Mapped Mesohabitat Features—Continued

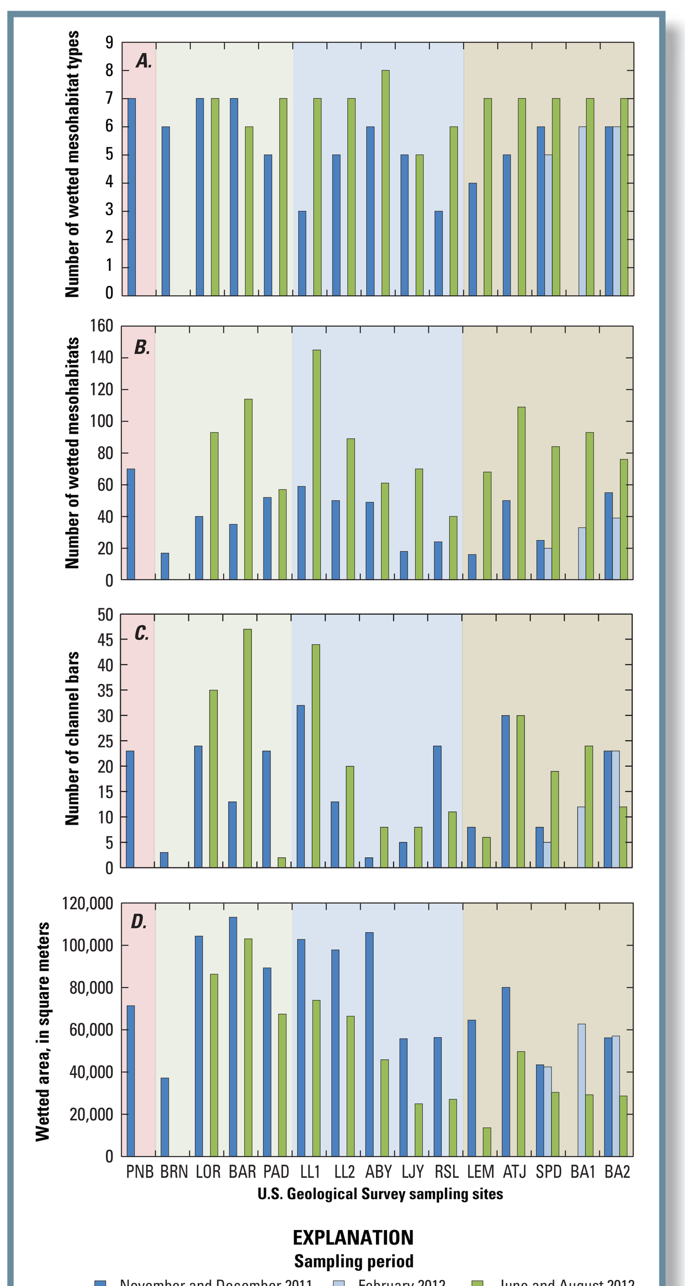


Figure 7. Number of *A*, wetted mesohabitat types mapped; *B*, wetted mesohabitats mapped; *C*, channel bars mapped; and *D*, wetted area at 15 sampling sites on the Middle Rio Grande, winter 2011–12 and summer 2012.

A total of eight different types of wetted mesohabitats were mapped across the entire study area: riffles, runs, pools, isolated pools, forewaters, backwaters, embayments, and flats. The only sampling site that contained all 8 wetted mesohabitat types was Abeytas on June 7, 2012, but 10 of the 13 sampling sites mapped in summer 2012 contained at least 7 of the 8 potential wetted mesohabitat types. In contrast, only 3 out of 15 sampling sites (Peña Blanca, La Orilla, and Barelas) that were mapped in winter 2011–12 contained as many as seven different wetted mesohabitat types, and all 3 of these sampling sites were located in the most upstream part of the study area (3 of the 4 most upstream sampling sites). La Joya contained the fewest types of wetted mesohabitats in summer 2012 with five, whereas Los Lunas I and Rio Salado contained the fewest types of wetted mesohabitats in winter 2011–12 with three each. The average number of different wetted mesohabitat types per site mapped in winter 2011–12 and summer 2012 were 5.3 and 6.8, respectively. In general, decreases in streamflow between winter 2011–12 and summer 2012 led to increased complexity in terms of the number of different types of wetted mesohabitats that were mapped at each sampling site. Barelas was the only sampling site where a greater number of wetted mesohabitats was mapped in winter 2011–12 compared to summer 2012.

Decreases in streamflow between winter 2011–12 and summer 2012 also led to increased complexity in terms of the total number of wetted mesohabitats that were mapped at each sampling site. More than half of the sampling sites that were mapped during winter 2011–12 contained fewer than 40 mesohabitats. During summer 2012, more than 40 mesohabitats were mapped at all of the sites except for the Rio Salado site, where 40 mesohabitats were mapped. In winter 2011–12, the largest number of wetted mesohabitats mapped at a sampling site was 70 at Peña Blanca, and the smallest was 16 at Lemitar. In summer 2012, more than 100 wetted mesohabitats were mapped at three different sampling sites (Barelas, Los Lunas I, and Arroyo del Tajo) with Los Lunas I having the most at 145. The average number of wetted mesohabitats mapped in winter 2011–12 was 38.1, whereas the average number of wetted mesohabitats mapped in summer 2012 was 84.5. In other words, decreases in streamflow between winter 2011–12 and summer 2012 resulted on average in more than twice as many wetted mesohabitats at each sampling site in summer 2012 relative to winter 2011–12.

In many cases, decreases in streamflow between winter 2011–12 and summer 2012 also led to increased complexity in terms of the total number of channel bars mapped. Channel bars are defined as a transitory parcel of land surrounded by water and typically either devoid of or containing annual vegetation (table 2). Reductions in stage associated with decreased streamflow resulted in the emergence of channel bars in areas that were shallow wetted mesohabitats, particularly flats and shallow runs, under higher streamflow conditions (figs. 8*A* and 8*B* show an example of this change in channel complexity at the Los Lunas I site). The emergence of channel bars contributes to the creation of additional wetted mesohabitats and higher complexity (particularly along the margins and at the downstream end of the channel bars) because of the flow-altering effects caused by the channel bars (figs. 8*A* and 8*B*).

Los Lunas I had the most channel bars (32) of any of the reaches in winter 2011–12 and the second most in summer 2012 (44), and not surprisingly, it had the second most wetted mesohabitats in winter 2011–12 (59) and the most in summer 2012 (145). The average and median number of channel bars mapped in winter 2011–12 was 16.0 and 13.0, respectively, whereas the average and median number of channel bars mapped in summer 2012 was 20.5 and 19, respectively. Figure 8*C* shows the relation between the number of channel bars and the number of wetted mesohabitats mapped at each of the 15 sampling sites on the Middle Rio Grande during winter 2011–12 and summer 2012.

Least-squares linear regression analyses were done to assess the relations between the number of wetted mesohabitats and the number of channel bars. In least-squared linear regression analyses, the R-squared (R^2) or coefficient of determination is one indicator of the goodness of fit, that is, how well the regression equation fits the data (Iman and Conover, 1982; Helsel and Hirsch, 2002).

The largest R^2 value was 0.89, which was measured at each of the three sites that were sampled in February 2012 (San Pedro, Bosque del Apache I, and Bosque del Apache II); the identical R^2 values for these three sites were not surprising because these three sampling sites are in close proximity to one another at the downstream part of the study area. There was also a relatively strong correlation (R^2=0.78) between the number of channel bars and the number of wetted mesohabitats for all sites sampled in June and August 2012; however, the correlation in sites sampled in November and December 2011 was relatively low (R^2=0.38).

Another factor that can contribute to channel complexity is bed-substrate composition. The bed-substrate composition of the Peña Blanca and Bernalillo sites was dominated by coarse-grained bed materials, particularly coarse gravels and cobble in samples collected in winter 2011–12 (fig. 9). Downstream from these two sampling sites, the Rio Grande is characterized by a broader, more low-gradient channel dominated by sand. Fine-grained silts and clays are more prevalent in the mid-reach sampling sites including Los Lunas I and II, Abeytas, La Joya, and Rio Salado. The increase in silts and clays at these sampling sites could be the result of finer-grained contributions from two large tributaries to the Rio Grande, the Rio Puerco and Rio Salado, both of which join the Rio Grande downstream from Albuquerque (fig. 3).

Consistent with the preceding discussion, decreases in streamflow typically led to increases in channel complexity in terms of the number of different wetted mesohabitat types present, total number of mesohabitats present, and the number of channel bars. Decreases in streamflow also led to reductions in wetted area for all sampling sites mapped in both winter 2011–12 and summer 2012. A graphical representation of discharge measured at or near each sampling site as it relates to channel complexity (represented by the number of wetted mesohabitats mapped) is shown in figure 10. In general, sampling sites that were mapped at higher discharge during winter 2011–12 resulted in the lowest number of wetted mesohabitats mapped, whereas sampling sites mapped at lower discharge in summer 2012 resulted in the highest number of wetted mesohabitats. Lower discharge rates result in increased mesohabitat fragmentation, increased numbers of slack water mesohabitats (isolated pools, backwaters, forewaters, and embayments), smaller (area) mesohabitats, greater numbers of mesohabitats, and a more braided stream channel. For higher discharge rates, smaller mesohabitats are flooded, and the stream channel is simplified overall, resulting in fewer slack water mesohabitats, larger (area) mesohabitats, and a stream channel that is less braided. Based on field experience, it is expected that during high magnitude discharge conditions when the channel is bankfull, each reach should consist of no more than a few mesohabitats.

Maps showing the mesohabitats for each of the 15 sites are presented in sheets 3–7. Maps are arranged from upstream to downstream order and grouped by MRGBI reach name. Numbered mesohabitats labeled in yellow correspond to the subset of mesohabitats where Rio Grande silvery minnows were caught. Numbered mesohabitats outlined in black on maps correspond to the subset of mesohabitats where physical habitat measurements (and water-quality properties were measured in summer 2012) and fish collection were attempted. In addition, graphs showing mesohabitat characteristics and selected photographs of field activities and site conditions are shown for each site.

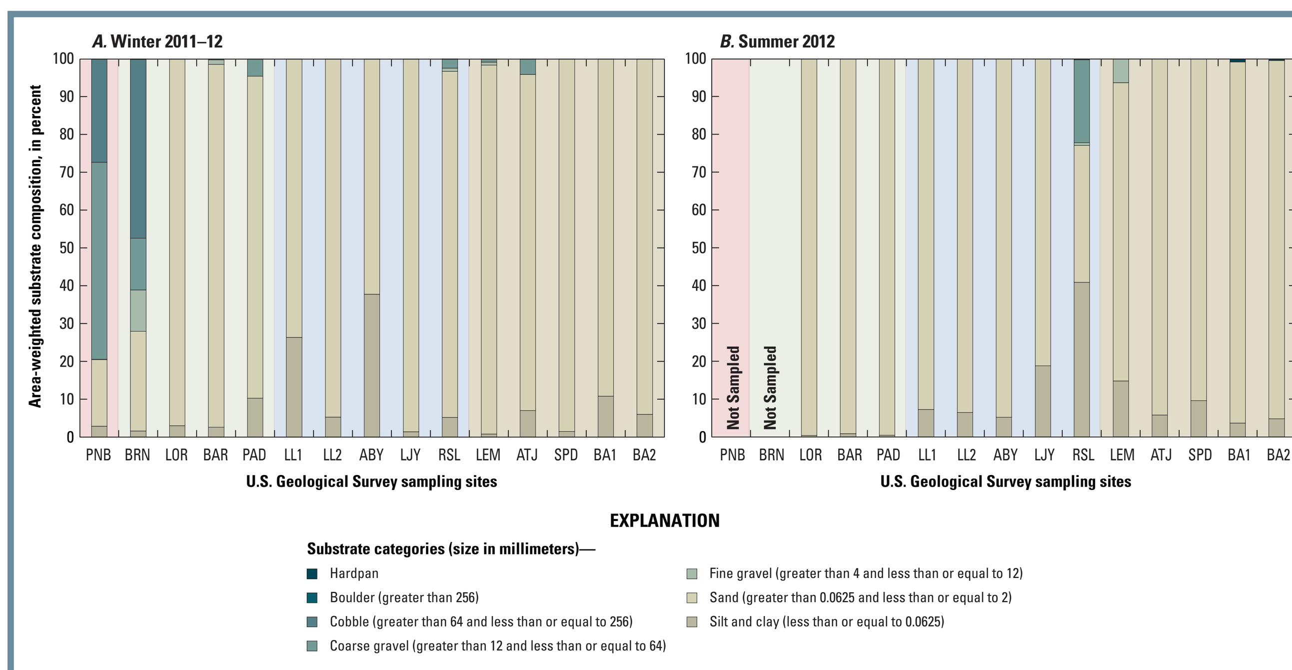


Figure 9. Area-weighted substrate composition at 15 sampling sites on the Middle Rio Grande, *A*, winter 2011–12; and *B*, summer 2012.

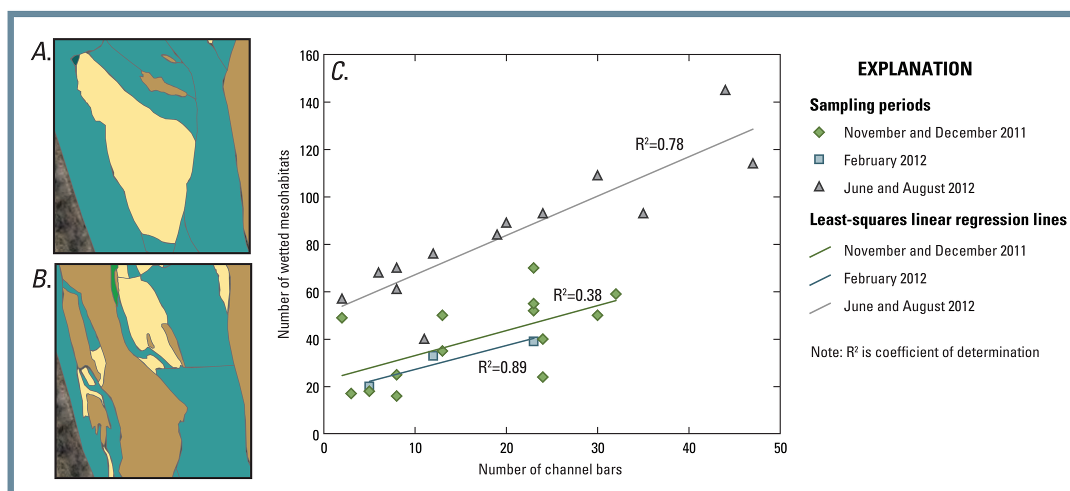


Figure 8. Comparison of differences in channel complexity at the Los Lunas I site during *A*, November 12, 2011, and *B*, June 5, 2012, following a reduction in stage; *C*, correlation between the number of channel bars and the number of wetted mesohabitats mapped at each site during winter 2011–11 and summer 2012.

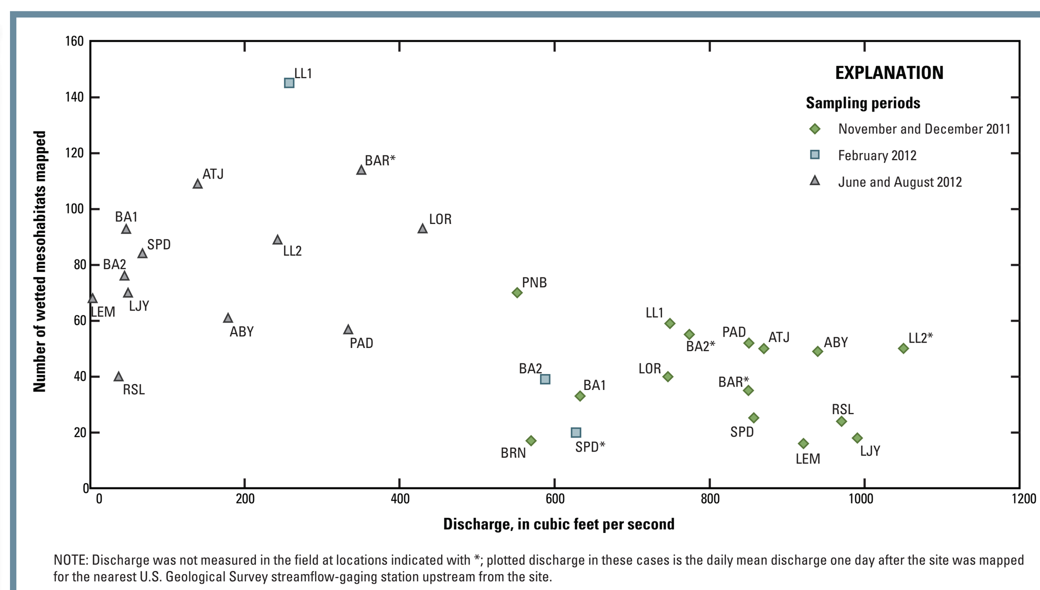
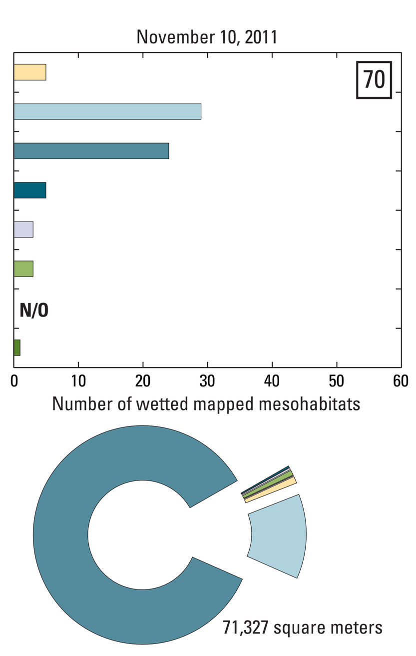
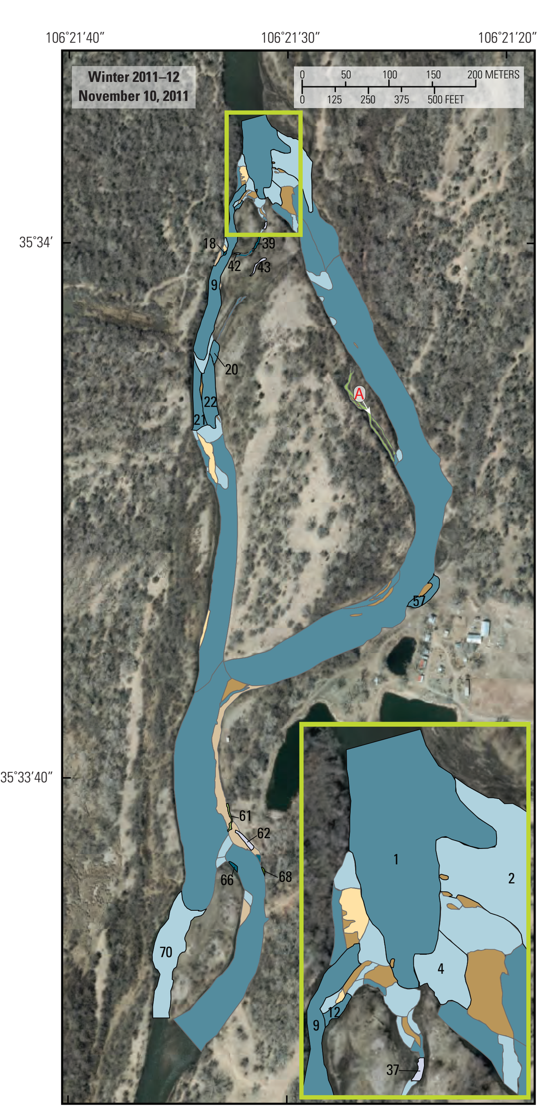


Figure 10. Graphical representation of discharge as it relates to channel complexity (represented by the number of wetted mesohabitats mapped).

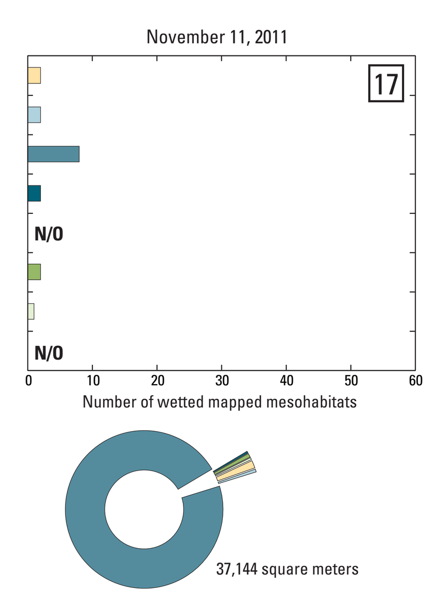
Peña Blanca Sampling Site

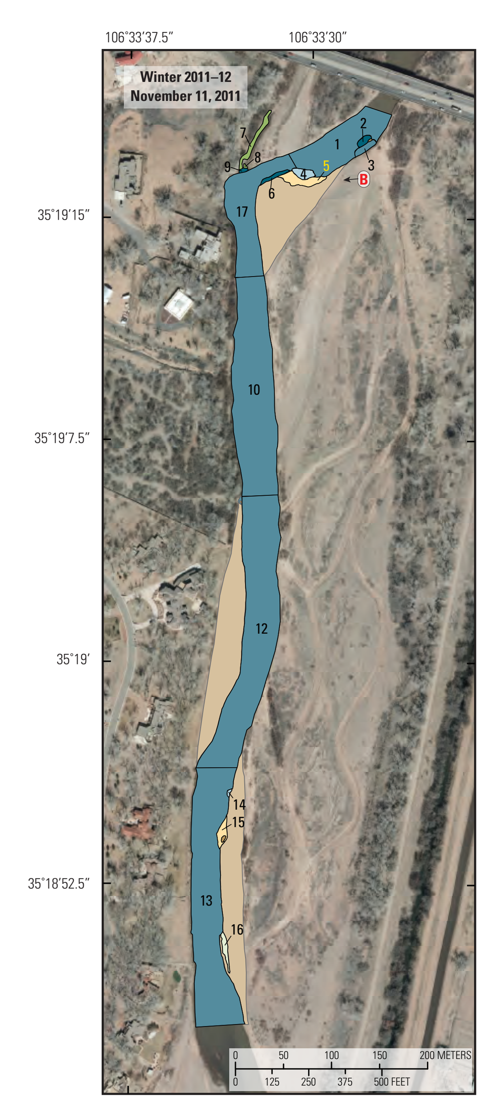




U.S. Geological Survey hydrologist delineates backwaters at Peña Blanca sampling site. Photograph by Daniel K. Pearson, U.S. Geological Survey, November 10, 2011.

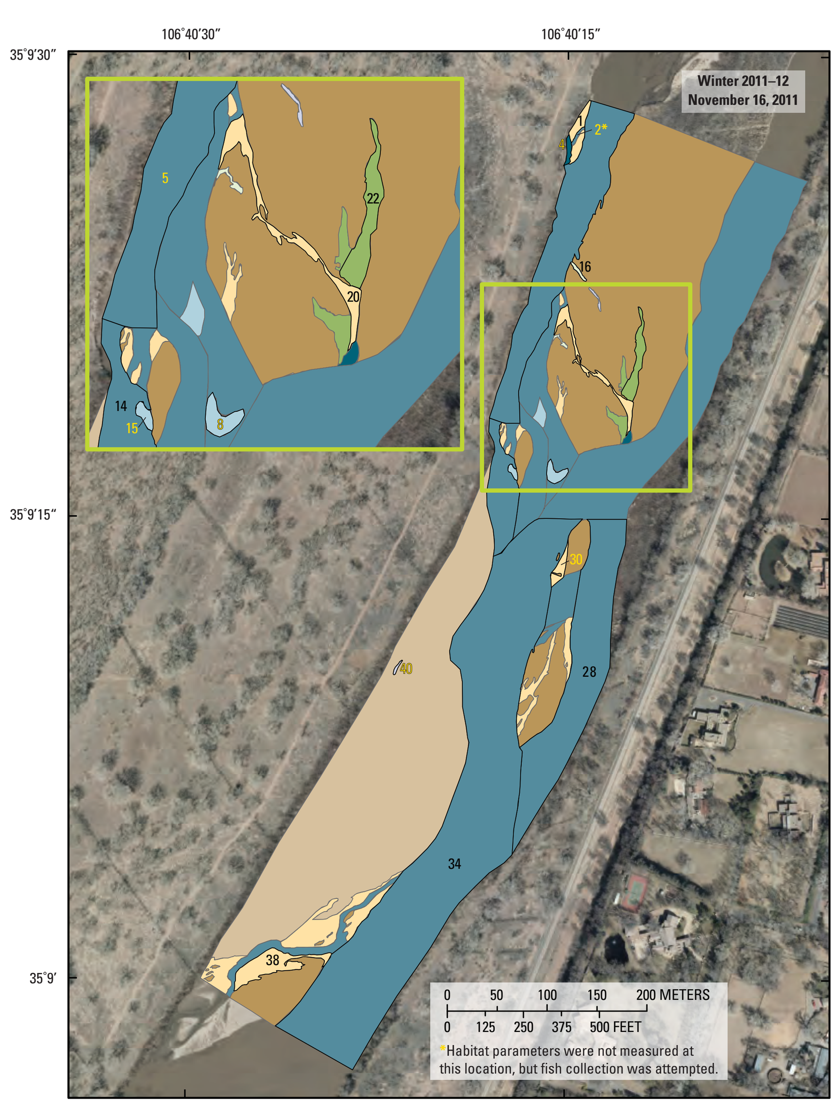
Bernalillo Sampling Site

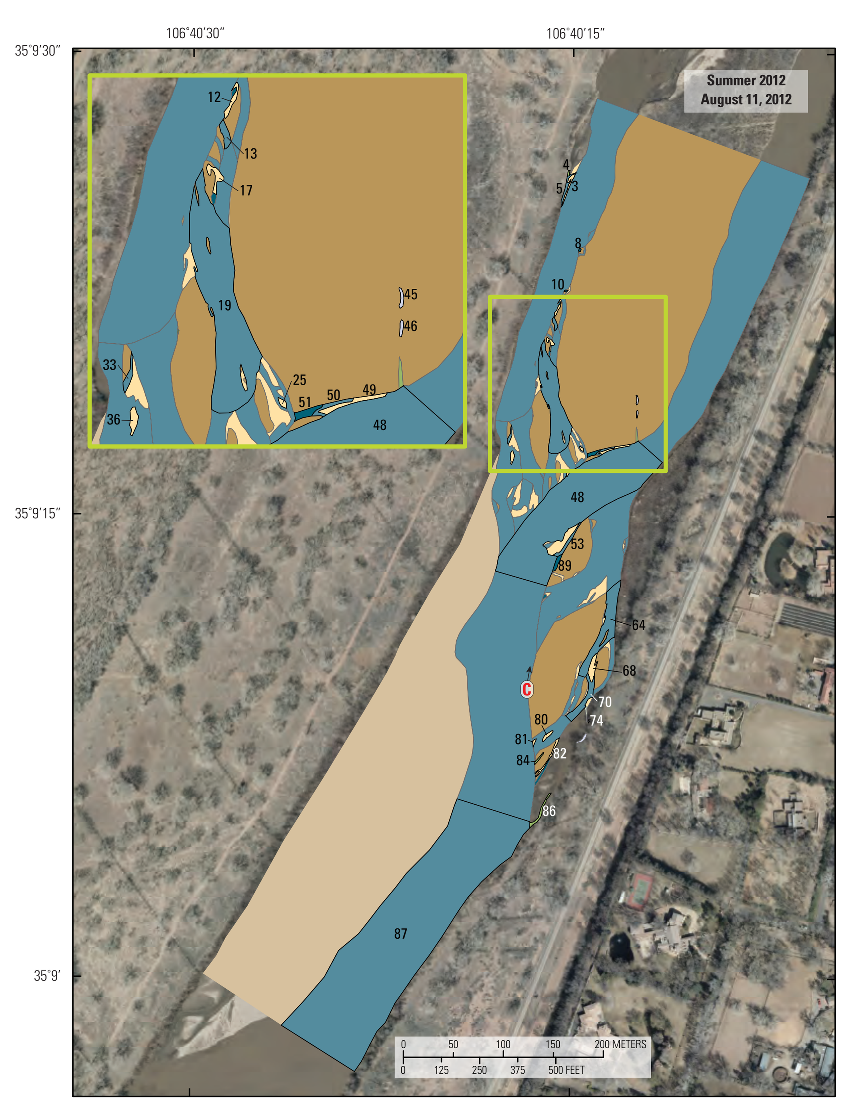


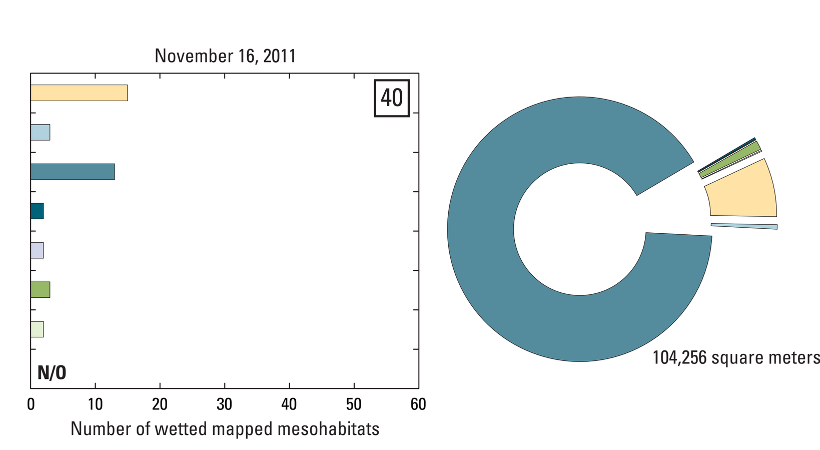


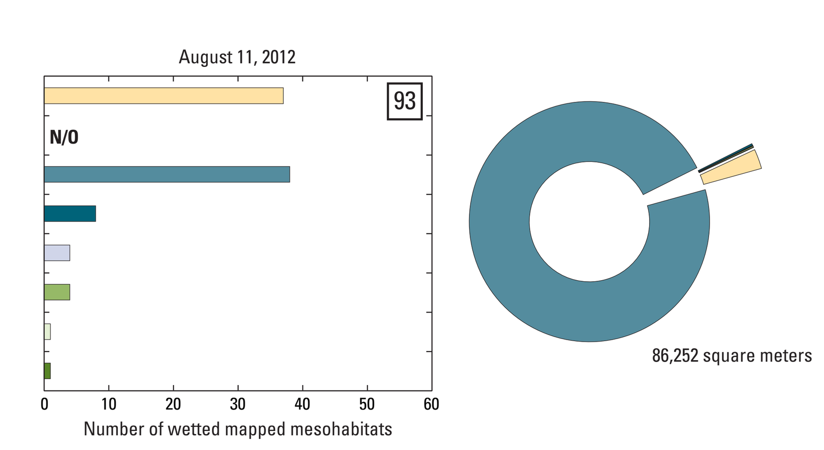
Upper end of Bernalillo sampling site showing submerged bar/riffle/run complex (from left to right) in the foreground and cut bank in the background. Photograph by Daniel K. Pearson, U.S. Geological Survey, November 11, 2011.

La Orilla Sampling Site



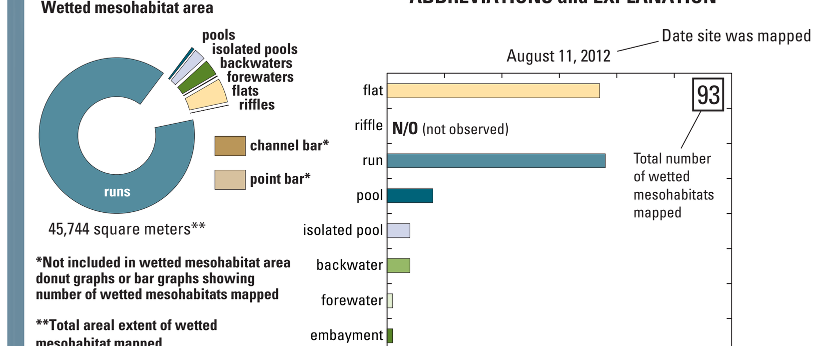






Looking upstream from western edge of channel bar towards the bottom end of the large channel bar that occupies mid-channel at the top of the La Orilla reach. Photograph by Daniel K. Pearson, U.S. Geological Survey, August 13, 2012.

ABBREVIATIONS and EXPLANATION



U.S. Geological Survey sampling sites short names and map identifier

- Peña Blanca, PNB
- Bernalillo, BRN
- La Orilla, LOR
- Barelas, BAR
- Los Padillas, PAD
- Los Lunas I, LL1
- Los Lunas II, LL2
- Abeytas, ABY
- La Joya, LJY
- Rio Salado, RSL
- Lemitar, LEM
- Arroyo del Tajo, ATJ
- San Pedro, SPD
- Bosque del Apache I, BA1
- Bosque del Apache II, BA2

NOTE: Mesohabitat area donut plots are scaled relative to one another as a function of area.
NOTE: Numbered mesohabitats labeled in yellow correspond to the subset of mesohabitats where Rio Grande silvery minnows were caught.
NOTE: Numbered mesohabitats that are outlined in black on maps correspond to the subset of mesohabitats where physical habitat measurements (and water-quality properties were measured in summer 2012) and fish collection was attempted.

Base credit in maps for Peña Blanca, Bernalillo, La Orilla, Barelas, Los Padillas, Los Lunas I, and Los Lunas II (sheets 3 and 4)
Base from Middle Rio Grande Conservation District,
March–May 2012, 0.5-foot resolution compressed mosaic,
New Mexico State Plane Central Zone,
North American Datum of 1983

Base credit in maps for Abeytas, La Joya, Rio Salado, Lemitar, Arroyo del Tajo, San Pedro, Bosque del Apache I, and Bosque del Apache II (sheets 5, 6, and 7)
Base from Bureau of Reclamation,
February 2012, 1.5-foot resolution compressed mosaic,
New Mexico State Plane Central Zone,
North American Datum of 1983

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Fish Assemblage Composition and Mapped Mesohabitat Features Over a Range of Streamflows in the Middle Rio Grande, New Mexico, Winter 2011–12, Summer 2012

By

Daniel K. Pearson, Christopher L. Braun, and J. Bruce Moring

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