



Department of Biology
MSC03 2020
Albuquerque, NM 87131
505.277.0758



BOSQUE SCHOOL



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BEMP Education Office
4000 Bosque School Road NW
Albuquerque, NM 87120

BOSQUE ECOSYSTEM MONITORING PROGRAM (BEMP) SITE MONITORING REPORT FOR 2016

2016 ANNUAL SITE MONITORING TECHNICAL REPORT

Submitted July 5, 2017

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Key personnel and contact information:

Kim Eichhorst, BEMP Co-Director; kimde@unm.edu; 505.277.0758

Dan Shaw, BEMP Co-Director; Dan.shaw@bosqueschool.org; 505.898.6388

Katie Higgins, BEMP Stewardship Coordinator, Katie.higgins@bosqueschool.org; 505.898.6388

Bosque Ecosystem Monitoring Program (BEMP)
2016 Annual Site Monitoring Technical Report
July 5, 2017

Objective: To collect and analyze abiotic and biotic data at Bosque Ecosystem Monitoring Program (BEMP) sites in the Middle Rio Grande Bosque. Additionally, to involve K-12 and university students in learning about and monitoring this system.

This report includes 2015 arthropod, vegetation and litterfall data, 2016 abiotic, Tamarisk Leaf Beetle, and woody debris data, and 2016-2017 outreach and education. All data and reports are available on the BEMP website, www.BEMP.org

Scope of Work: BEMP combines long-term ecological research with community outreach by involving K-12 teachers and their students in monitoring key indicators of structural and functional change in the Middle Rio Grande riparian forest, or “bosque.” In 1997, BEMP began as a collaboration between the Department of Biology at UNM and Bosque School in Albuquerque, with fewer than 200 participants in its first year. Now, BEMP averages approximately 9000 participants annually. The experiences of these community members support science education reform efforts and help to increase understanding and appreciation of the Rio Grande riparian ecosystem. BEMP findings derived from student-gathered data are used by government agencies to inform multi-million dollar river and riparian management decisions.

BEMP has 31 active monitoring sites along 230 miles of the Rio Grande, including 30 sites within the Middle Rio Grande (Figure 1). Through the strategic location of these sites, BEMP aims to study the ecological drivers of fire, flooding, climate change, and human alteration on the bosque ecosystem. Two thirds of BEMP sites were installed at the request of natural resource managers to monitor the long-term ecological impacts of restoration projects such as mechanical clearing, wood chipping, and bank-lowering. Both biotic and abiotic variables are monitored. Our abiotic datasets are depth to groundwater; water level in ditches and drains; precipitation; above- and belowground temperature; and water quality in the Rio Grande, ditches and drains, and groundwater. Our biotic datasets are litterfall; vegetation cover; fuel load and woody debris; cottonwood sex and diameter; surface-active arthropod richness and abundance; and tamarisk leaf beetle presence and impact. BEMP hosts three events throughout the year to present new data, visualizations, and analyses: the Fall Field Tour, the Data Users Meeting (combined with the Fall Field Tour in 2016), and the Crawford/Green Trails Symposium.

Forty schools from Rio Arriba, Sandoval, Bernalillo, Valencia, Socorro and Doña Ana counties are involved with BEMP (Table 1). Participants include traditional public, charter, parochial, private, alternative and home school students. Throughout the school year, BEMP staff deliver Common Core correlated curricula both in the classroom and out in the field. At the end of the school year, BEMP hosts two annual student congresses in partnership with a variety of local agencies and organizations. Students present and share their experiences at their sites with each other and engage in bosque-related activities and workshops. As BEMP is the official schoolyard program for the Sevilleta Long-Term Ecological Research (LTER) Network site, our students also present at the LTER Schoolyard Spanish Webinar. This symposium connects Spanish-speaking BEMP students with students at the Luquillo, Puerto Rico LTER site to share data and compare experiences.

Timing of Data Collection: Depth to groundwater, water level in nearby ditches and/or drains, precipitation, and litterfall are collected during the week of the third Tuesday of each month. Surface-active arthropods are collected three times each year, in May, June and September. Vegetation cover is collected once each year in August/September. Tamarisk leaf beetle monitoring is conducted in May-August. All other datasets are collected as funding permits.

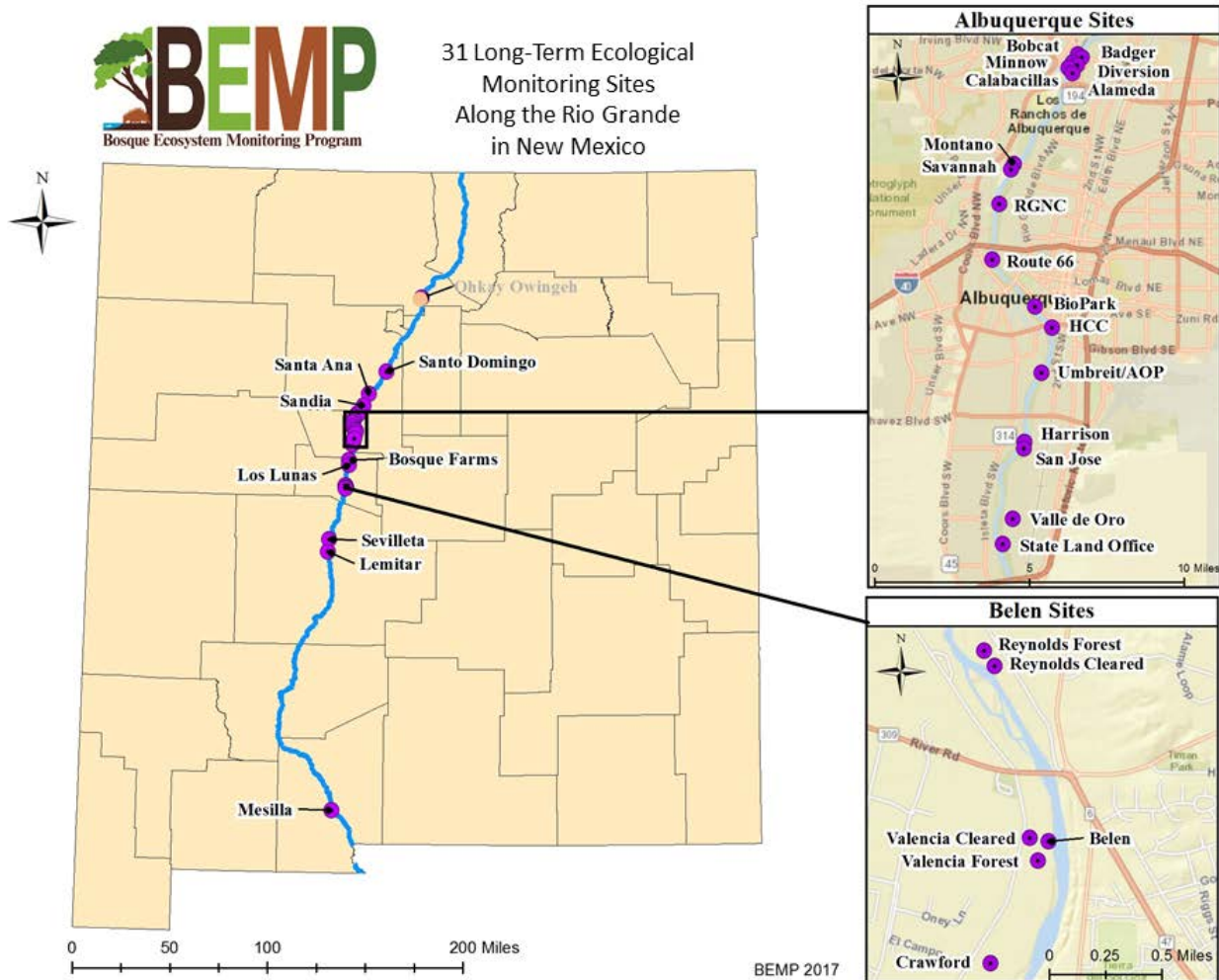


Figure 1: Map of 31 active BEMP sites along the Rio Grande; Ohkay Owingeh is no longer an active site and is shown in orange and grey.

Results:

Education and Outreach:

In the 2016-2017 school year, 8920 community members, largely students and teachers, participated in BEMP's education and outreach (Figure 2). Over 5000 participants were out in the field conducting core BEMP monitoring or collecting data for special research projects. Of those, over 2000 students were involved in year-round monthly monitoring with Common Core correlated follow-up classroom sessions. This number is mostly limited by staff time constraints and budgeting needs. There has been a

shift this year to more students being involved in long-term monitoring as opposed to single-day classroom visits or field trips. There were about 20 students involved in in-depth research projects with BEMP, which included field work, data analysis, and presentation/dissemination of the data to broader audiences at professional conferences and local events.

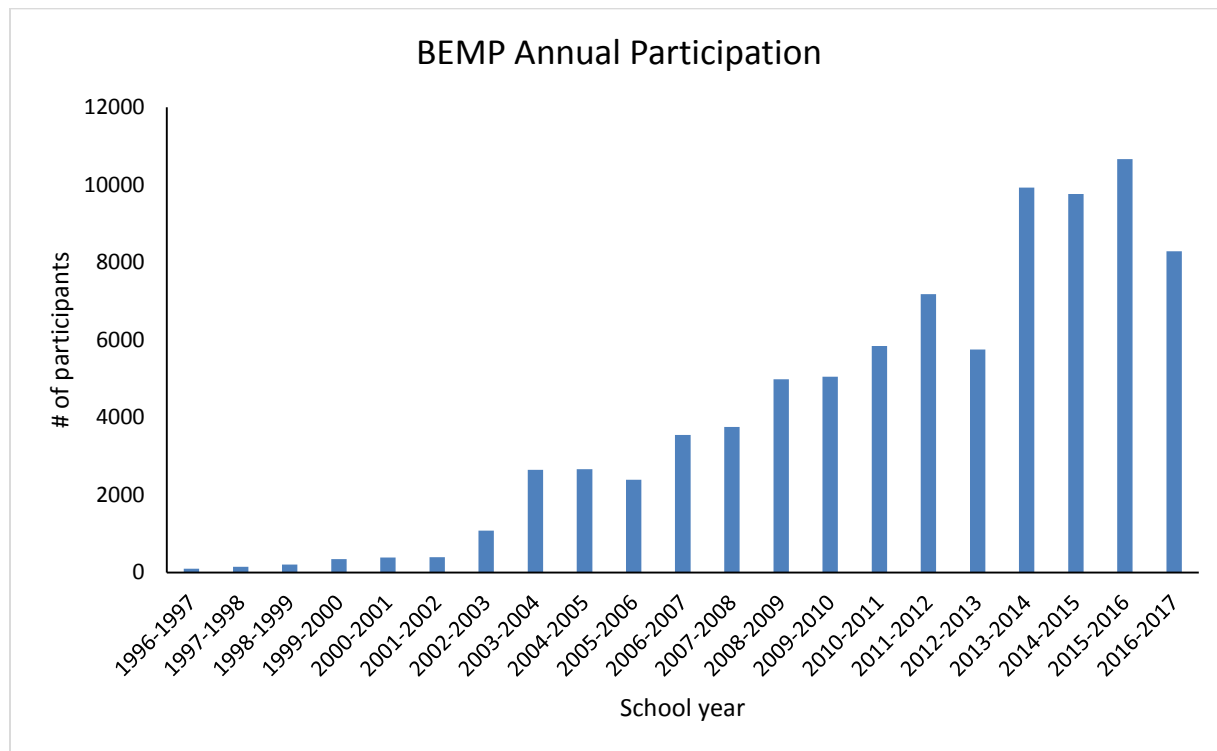


Figure 2. BEMP annual participation numbers from 1996 through 2017 school year.

Table 1. BEMP participation numbers by category of outreach.

Type of outreach	students	adults	total
long term, multiple field days	2168	125	2293
short term or classroom (1-2 days)	2862	146	3008
summer programs	193	234	427
wildlife programs	14	0	14
adult/teacher training	0	76	76
festivals, events, etc.	1291	395	1686
conferences, meetings, etc.	42	744	786
Total	6570	1720	8290



Rio Grande Elementary students monitor the Valencia Cleared BEMP site in Belen.



Students from South Valley Academy learn to program and install weather stations at BEMP sites.

Monitoring Data:

Groundwater

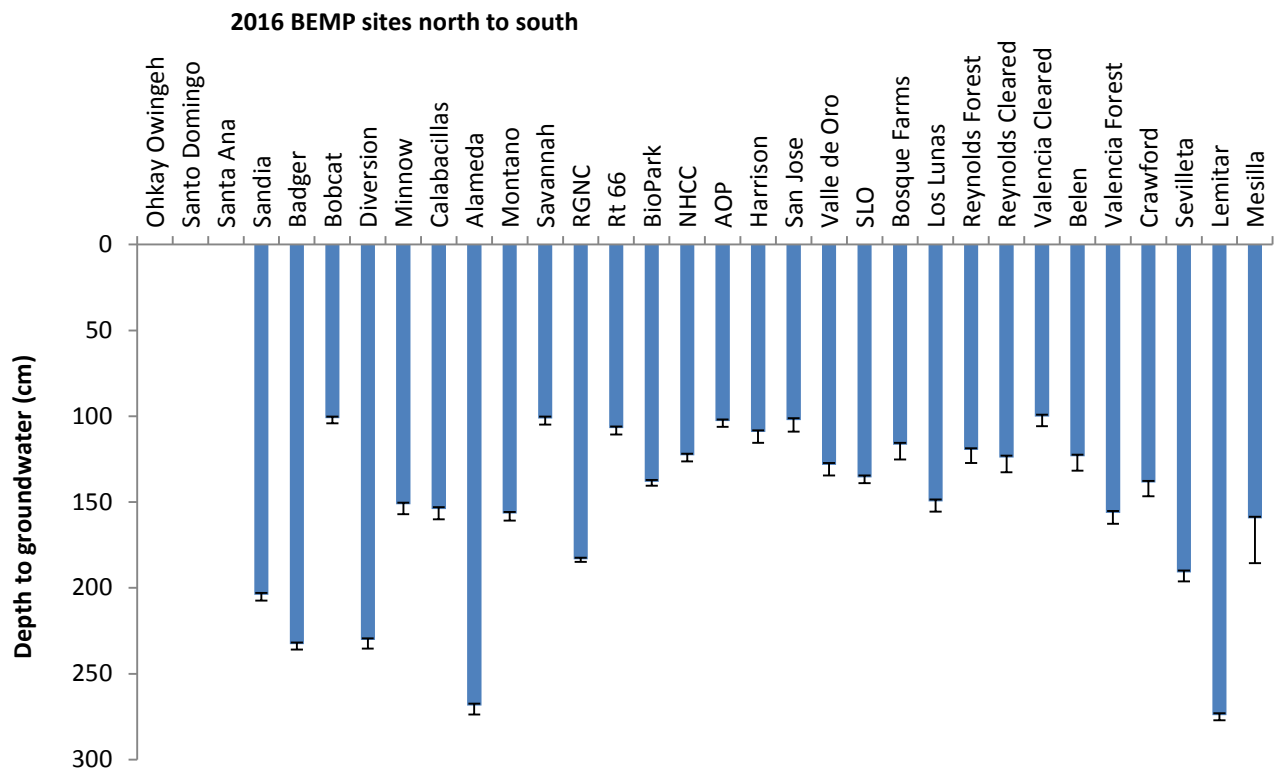


Figure 3. 2016 mean depth to groundwater (cm) at BEMP sites from north to south.

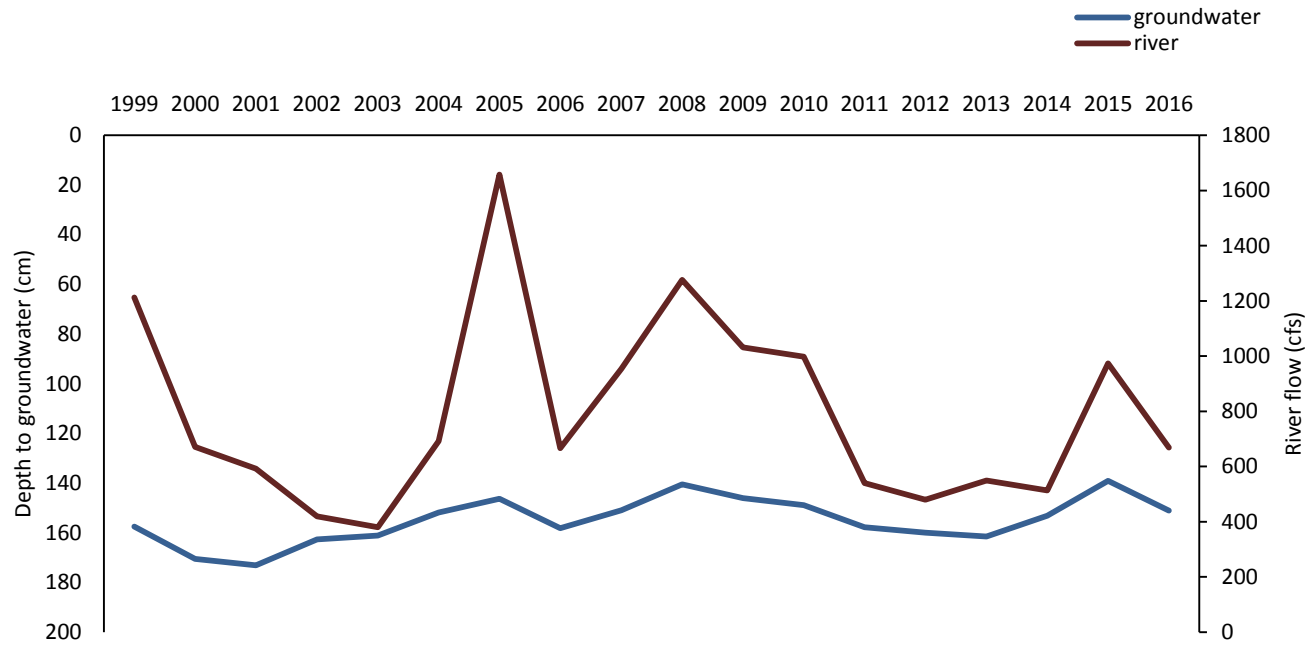


Figure 4. Mean annual depth to groundwater and mean annual river flow across all BEMP sites

Depth to groundwater did not vary much within most sites (Figure 3). Overall, river flows were lower in 2016 (Figure 4), resulting in lower groundwater levels at individual sites. The strong connection between river flow and groundwater level is apparent when examined across BEMP sites using an overall mean to compare the two variables (Figure 4).

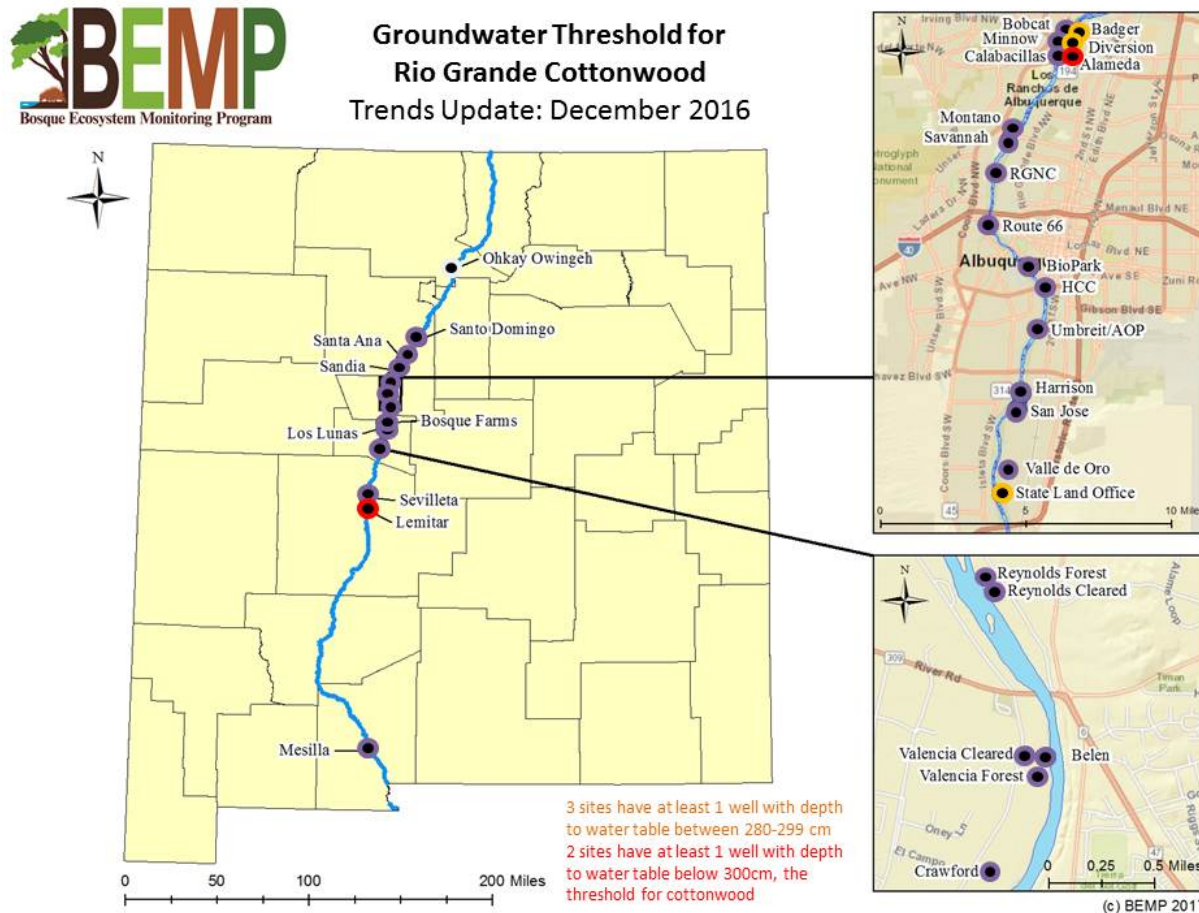


Figure 5. Map indicating groundwater threshold for cottonwoods for December 2016.

In August 2016, BEMP began posting monthly updates of our groundwater data on our website in the form of threshold maps (Figures 5 & 6). Currently, we are highlighting sites where groundwater is approaching or has dropped below three meters, which is the accepted maximum depth for cottonwood root growth. In the interval from August to December 2016, the two sites that consistently fell below this threshold were Alameda, which may be experiencing effects related to water diversions from the nearby upstream drinking water diversion dam; and Lemitar, which is outside of the levee system and thus more disconnected from the river. In the coming year, we hope to add other monthly updates to the website, particularly groundwater thresholds for other native species. Cottonwood threshold maps are updated monthly and can currently be found on our website.

**Groundwater Threshold for
Rio Grande Cottonwood
Trends Update: May 2017**

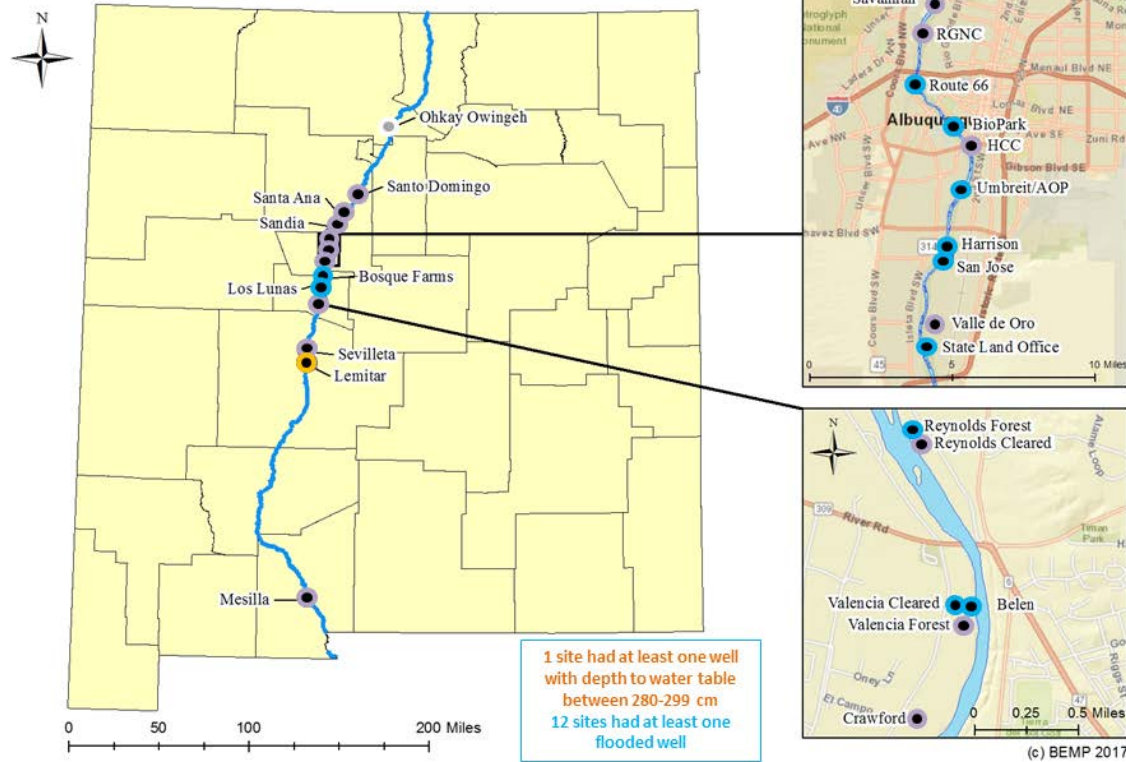


Figure 6. The most current threshold map shows the flooding that occurred in May, 2017 at 12 BEMP sites. Seventeen sites had some level of flooding, but only sites that had standing water at the groundwater wells were displayed.



Overbank flooding at the Belen BEMP site in May, 2017.

Due to drought and river drying during 2008-2013, groundwater depth decreased at all but one BEMP site; the exception was directly above the Drinking Water Diversion Dam in Albuquerque (Figure 7). From 2013 to 2015 there was an increase (or “recovery”) in river flow, which resulted in an increase/recovery in groundwater levels at most sites (Figure 7). The only site to continue to experience a decline in groundwater levels was the Belen BEMP site, near the Willie Chavez State Park; however, adjacent sites did show recovery of groundwater levels.

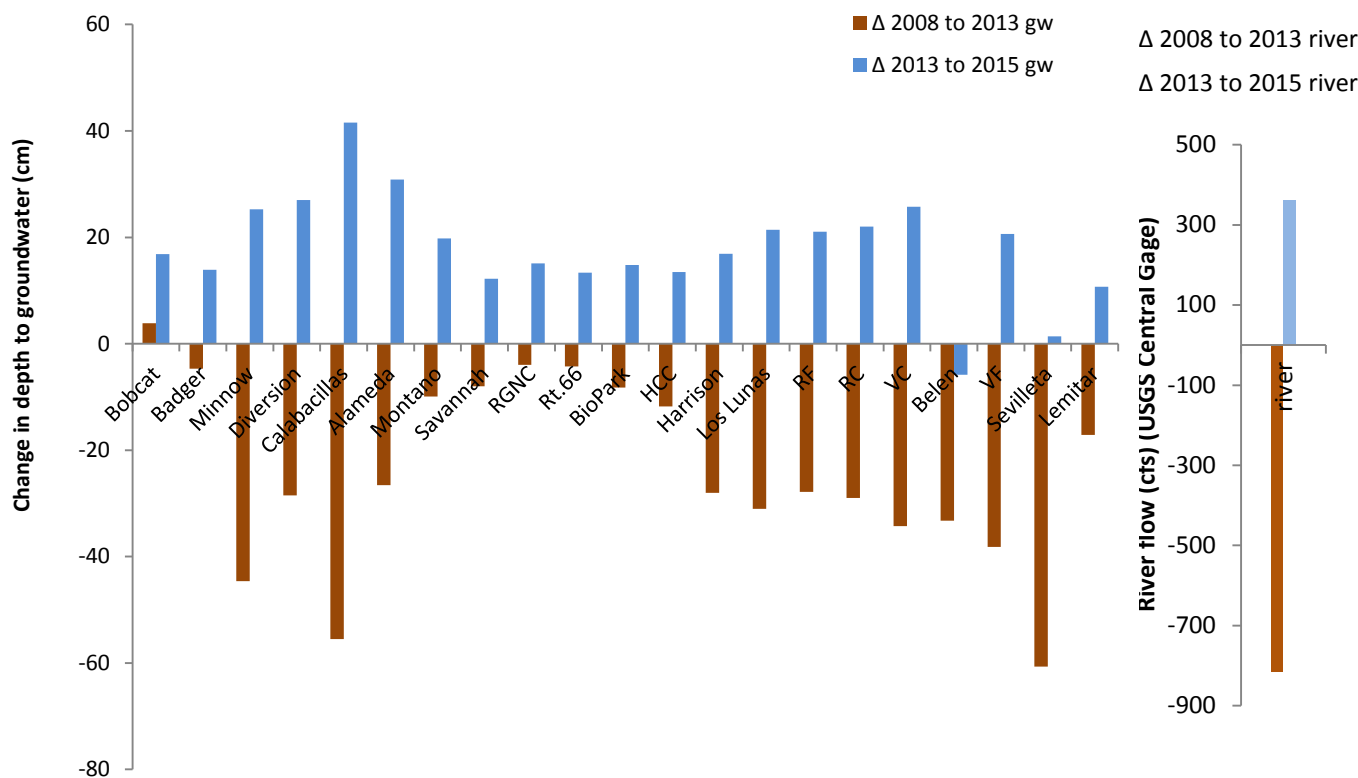


Figure 7. Change in depth to groundwater (cm) during drought years (2008-2013) and recovery years (2013-2015), as compared to the change in river flow during the same time frames.

Precipitation

Most precipitation peaks in the Middle Rio Grande occur in August (Figure 8). 2016 was a below-average rainfall year (Figure 9).

Note: Starting in January 2016, the Tru-Check rain gauges that BEMP has used since 1997 began to crack, regardless of temperature, resulting in lost precipitation data. In January 2016, 16 out of 60 rain gauges cracked. Replacement gauges would also crack easily, sometimes within 48 hours. In some months, as many as 13 sites had at least one cracked rain gauge. Even in warmer months, multiple gauges have cracked (e.g., July 2016, 4 gauges cracked). After multiple conversations with Tru-Check manufacturers in the hopes of resolving the issue, BEMP began experimenting with two other brands. One brand is prohibitively expensive to install at all sites, and has the added drawback of lower precision than the Tru-Check gauges. The second brand is more affordable and precise, but also tends to crack in the field, including in warm months. BEMP is still working to resolve this issue to prevent further data loss.

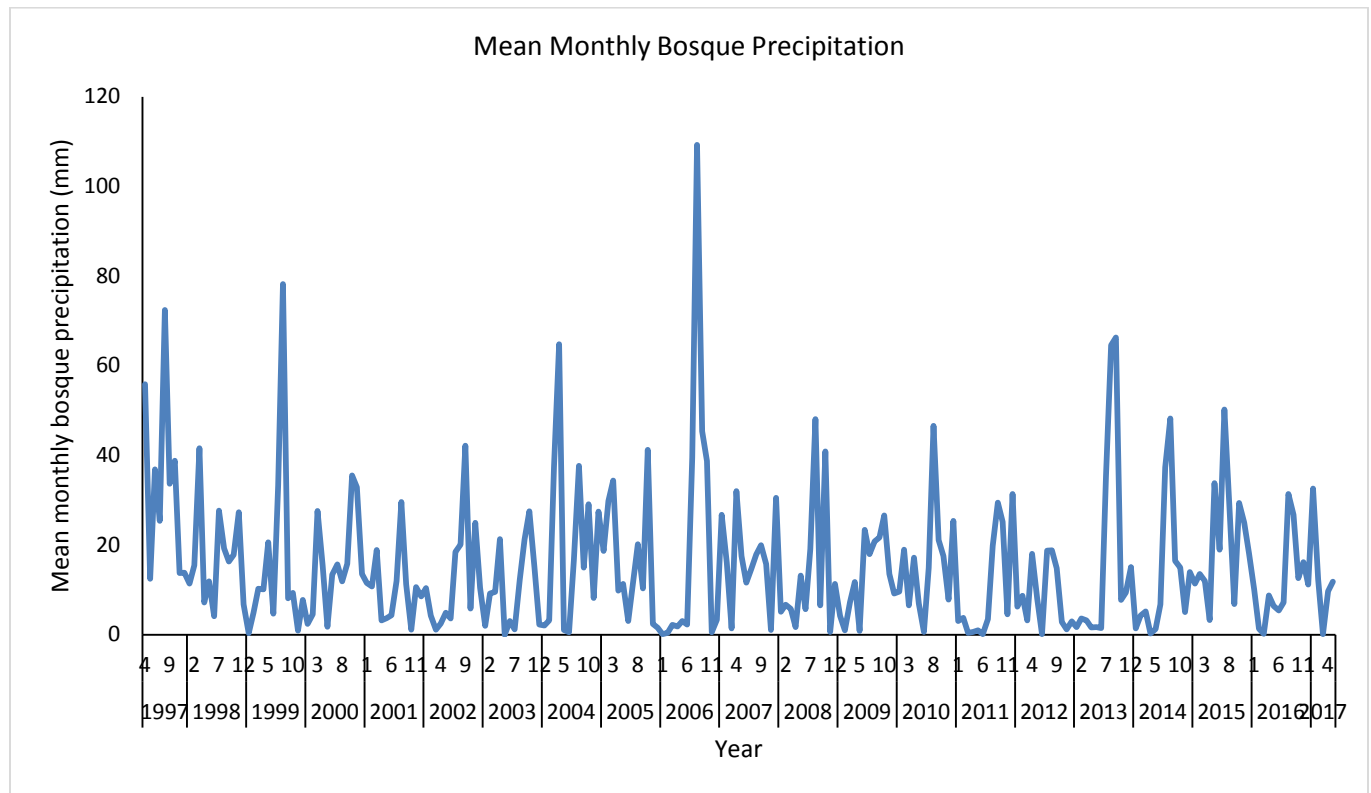


Figure 8. Precipitation averaged across all sites for each month.

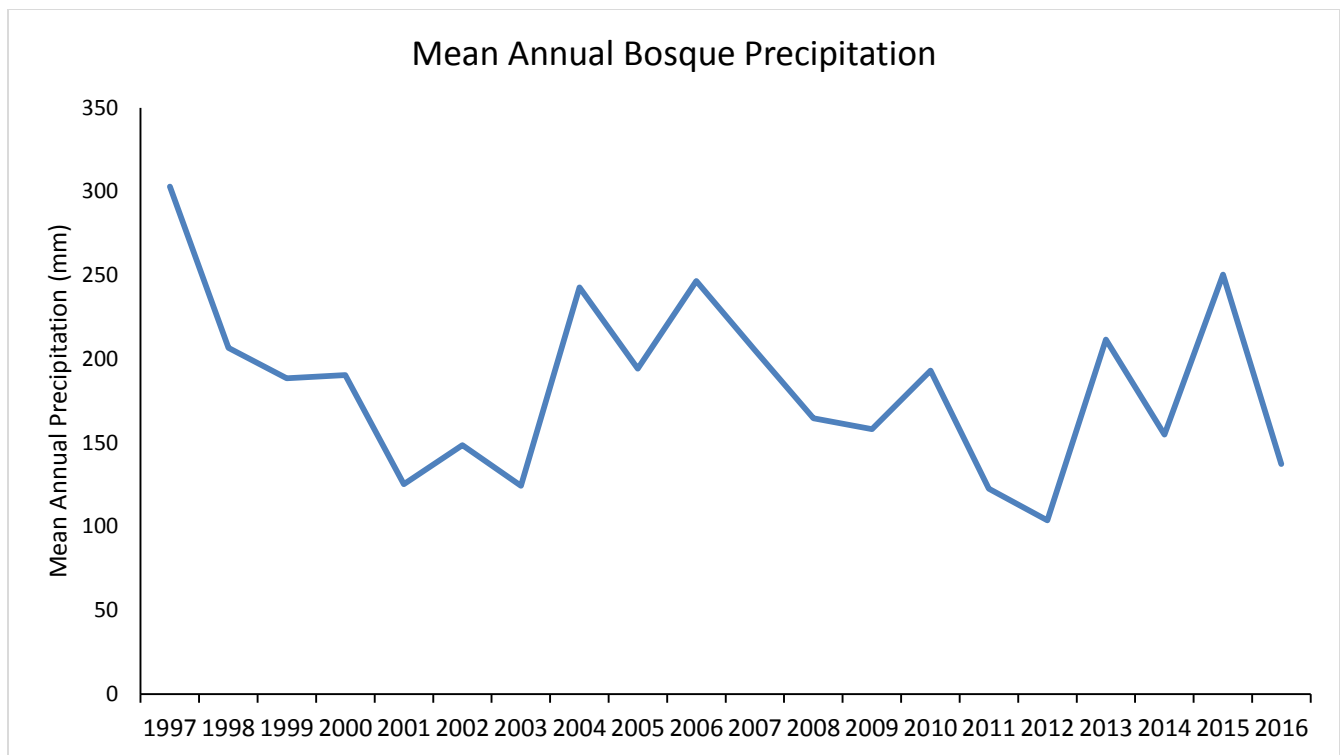


Figure 9. Mean annual bosque precipitation (mm), averaged across all BEMP sites.

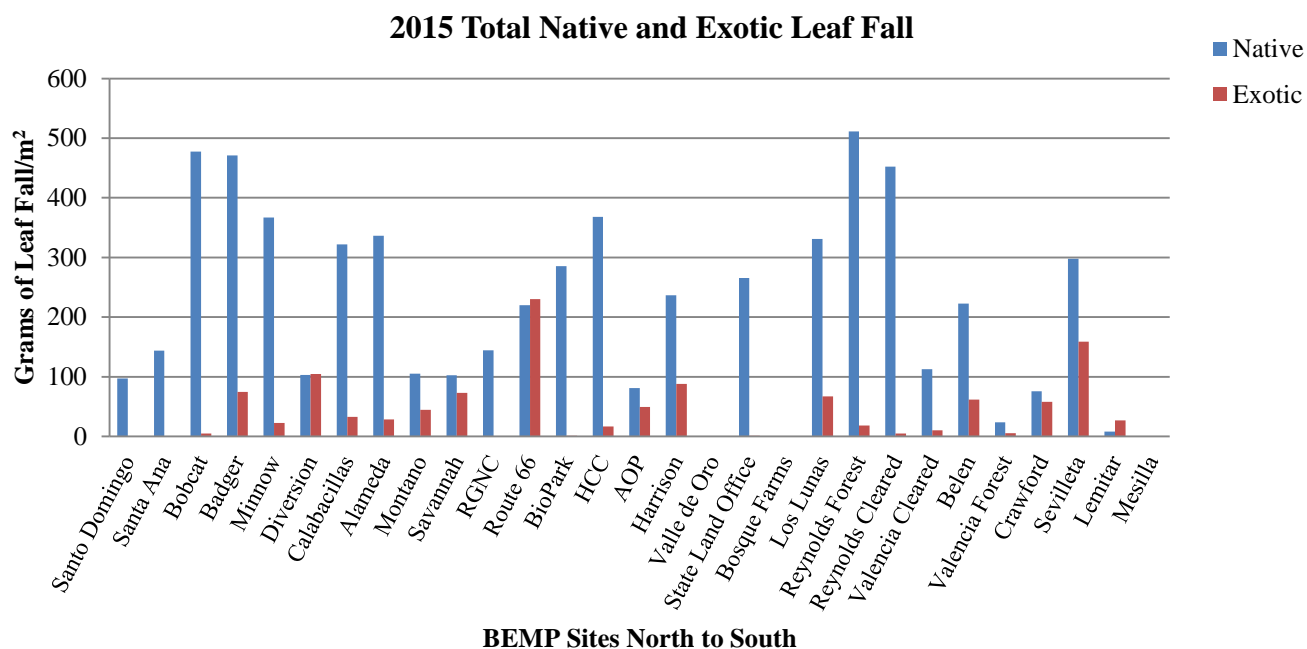


Figure 10. Total native and exotic leaf litter fall in grams, at 29 BEMP sites in 2015. The Bosque Farms site was not monitored in 2015 and the lack of data should not be construed as zero leaf fall.

Native species comprise the vast majority of leaf fall collected all but two sites: Diversion and Route 66 (Figure 10). Cottonwood accounts for the vast majority of total native leaf fall and as well as total leaf fall at most of our sites (Figure 11). Cottonwood comprises the majority of reproductive litterfall at most sites (Figure 12). The majority of sites have senescing cottonwoods (as seen in Figure 14, vegetation cover), and this can clearly be seen at the Santa Ana site where cottonwoods have been rapidly dying off (Figure 13).

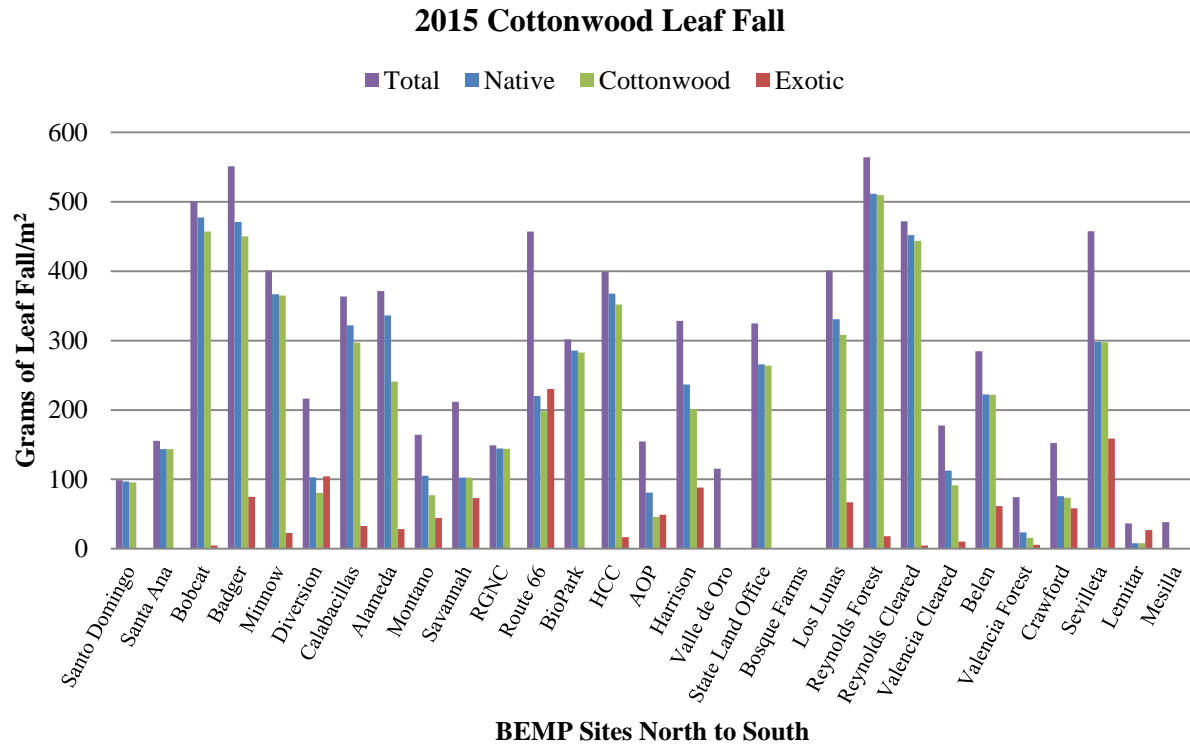


Figure 11. Total cottonwood leaf fall in grams/m², as compared to total leaf fall, total native leaf fall, and total exotic leaf fall, at 29 BEMP sites in 2015. The Bosque Farms site was not monitored in 2015 and the lack of data should not be construed as zero leaf fall.

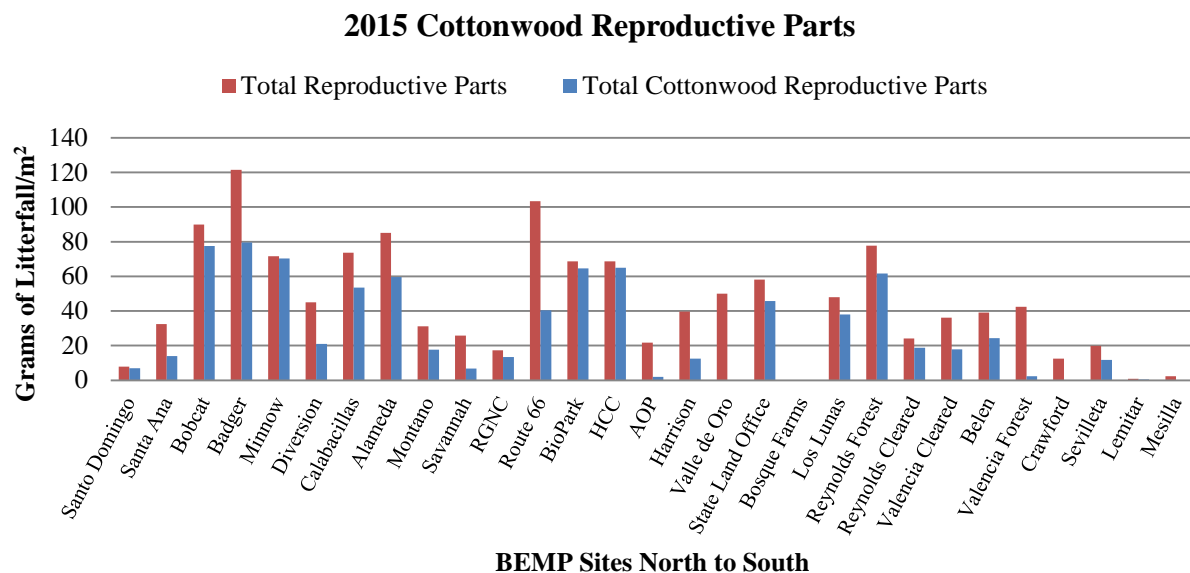


Figure 12. Total litterfall of cottonwood reproductive parts at 29 sites, as compared with total reproductive litterfall. The Bosque Farms site was not monitored in 2015 and the lack of data should not be construed as zero litterfall.

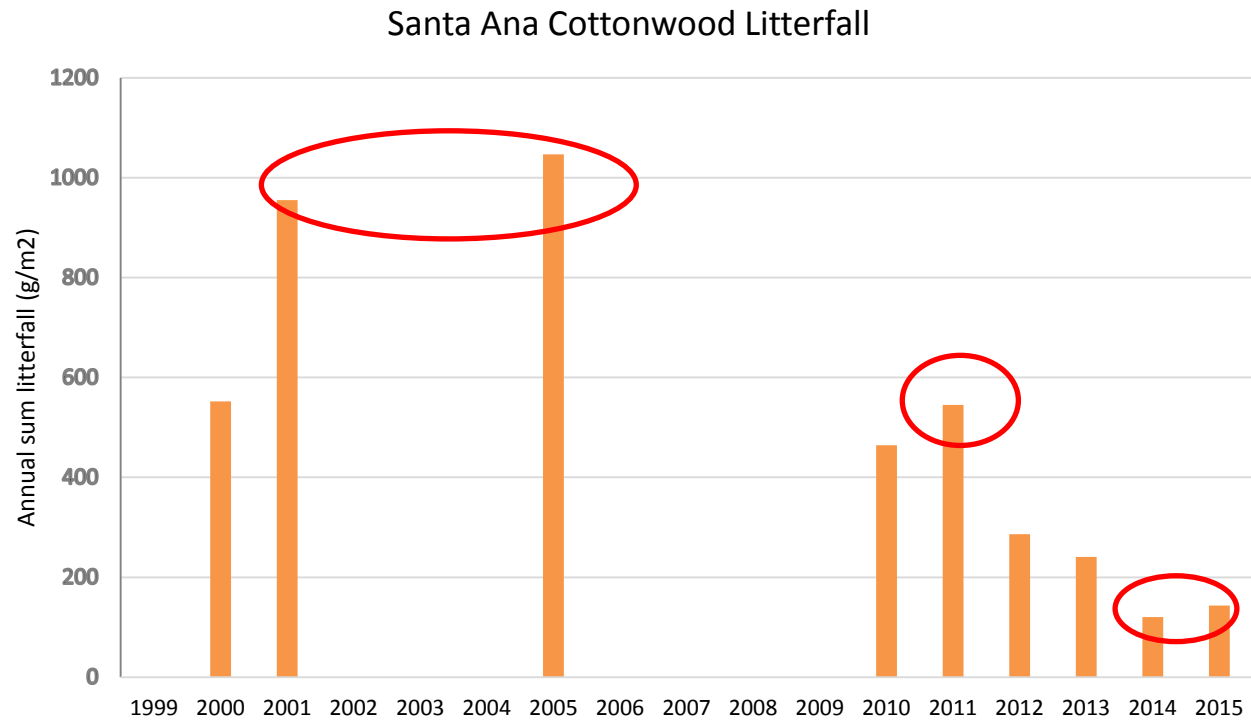


Figure 13. Cottonwood litterfall at the Santa Ana BEMP site. Years with missing data had more than 3 months of data missing, and so sums for those years are not representative of the full year. Red circles indicate significant differences.

Vegetation Cover 2015

Vegetation cover surveys are conducted in August/September. Our contracted botanists recently finished identifying samples in the herbarium and the final datasheets for 2016 were turned in to BEMP in June, 2017. These data will be entered, quality controlled, and analyzed for the next report. The 2015 vegetation cover data are presented here.

In response to dropping groundwater levels, senescing cottonwoods have experienced limb or tree mortality. The majority of cottonwoods at BEMP sites (and in the Middle Rio Grande Valley generally) are senescing (Figure 14), and they form the dominant cover. Based on current cover, it appears these cottonwoods will be replaced by exotic species, mostly Russian olive and tamarisk, with some Siberian elm (Figure 14).

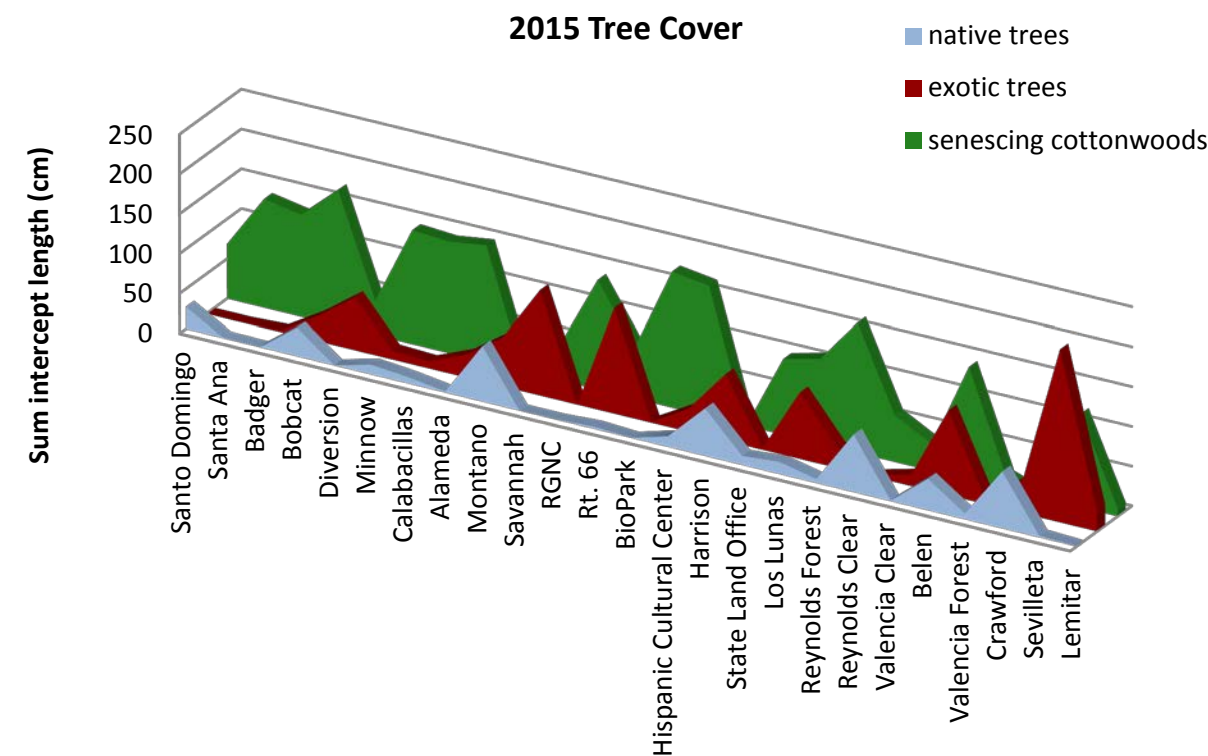


Figure 14. Dominant tree cover at BEMP sites, divided into senescing cottonwoods (green), native trees (mostly willows and young cottonwoods) (blue), and exotic trees (Russian olive, saltcedar, and Siberian elm) (brown).

Tamarisk Leaf Beetle 2016

From May to August 2016, BEMP monitored tamarisk leaf beetle at 27 of 31 sites, excluding only those sites with no saltcedar on or in close proximity to the site (Badger, HCC, Valle de Oro, and Belen). Tamarisk leaf beetles were found at all but 3 of 27 sampled sites: Calabacillas, Los Lunas, and Mesilla (Figure 15). Tamarisk leaf beetles have been found in previous years at both Calabacillas and Los Lunas, and were found in close proximity to the Mesilla site in 2016. A more detailed report of our findings is available on our website.

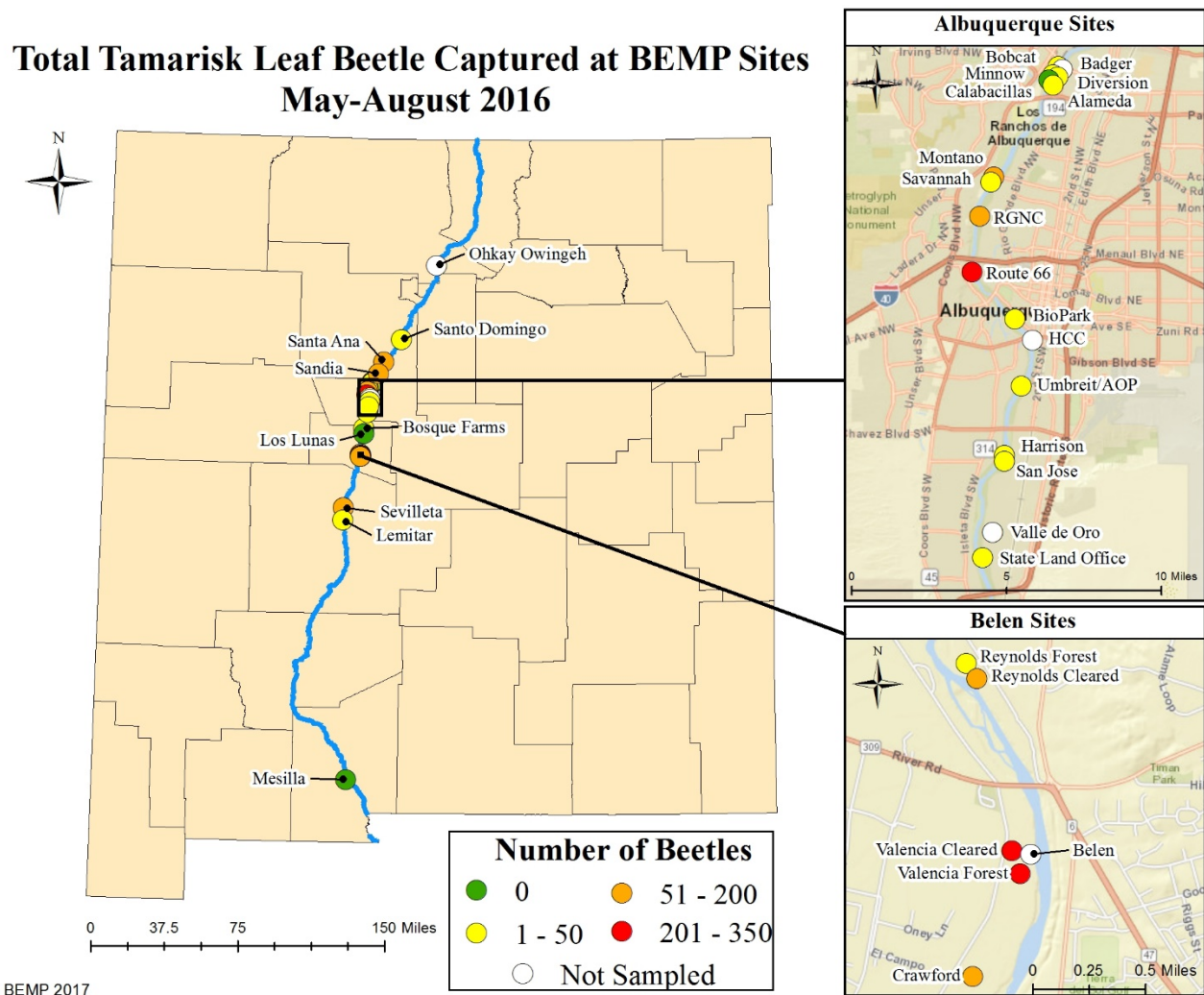


Figure 15. 2016 map of tamarisk leaf beetle presence and abundance.

Preliminary data show that in spite of the introduction of the tamarisk leaf beetle, saltcedar cover at our sites has recovered after an initial decrease (Figure 16). Large-scale defoliation is still notable and is documented in our photo record for each site. Continued monitoring will indicate the efficacy of the beetle in controlling saltcedar. BEMP also monitors two other tamarisk defoliators present in the bosque: the splendid tamarisk weevil (*Coniatus splendidulus*), and the tamarisk leafhopper (*Opsius stactocalus*) (Figure 17). The tamarisk leafhopper was present in greater numbers than the tamarisk leaf

beetle in all months but July, though large-scale defoliation can be attributed to the tamarisk leaf beetle only. The two insects consume different parts of the leaf, resulting in distinct coloration and pattern of defoliation that can be verified via our photo record. (Figure 17).

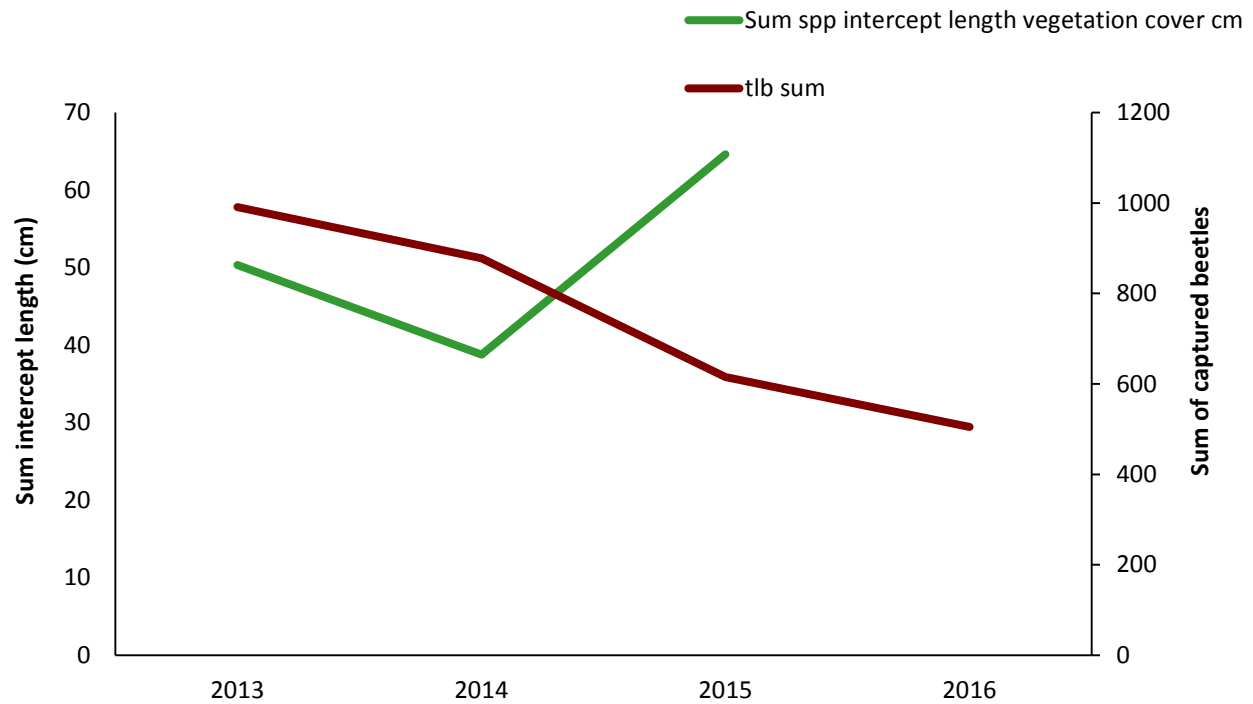


Figure 16. Abundance of tamarisk leaf beetle and saltcedar cover in BEMP sites from 2013 to 2015.

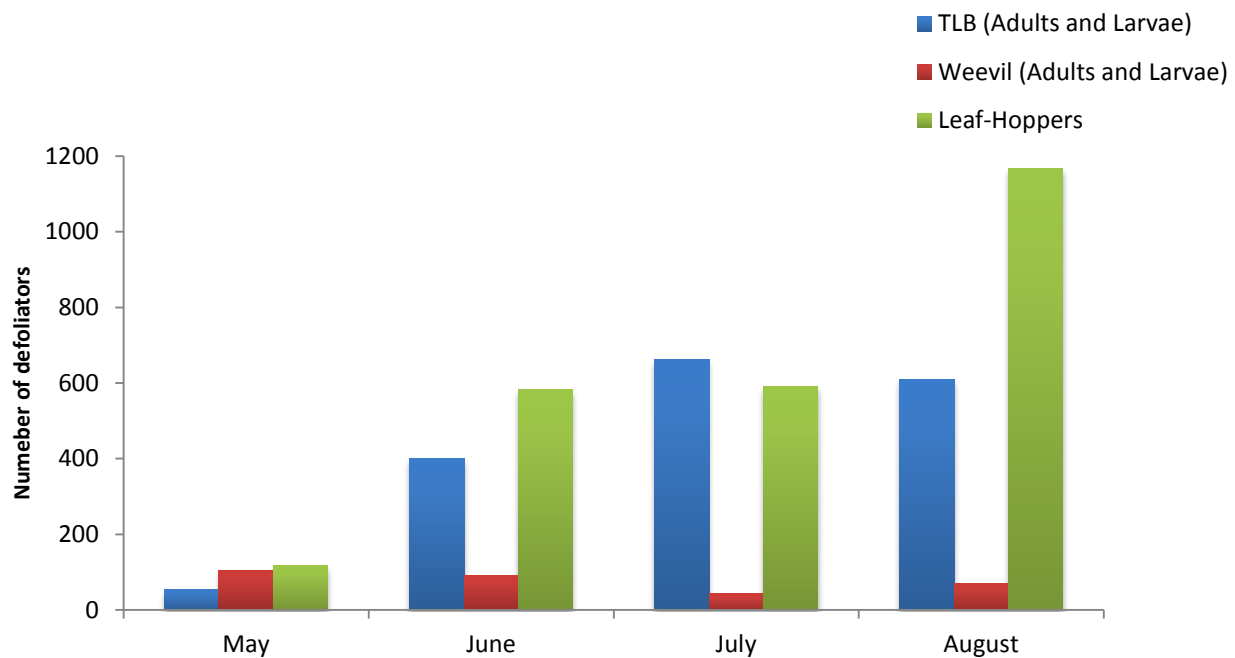


Figure 17. Total number of saltcedar-specific defoliators (tamarisk leaf beetles (TLB), splendid weevils, and leaf-hoppers) by month in 2016.

Fuel Load and Woody Debris 2016

Woody debris sampling is conducted each year at 17 Albuquerque sites, and at all 31 sites every 3 or 4 years (contingent on funding). All sites were sampled in 2016 (Figure 18). BEMP has produced fuel load maps of this dataset that also display other dimensions of fire risk at our sites, including large amounts of small-diameter fuels, high foot traffic, and ease of access (Figures 19 & 20). We hope that these maps will help managers to identify areas of heightened fire risk for monitoring or intervention.

catastrophic fire hazard = 12 tons/acre

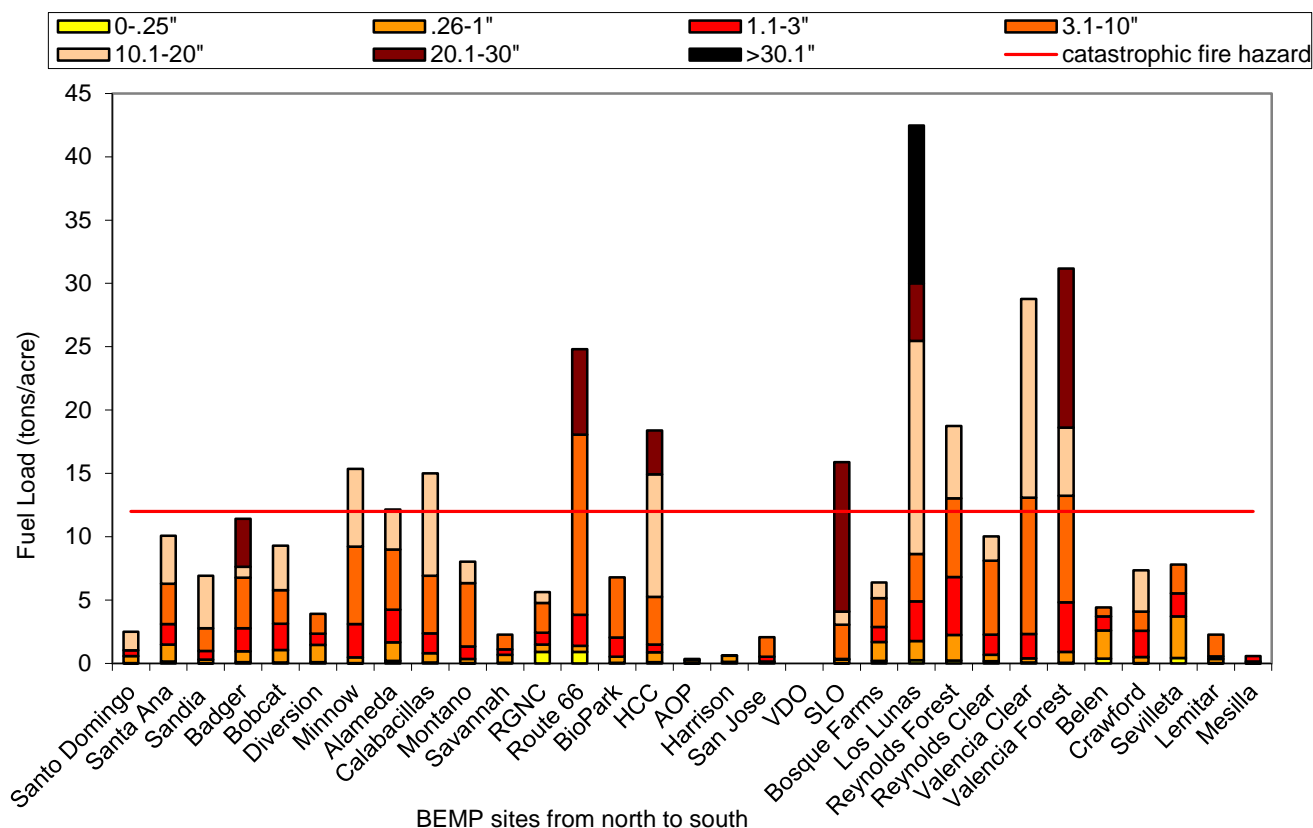
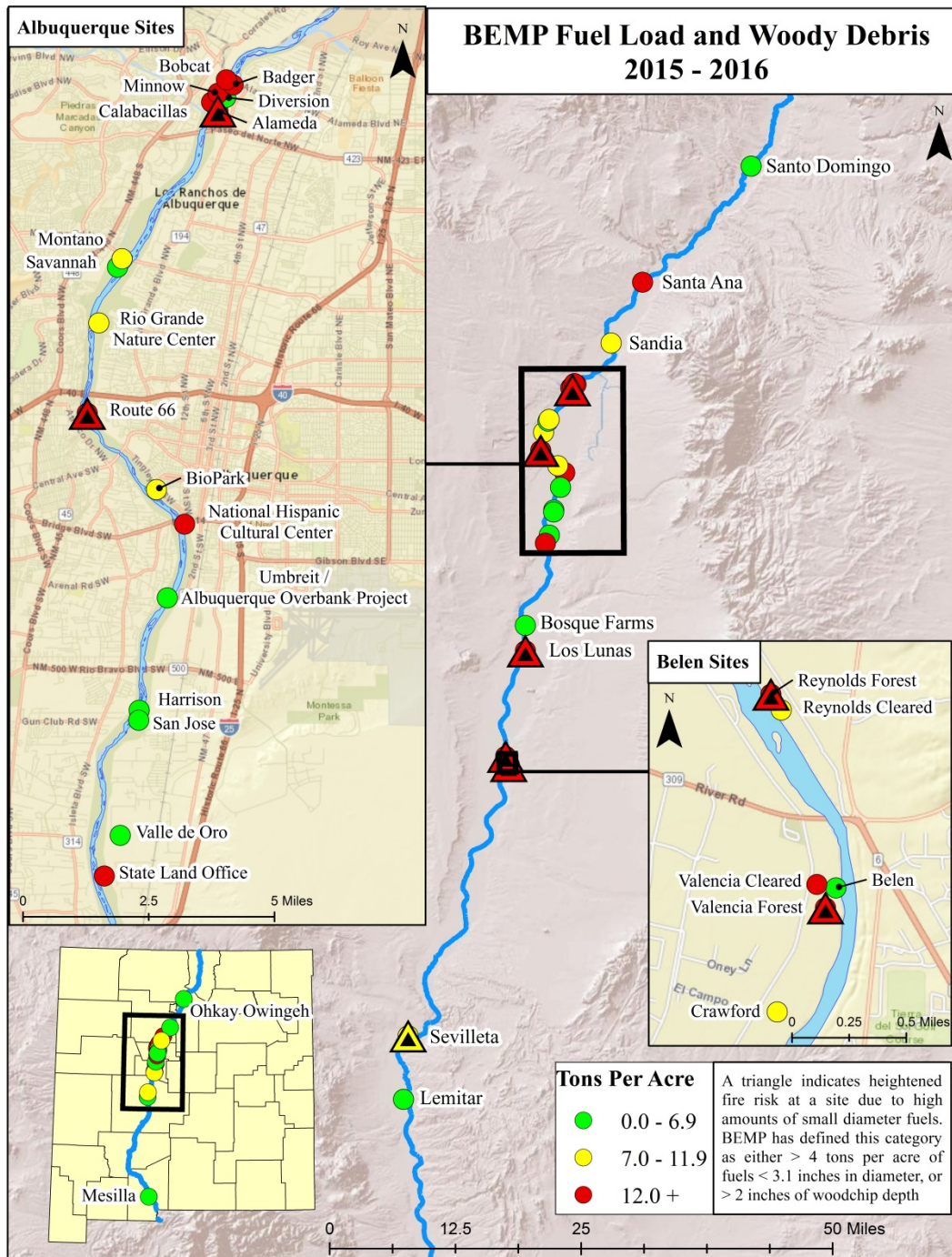
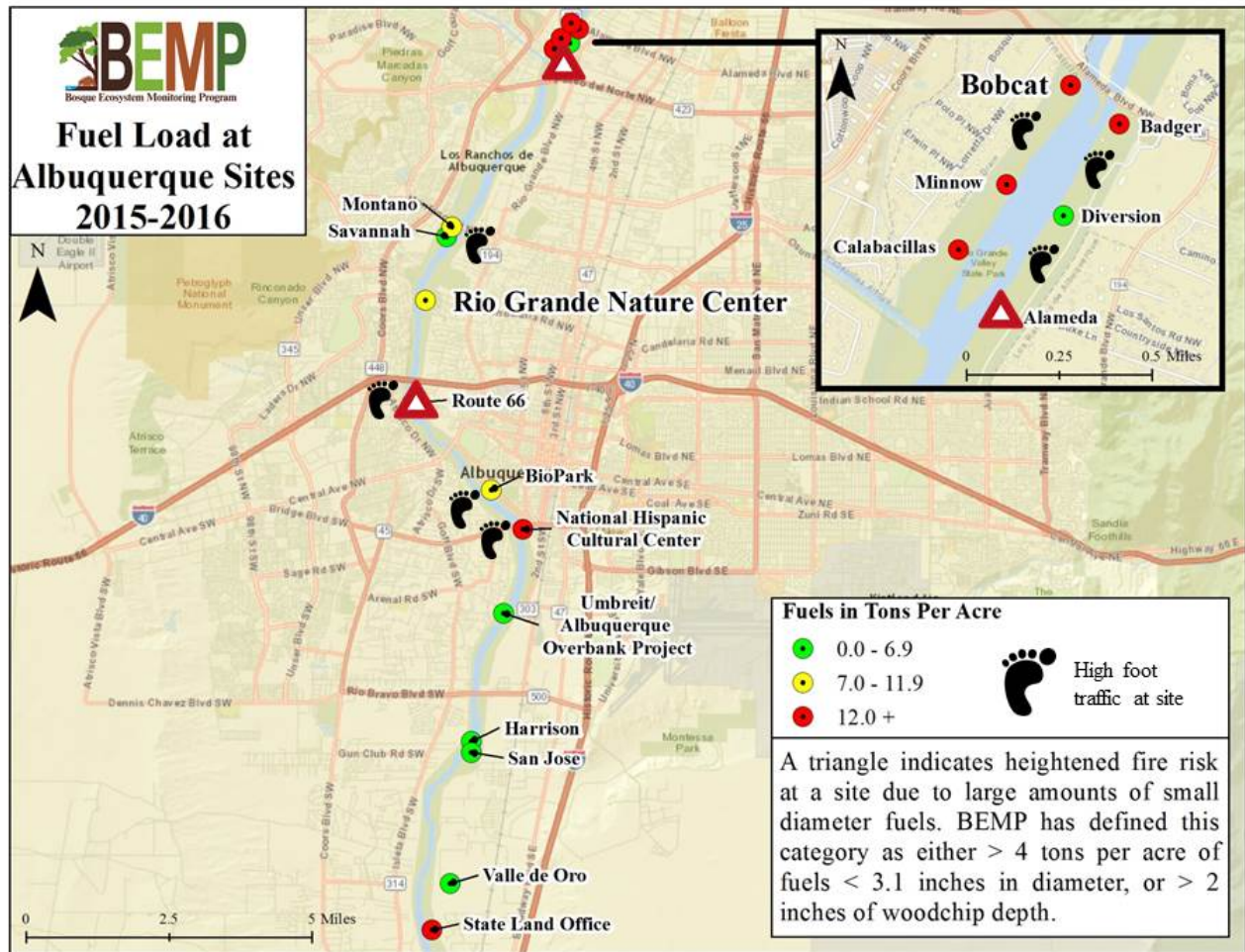


Figure 18. 2016 fuel load at BEMP sites. The tons per acre calculations are broken down into categories based on the size class of the wood. The red trend line indicates catastrophic fire hazard fuel load (12 tons per acre).



(c) BEMP 2017

Figure 19. Fuel load/woody debris at BEMP sites in 2016. Color of the site indicates the total tons per acre, with red indicating a fuel load of over 12 tons per acre. Triangles indicate that the fuel load is made up of predominately small diameter fuels and/or greater depth of fuels, which are higher fire hazards.



(c) BEMP 2017

Figure 20. Fuel load map indicating total fuel load (color), heightened fire risk (triangles), and public accessibility (foot prints).

LOW-MOD FUEL LOAD



High foot traffic / easy access



Moderate fuel load (5.6 tons/acre)

Site Location: Rio Grande Nature Center State Park



HIGH FUEL LOAD SITE



High foot traffic / easy access



High fuel load (14.4 tons/acre)

Site Location: South of Alameda Bridge, Bobcat



Photo comparison of low fuel load and high fuel load sites.

Surface-Active Arthropods 2015

Lab identifications of 2016 surface-active arthropod data have been completed as of May 2017. These data will be entered, quality controlled, and analyzed for the next report. Data from 2015 are presented here.

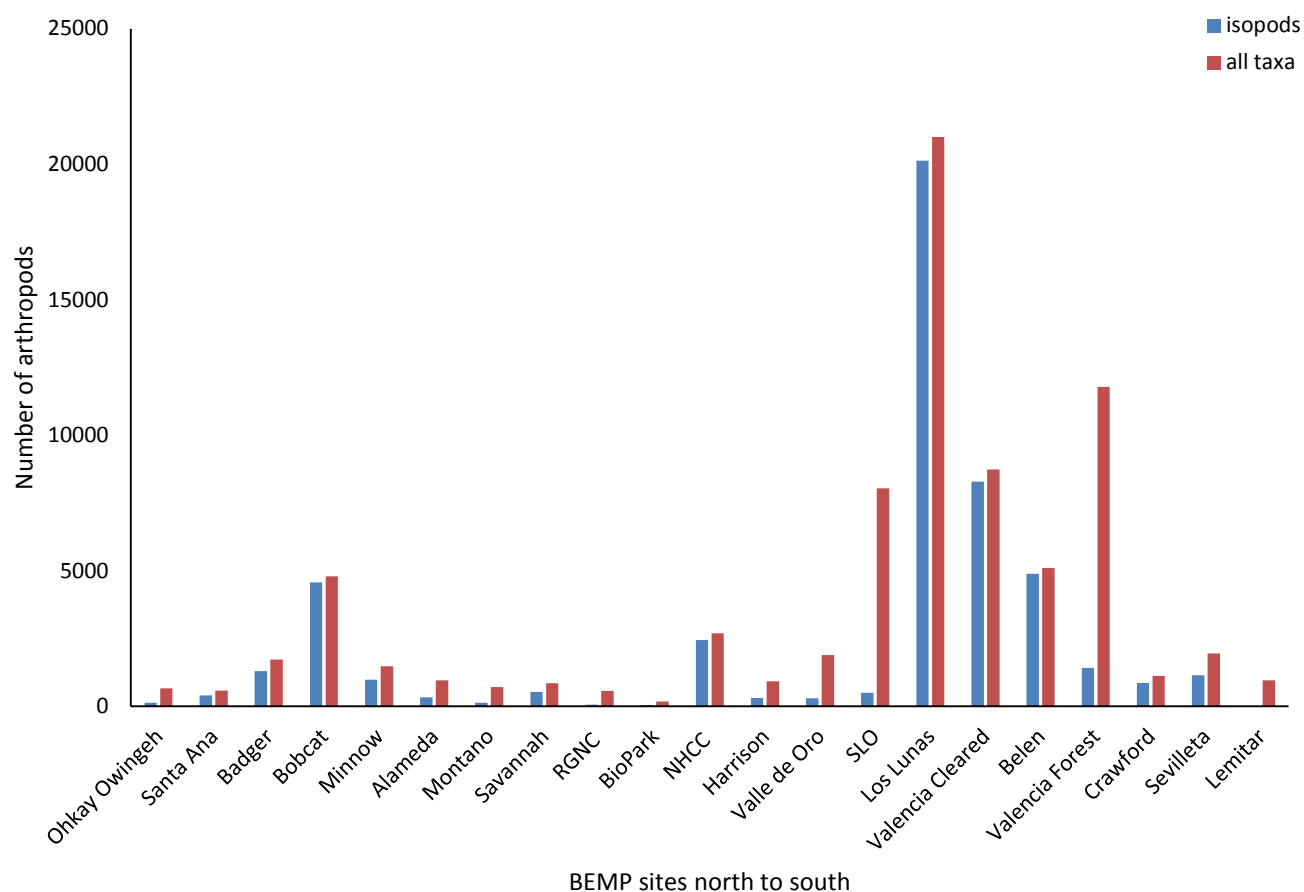


Figure 21. 2015 annual sum of arthropods (all taxa) and isopods captured in pitfall traps at BEMP sites.

The annual sum of abundance for sites in 2015 show the highest abundances at many of our wetter sites: SLO (reconstructed wetlands and swales), Los Lunas, and Belen (VC, Belen, and VF), although not all sites in Belen (Figure 21). Although Ohkay Owingeh is a wetland site, it had a low total of arthropods captured (Figure 21). Overall, isopods tend to dominate, representing over 50% of the arthropods caught across all sites (Figure 21).

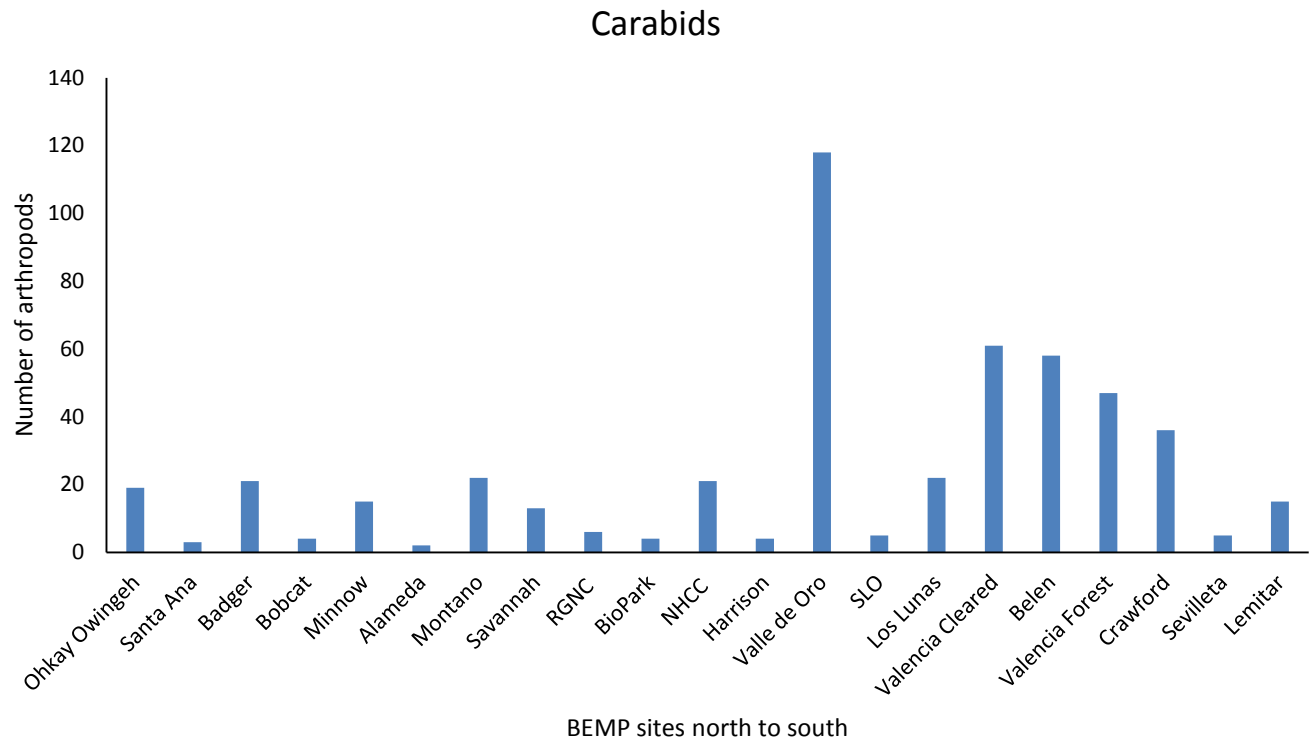


Figure 22. 2015 annual sum of carabid beetles captured in pitfall traps at BEMP sites.

Carabid beetles (or ground beetles) can be environmental indicators of wetter habitat conditions. Carabid beetles represent only 6% of the total arthropods captured in 2015, and are predominantly found at sites south of Albuquerque (Figure 22).

Water Quality

In 2014-2016, BEMP was funded by the US EPA to monitor water quality in the Middle Rio Grande, including field parameters (i.e., dissolved oxygen, water temperature, turbidity, specific conductance, and pH), anions/nutrients, pesticides, PCBs, *E. coli*, pharmaceuticals and personal care products. These data can be shared on request, although they are for educational purposes only and not to be used to inform management decisions (although they can be used to determine where more monitoring should be done). BEMP is interested in continuing water quality monitoring and using funding that will also us to share the data.

Concluding Remarks:

There were over 2000 students involved in year-round monthly monitoring during the 2015-16 school year, and another 3000 students involved in hands-on field work. This is indicative of BEMP shifting focus to support long-term engagement with students with multiple contacts in the field and in the classroom.

Most BEMP sites have a strong hydrological connection between groundwater and river flow; as annual river flow fluctuates, the groundwater depth responds. 2016 had below average precipitation levels as well as below average river flows. This resulted in a drop in depth to groundwater at most sites. Cottonwoods are still dominant at most sites (both in litterfall and in cover), but the majority of these trees are senescing. Fuel loads are expected to increase as more cottonwoods experience limb or full mortality. Finally, in response to feedback from data users and resource managers, BEMP has begun producing maps in order to better visualize complex variables such as viability of native species, or fire hazard.

All data and reports are currently available at BEMP.org. Additional graphs and maps can be produced upon request.

The information in this report is based upon BEMP's non-proprietary datasets, collected between January 2015 and December 2016, with reference to data collected from 1997-2017. All raw data are available upon request. We would like to thank the US Army Corps of Engineers, Albuquerque Bernalillo County Water Utility Authority, US Bureau of Reclamation, Bernalillo County Open Space, Valencia Soil and Water Conservation District, Middle Rio Grande Conservancy District, US Environmental Protection Agency, US Fish and Wildlife Service Valle de Oro National Wildlife Refuge, NM State Land Office, National Science Foundation (through Sevilleta Long-Term Ecological Research), NM State Parks, Albuquerque Community Foundation, McCune Foundation, Davidson Foundation, Goodman Foundation, Greater Rio Grande Watershed Association, Middle Rio Grande Stormwater Quality Team, and the Black Institute for their ongoing support of this vital monitoring and education work along the Middle Rio Grande.