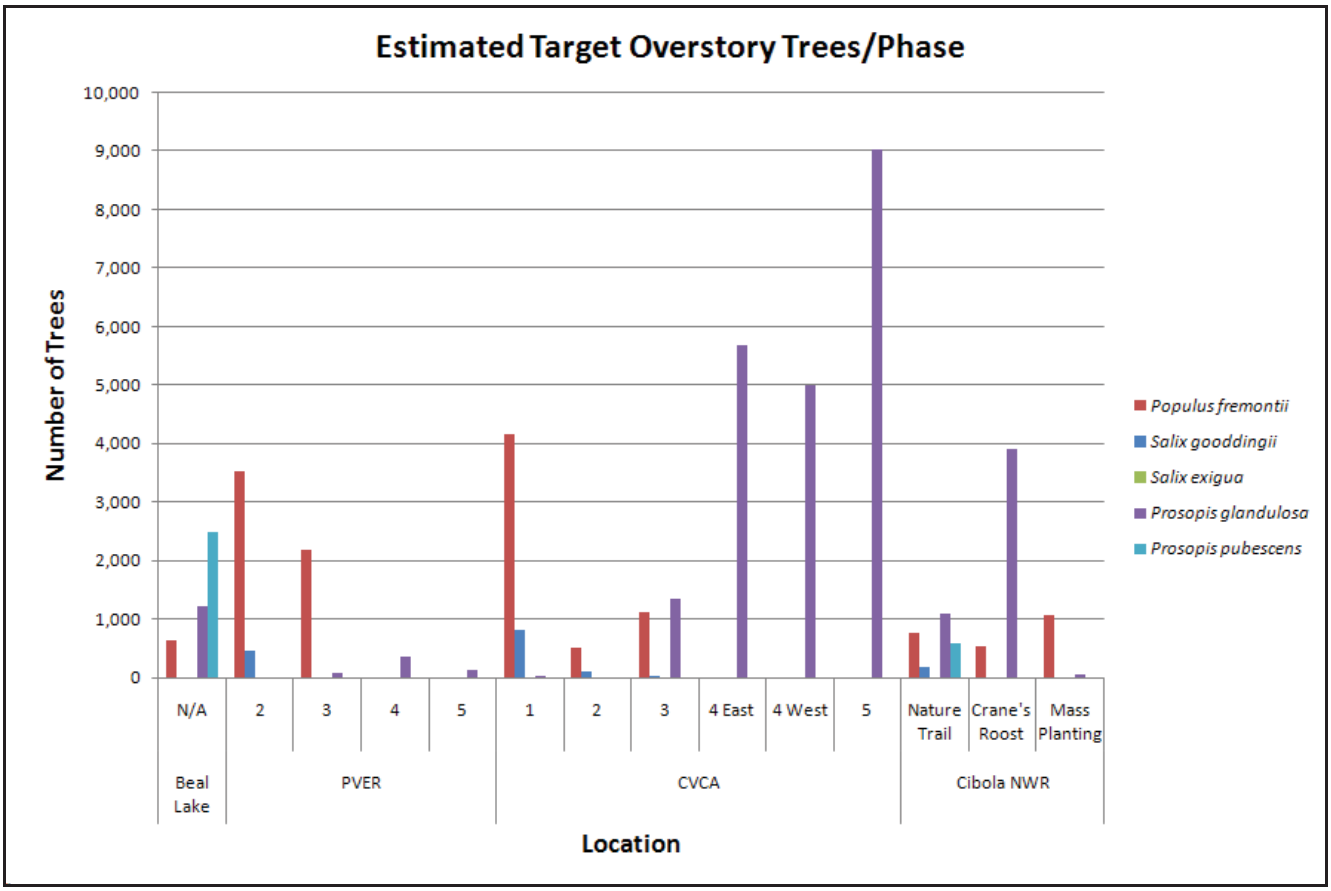

Figure A6. The estimated number of each intensive plot target overstory tree species per phase.

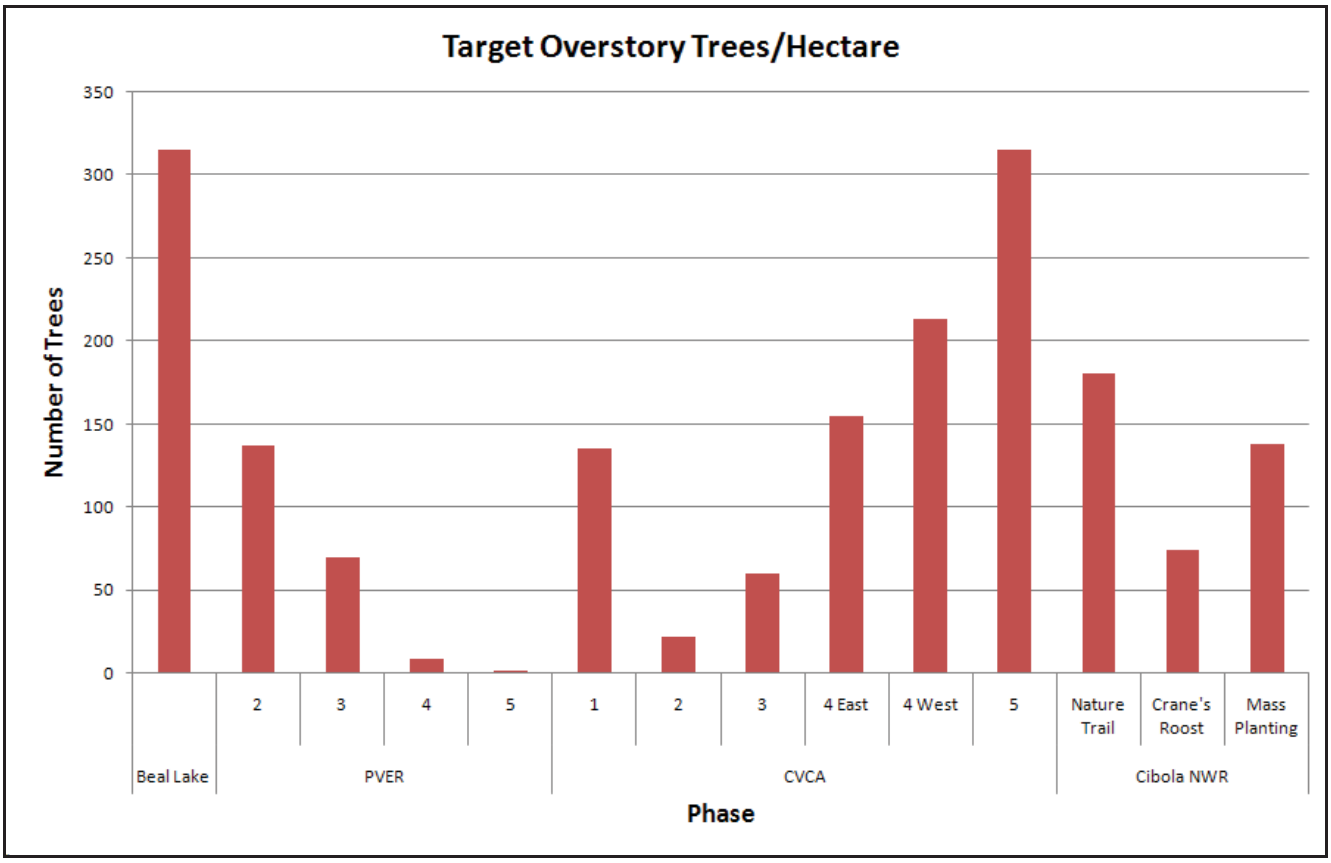

Figure A7. The number of all intensive plot target overstory tree species per hectare.

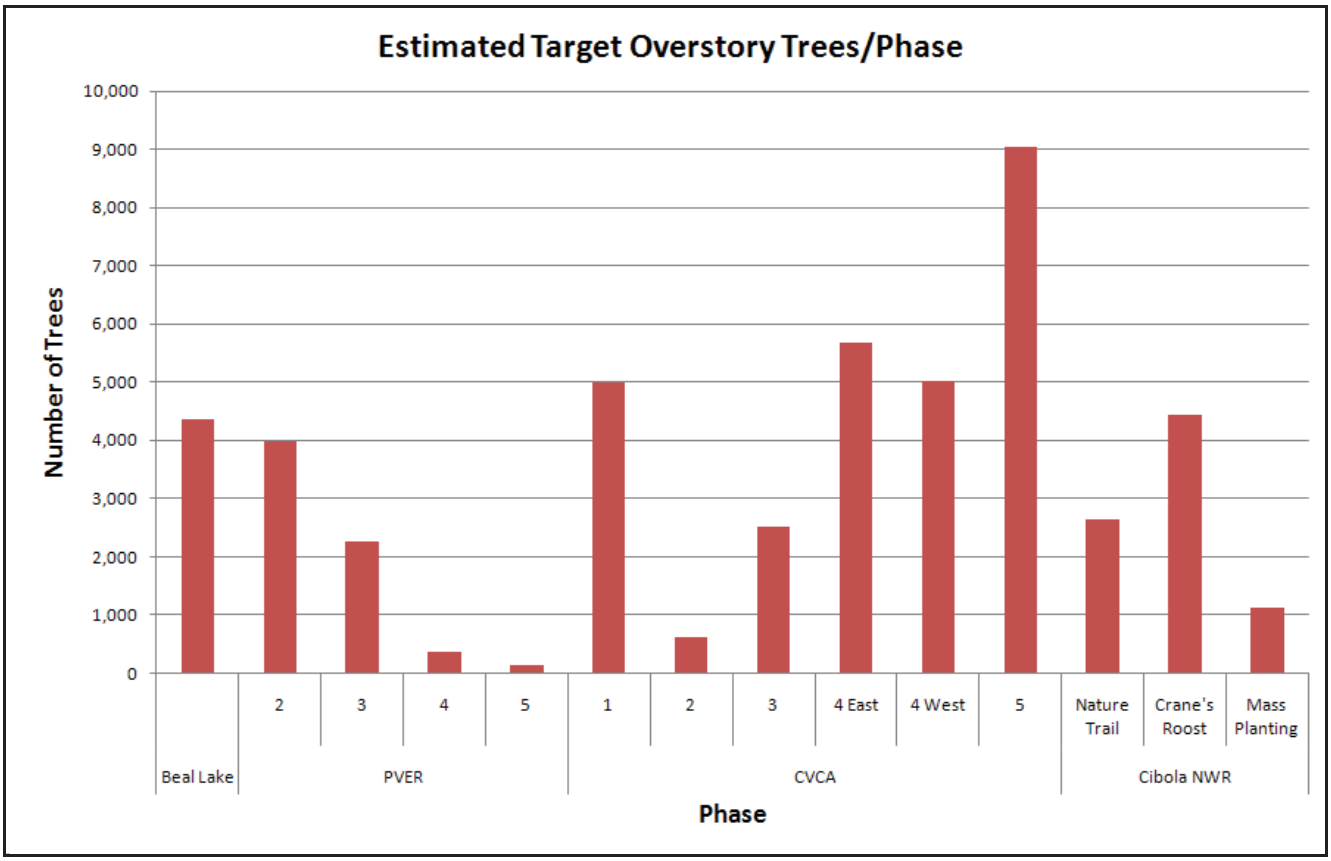

Figure A8. The estimated number of all intensive plot target overstory tree species per phase.

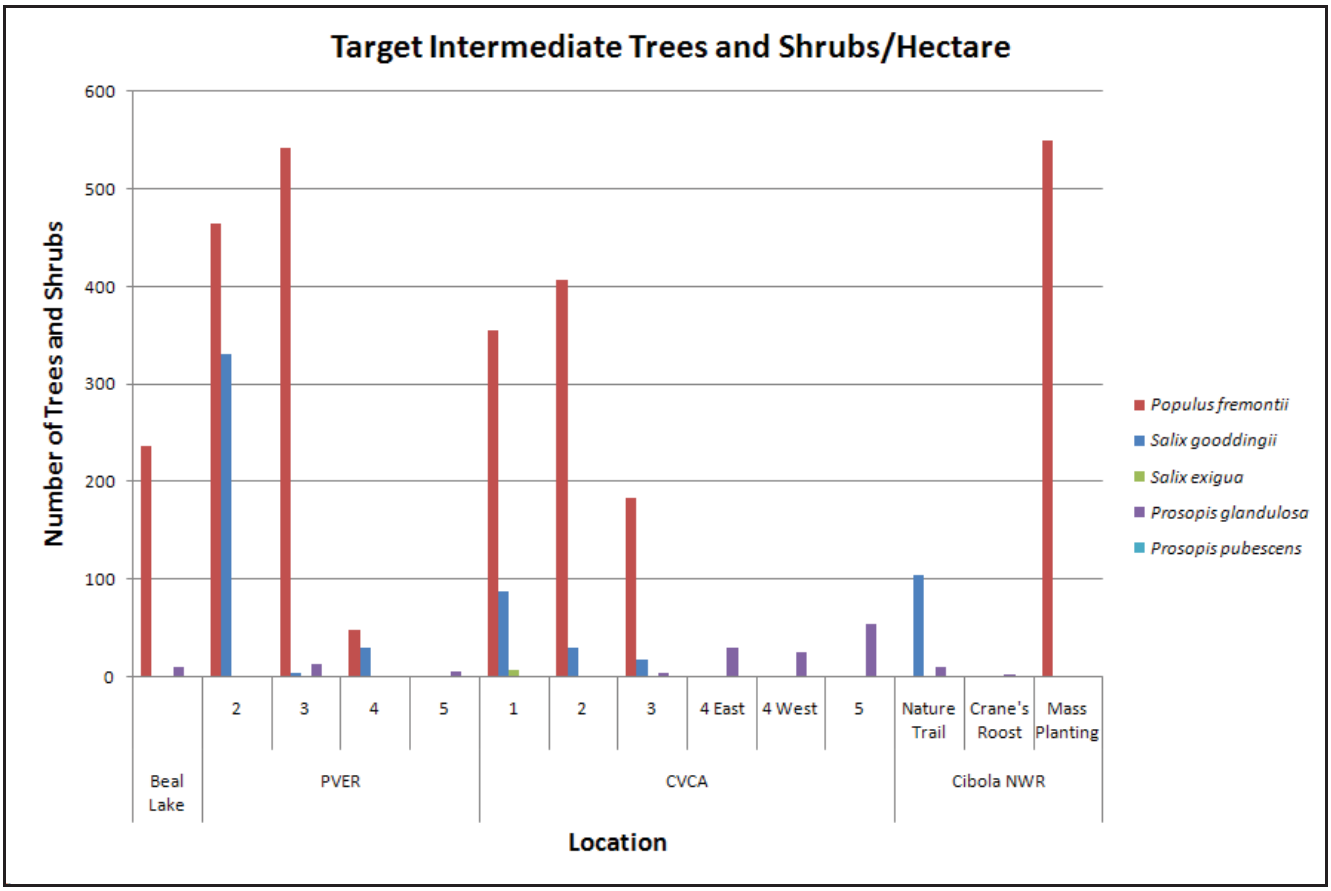

Figure A9. **The number of each intensive plot target intermediate tree and shrub species per hectare.**

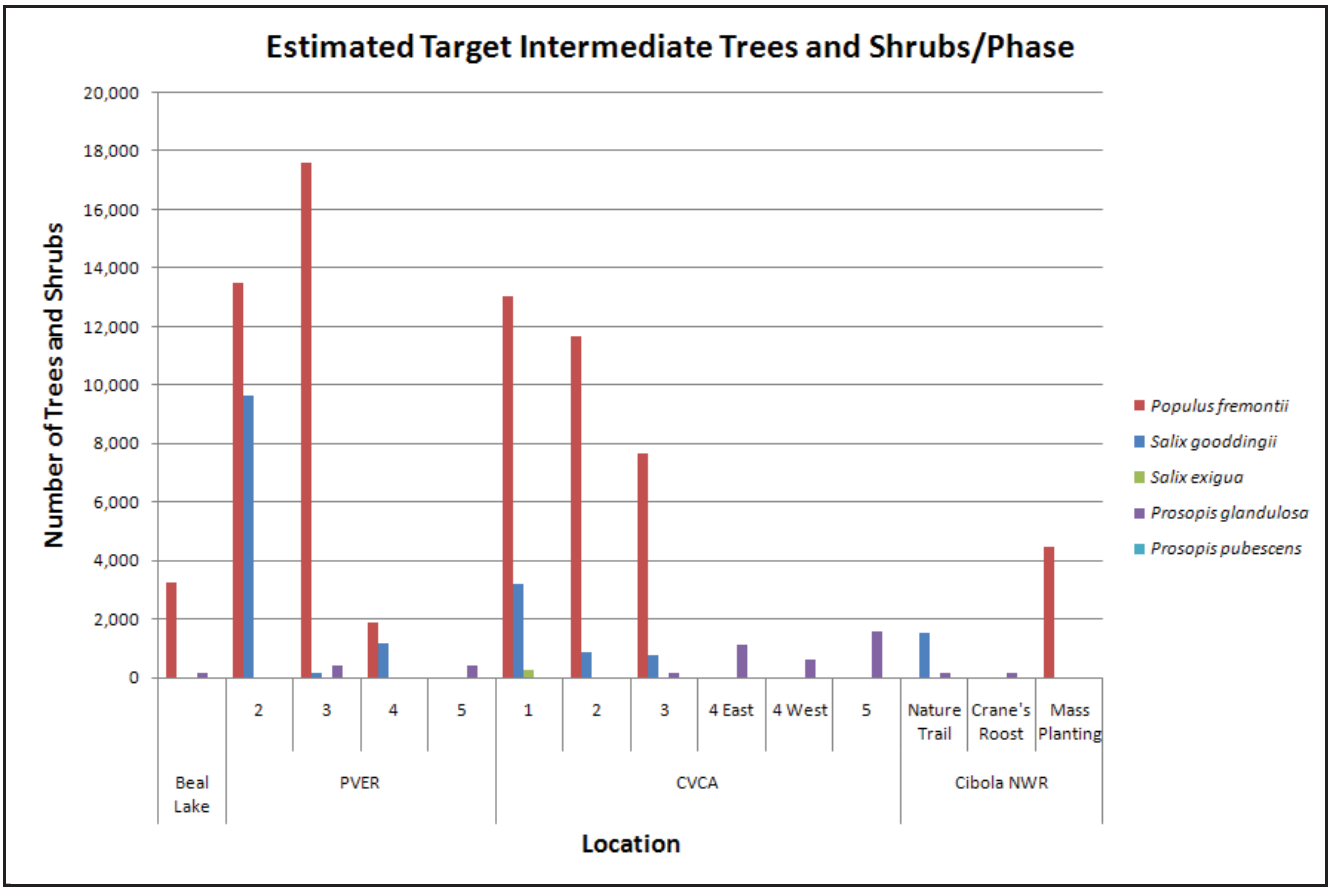

Figure A10. The estimated number of each intensive plot target intermediate tree and shrub species per phase.

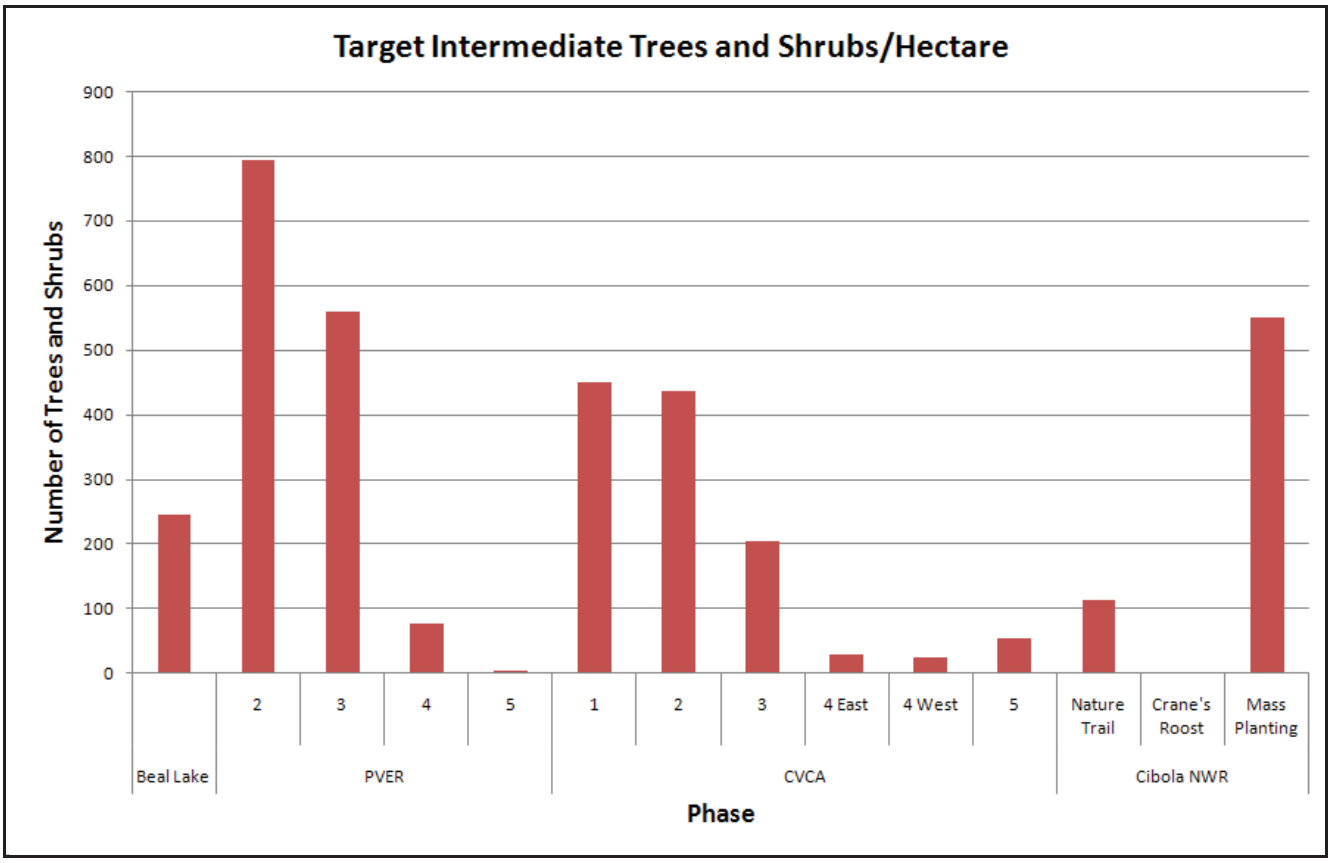

Figure A11. The number of all intensive plot target intermediate tree and shrub species per hectare.

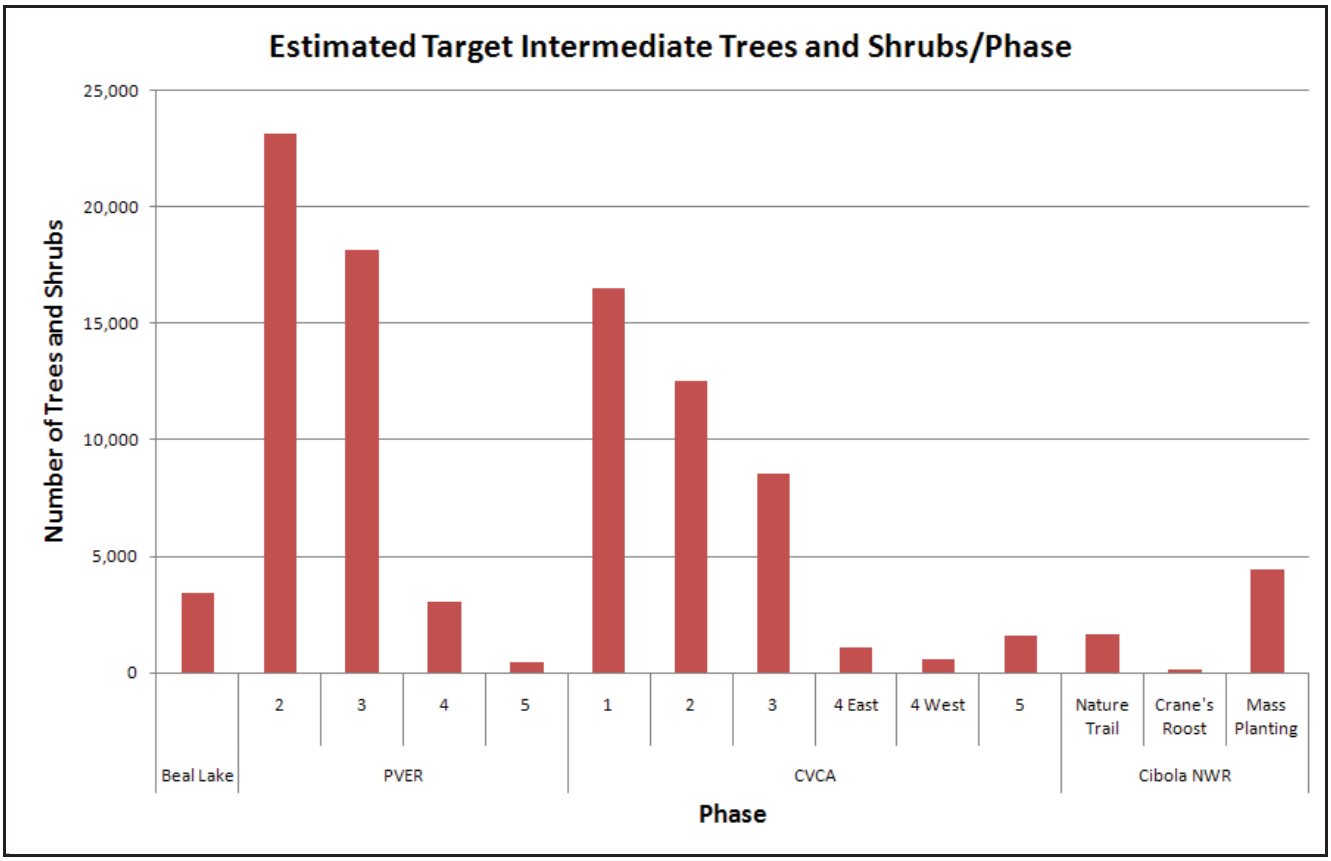

Figure A12. The estimated number of all intensive plot target intermediate tree and shrub species per phase.

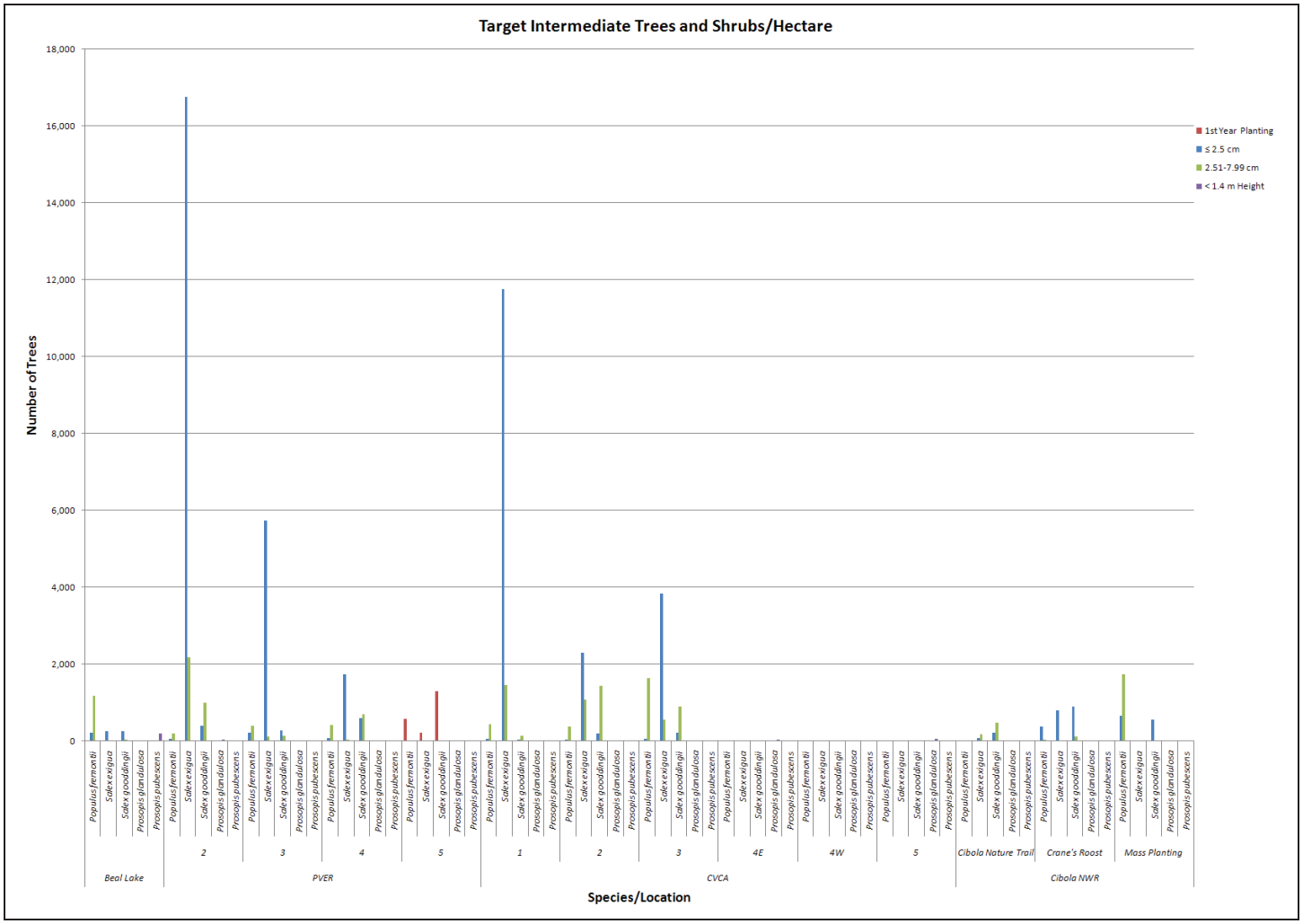

Figure A13. The number of each intensive plot target intermediate tree and shrub species within each size class per hectare.

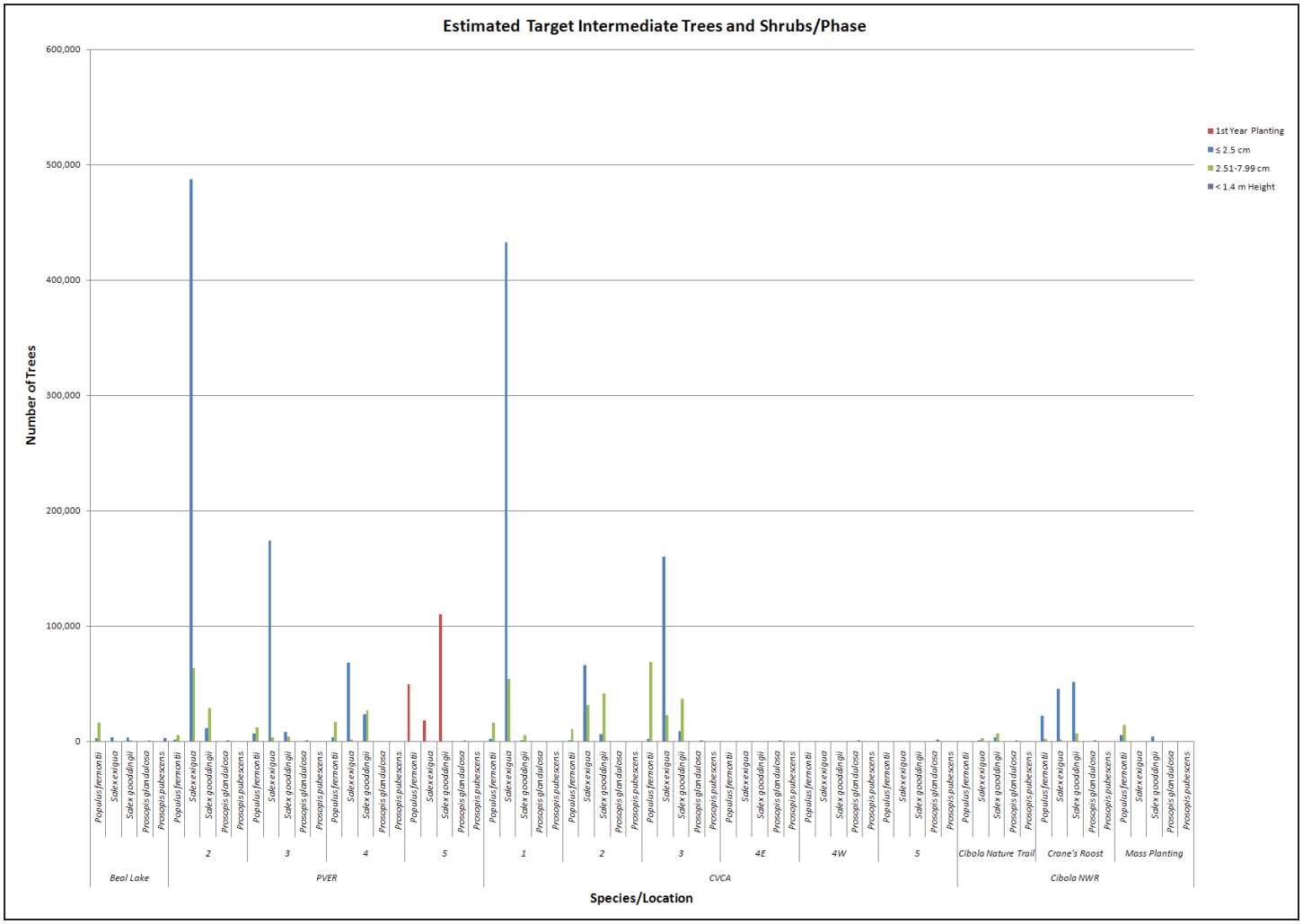

Figure A14. The estimated number of each intensive plot target intermediate tree and shrub species within each size class per phase.

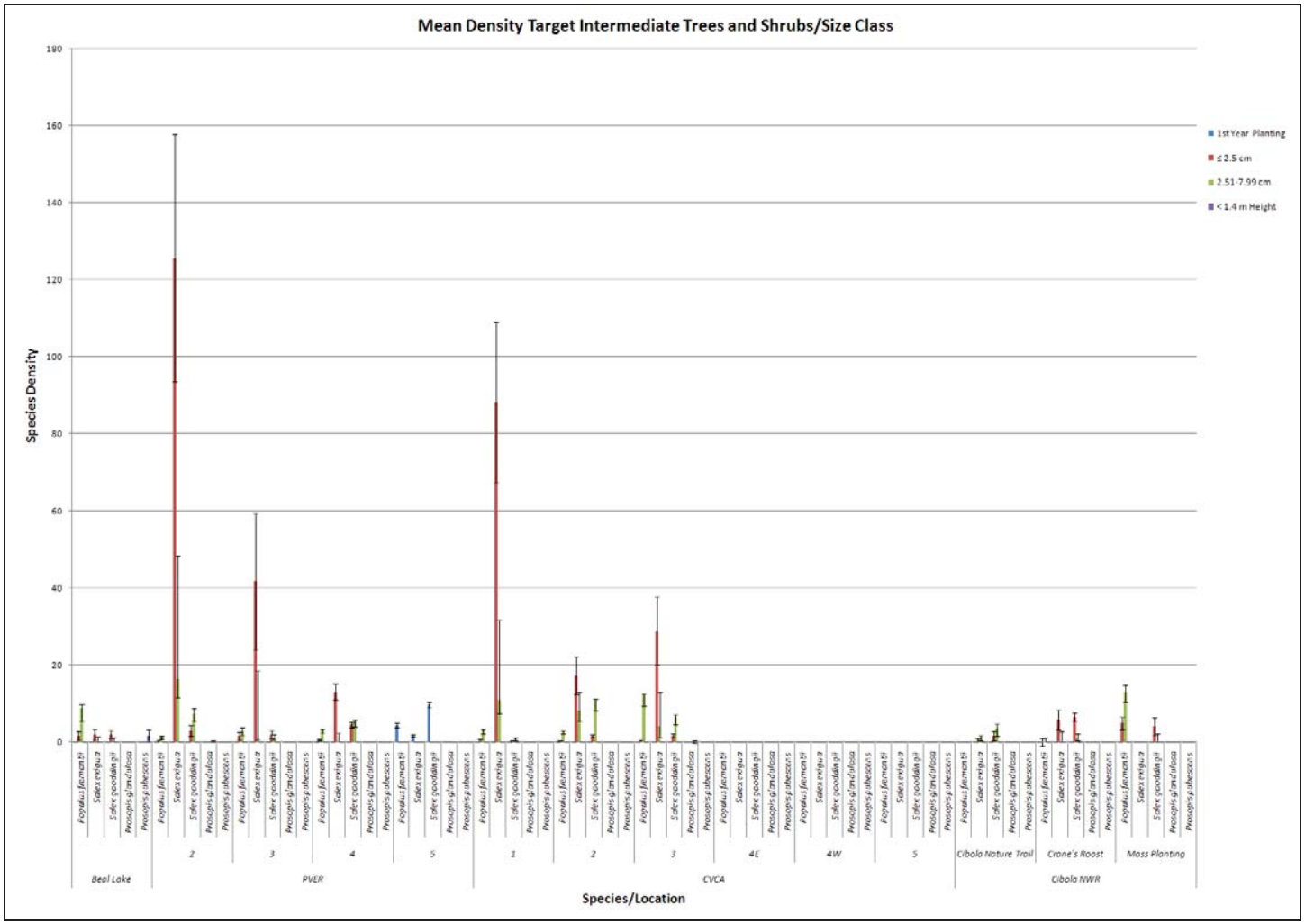

Figure A15. The mean density of each intensive plot target intermediate tree and shrub species per size class.

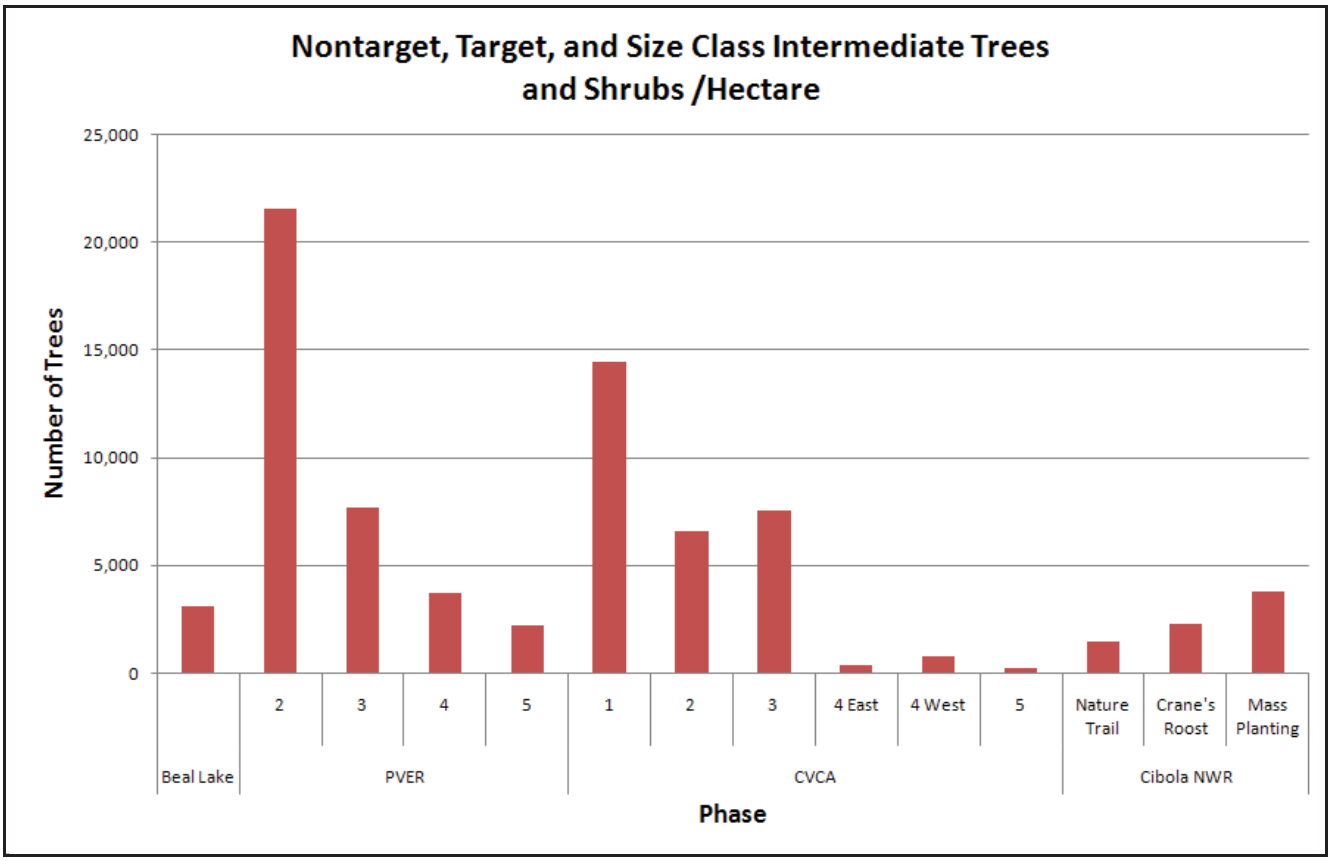

Figure A16. The number of all intensive plot (nontarget and target) intermediate tree and shrub species per hectare.

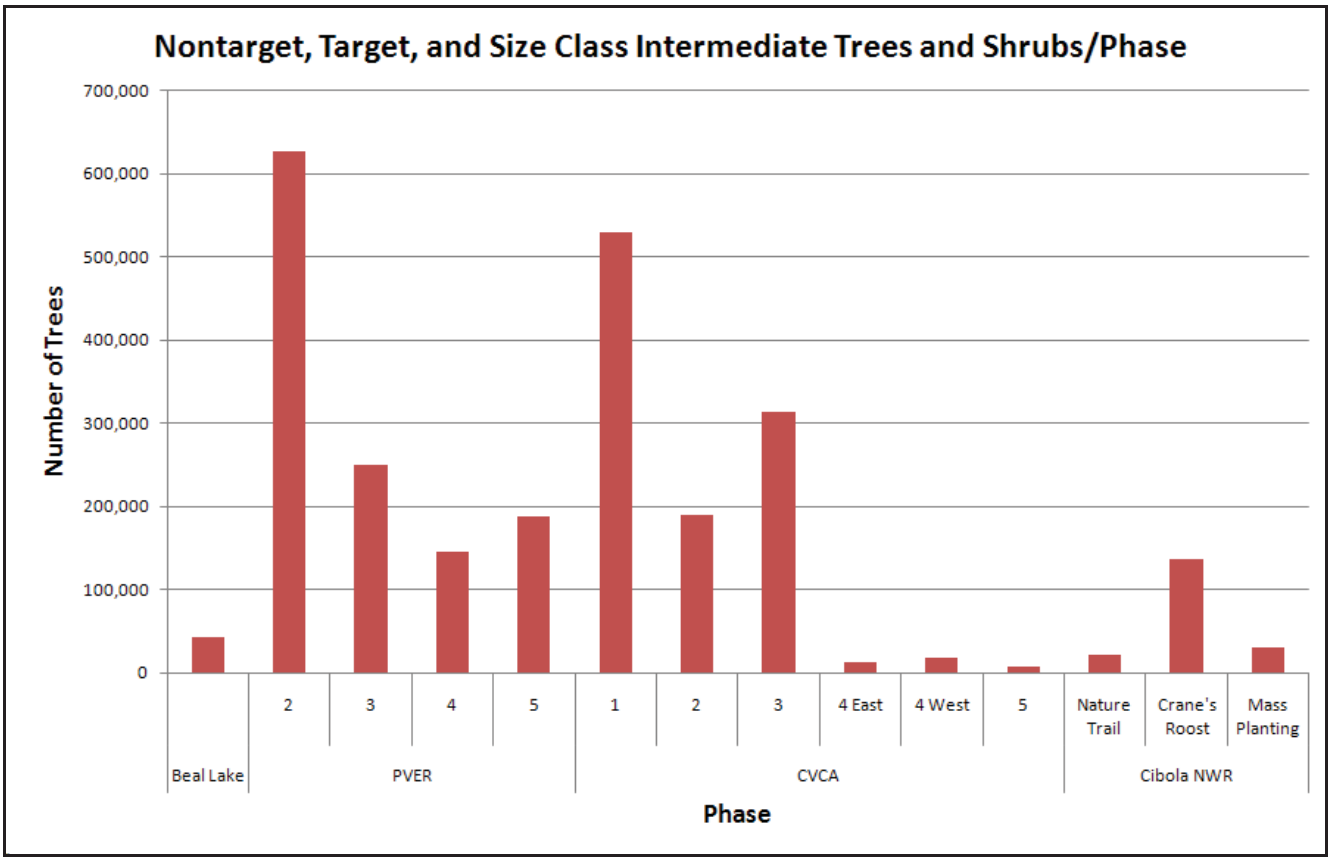

Figure A17. The estimated number of all intensive plot (nontarget and target) intermediate tree and shrub species per phase.

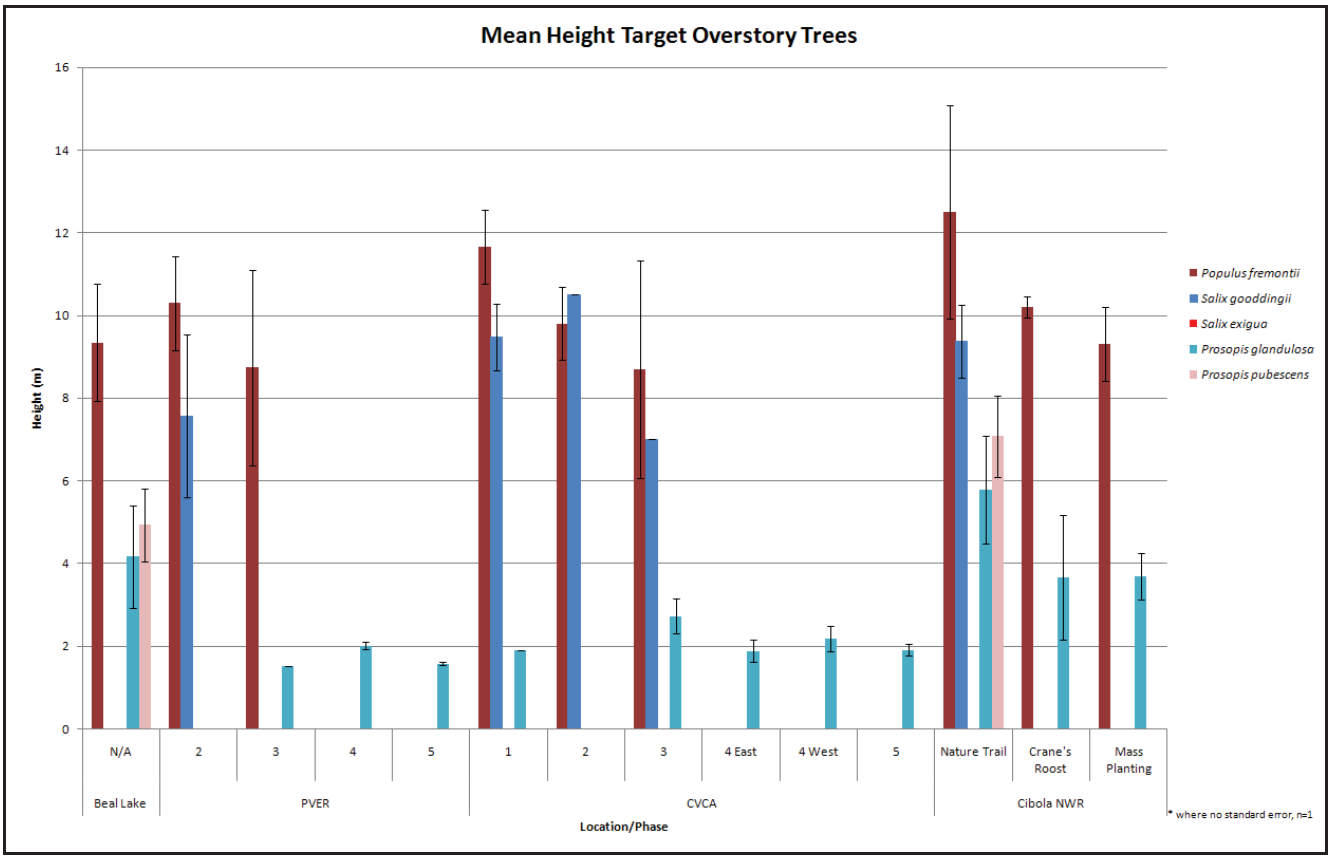

Figure A18. The mean height of each target overstory tree species per intensive plot.

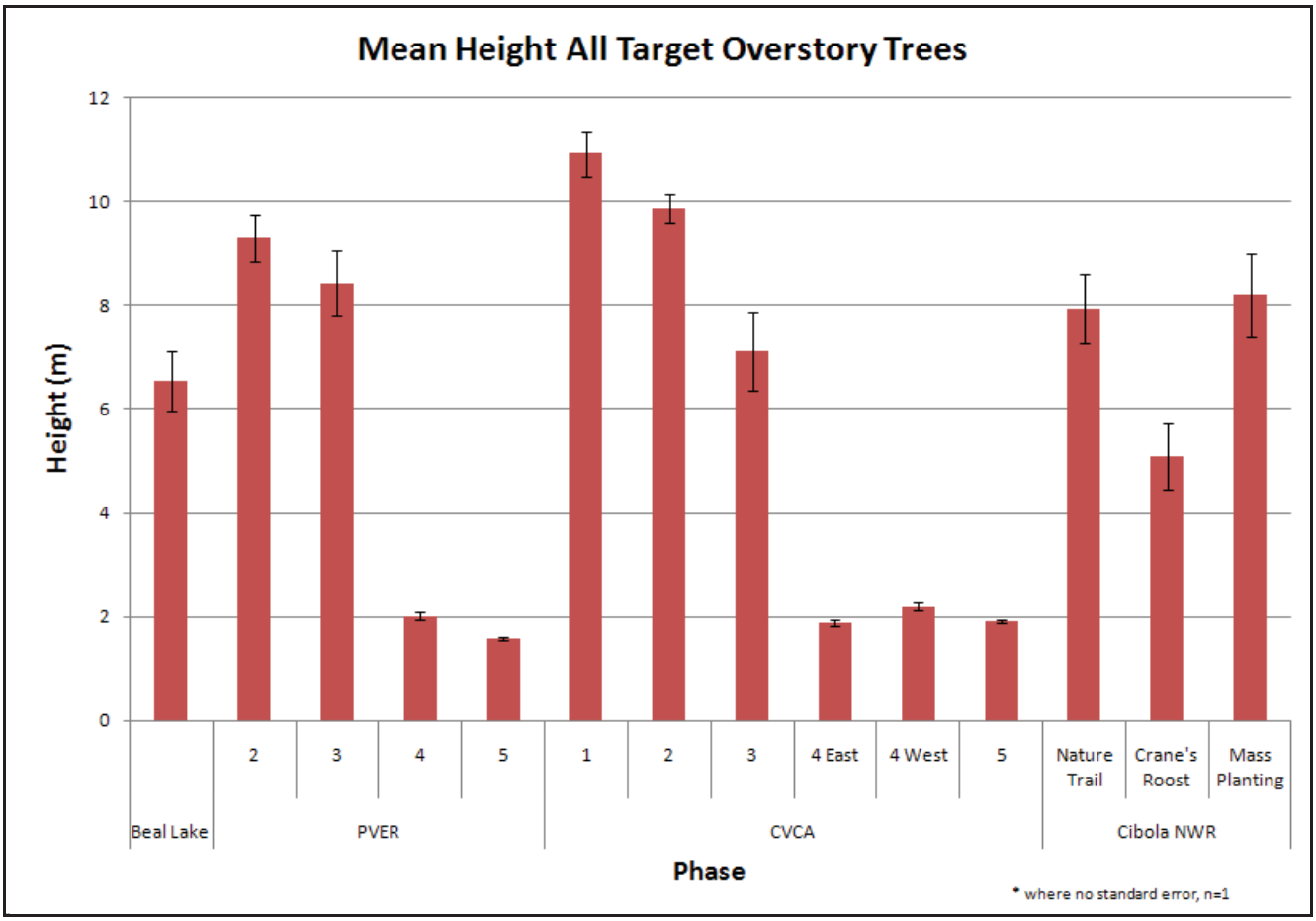

Figure A19. The mean height of all target overstory tree species per intensive plot.

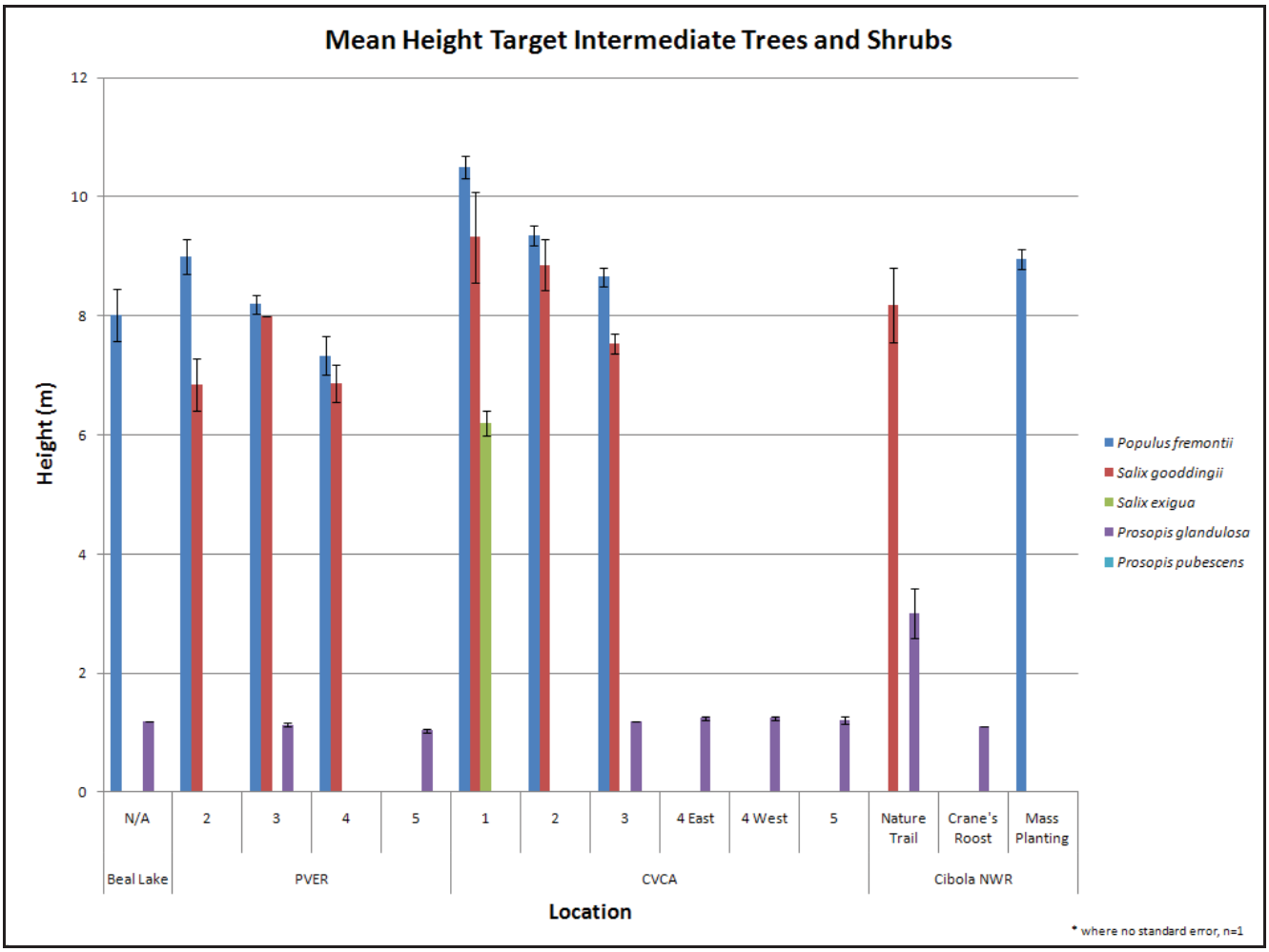

Figure A20. The mean height of each target intermediate tree and shrub species per intensive plot.

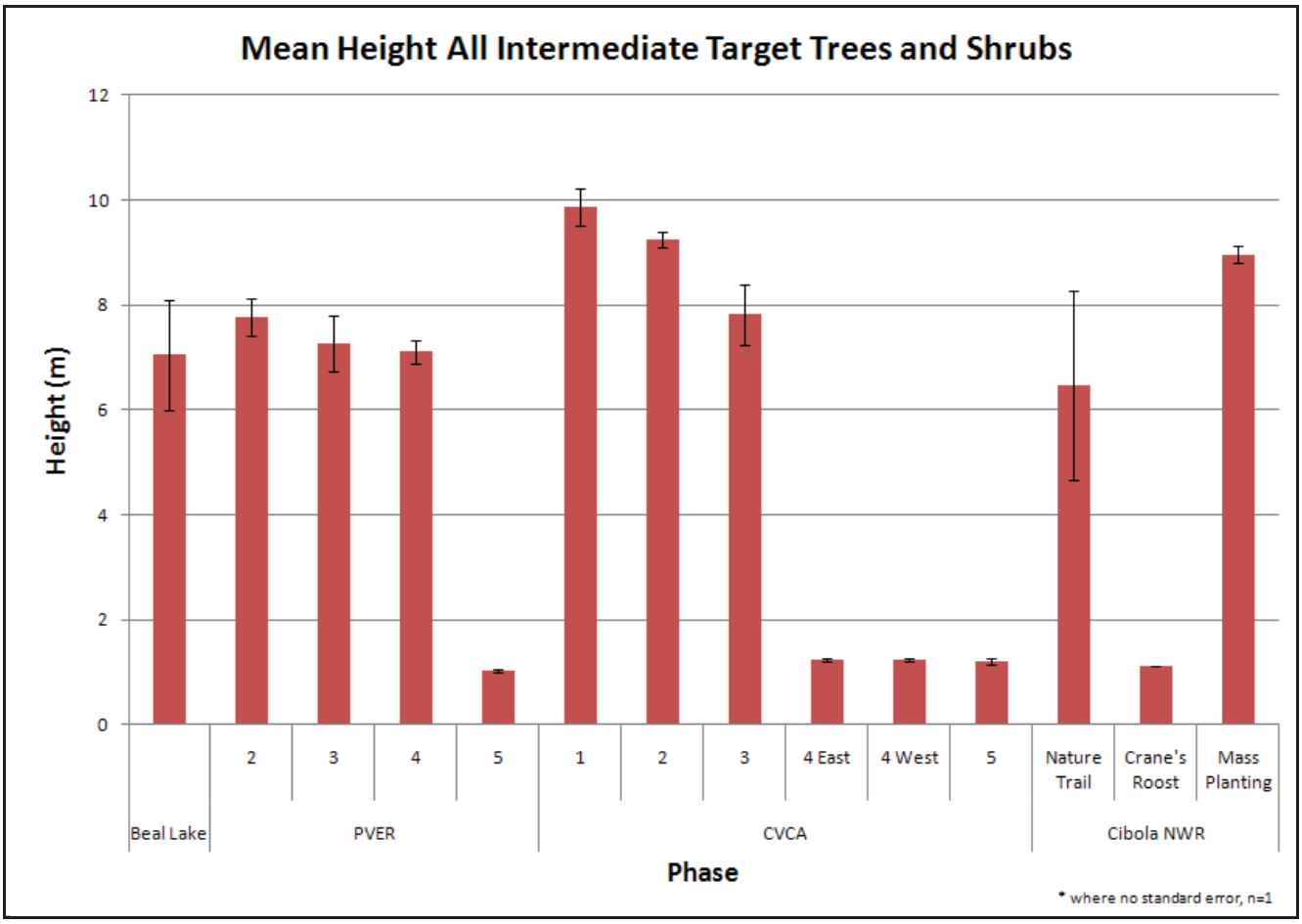

Figure A21. The mean height of all intermediate tree and shrub species per intensive plot.

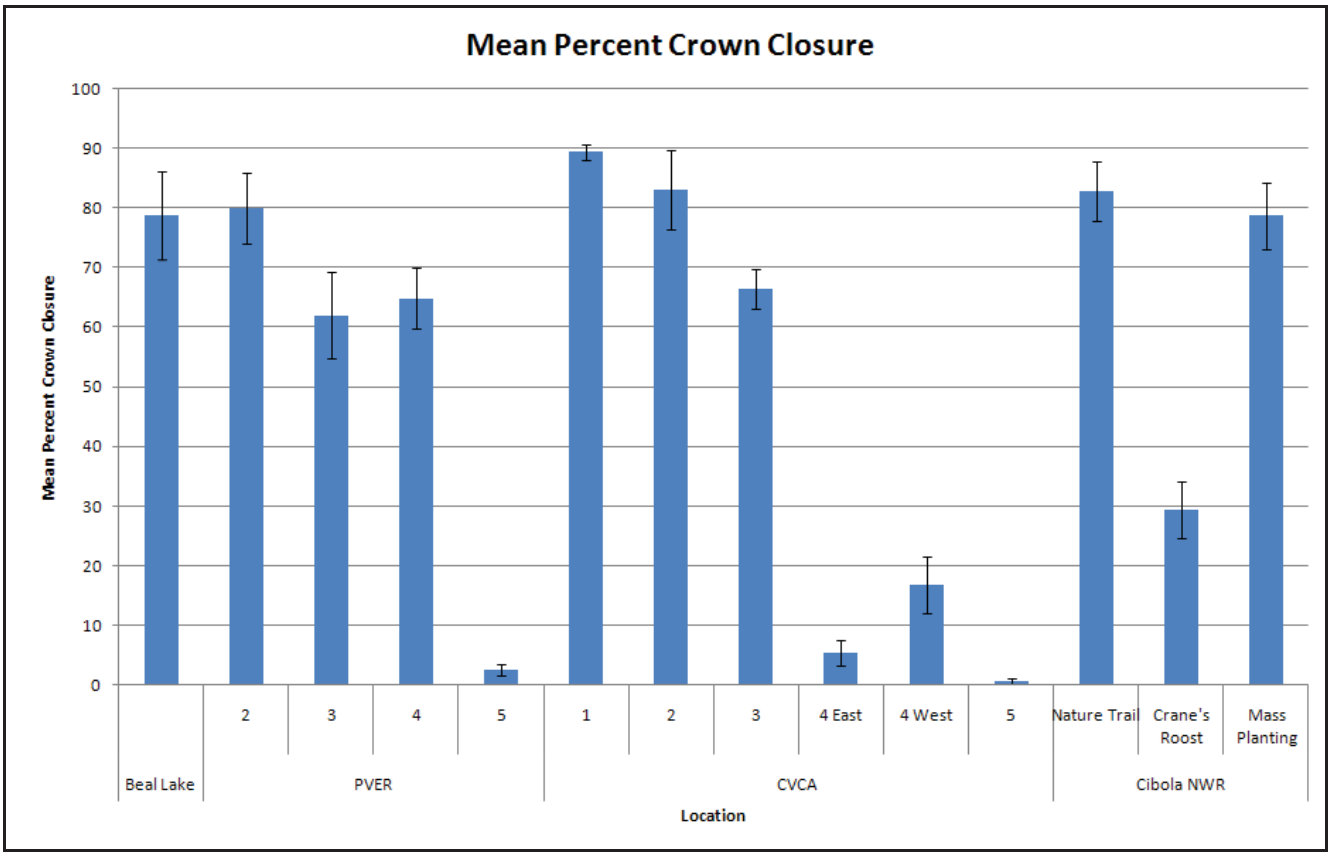

Figure A22. The mean percent crown closure per intensive plot.