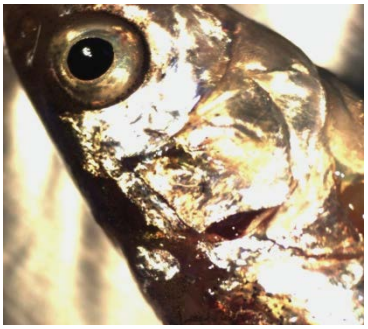
U.S. Fish & Wildlife Service

Rio Grande Silvery Minnow Health Study



Report prepared for the U.S. Bureau of Reclamation under Interagency Agreement 06-AA-40-2548.

Report prepared by:

U.S. Fish and Wildlife Service
New Mexico Ecological Services Field Office
2105 Osuna Road NE
Albuquerque, New Mexico 87113
http://www.fws.gov/southwest/es/NewMexico/

December 2012

DISCLAIMER

The findings, opinions, conclusions, and recommendations expressed in this report are those of the authors and have not been formally disseminated by the U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Reclamation, or U.S. Geological Survey, and should not be construed to represent any agency determination or policy. Reference to any commercial product, process, or service by trade name, manufacturer, or otherwise, does not constitute endorsement by the United States Government.

Cover photography (beginning top left): 1) "Examination of fish health"; 2) "Rio Grande silvery minnow with shortened opercula"; 3) "Deployment of water quality monitoring equipment in the Rio Grande"; and 4) "Examination of fish for parasites" by U. S. Fish and Wildlife Service/J. Lusk (photographs 1, 3, and 4) and A. Davis (photograph 2).

Suggested citation: Lusk, J. D., A. P. Davis, M. J. Osborne, D. M. Papoulias, J. E. Woodland, and W.J. Remshardt. 2012. Rio Grande Silvery Minnow Health Study. U.S. Fish and Wildlife Service, New Mexico Ecological Services, Albuquerque, New Mexico.

Example appendix or chapter citation: Papoulias, D. M., M. L. Annis, A. P. Davis, J. D. Lusk, E. Zabotkina, E. Nazarova, and D. E. Tillitt. 2009. Health and Histopathological Evaluation of Rio Grande Silvery Minnow from the Rio Grande, New Mexico. U.S. Geological Survey, Columbia Environmental Research Center, Columbia, Missouri.

Acknowledgements: Our appreciation for the staff and participation of the New Mexico Fish and Wildlife Conservation Office, the New Mexico Ecological Services Field Office, the Region 2 Fish Health Unit, the University of New Mexico, the Museum of Southwestern Biology, the Southwest Regional Office, and the New Mexico Environment Department Surface Water Quality Bureau. Additionally, this study could not have been conducted without the assistance of C.Abeyta, E.Anderson, T.Annes, R.Aragon, T.Archdeacon, T.Auspring, L.Baca, J.Bachus, N.Baczek, B.Bixby, C.Botnik, H.Bradenburg, J.Brooks, W.Brown, K.Buhl, L.Buitink, S.Bulgrin, M.Bullard, C.Caldwell, D.Campbell, S.Cho, M.Christman, C.Dahm, S.Davenport, A.Davis, J.Davis, G.Dean, L.Dechante, G.Dennis, J.DeRose-Baumann, J.Dick, P.Dodge, M.Donovan, P.Dowling, T.Edelen, D.Eib, K.Eldridge, M.Etemadi, M.Farington, S.Ferguson, W.Furr, S.Gonzales, L.Gemlo, N.Gloman, R.Gomez, W.Gould, E.Hein, H.Henderson, D.Hill, P.Hines, S.Jacobsen, A.James, K.King-Wrenn, C.Kitcheyan, T.Knect, M.Kreutzian, C.Lee, T.Lewis, J.Lewis, L.Lewis, L.Lienesch, C.Linterman, D.Longenbaugh, M.Longenbaugh, S.Maestas, D.Mafnas, J.Manuelito, M.Martinet, R.Mattale, B.McGee, R.McHale, J.McIntyre, B.Millsap, D.Montoya, W.Murphy, D.Myers, M.Myers, Y.Najmi, S.Netc, A.Neveraz, J.Norris, E.Oms, M.Osborne, D.Papoulias, J.Perea-Richmann, C.Pickering, L.Pieyns, S.Platania, M.Porter, D.Price, D.Prichard, A.Puglisi, J.Reale, J.Remshardt, S.Robertson, L.Robertson, R.Robichard, M.Rodarte, J.Sandoval, H.Schaller, A.Sharp, K.Slown, C.Smith, A.Snyder, S.Stringer, C.Sykes, T.Tadano, J.Thoeson, L.Torres, T.Turner, M.Ulibarri, D.VanHorn, R.Vigil, L.Wellman, S.Whitmore, K.Winter, J.Woodland, J.Worthington, A.Zerrener, and many, many more. Thank you.

PROJECT SUMMARY

It is widely known that the health of fish can be adversely affected by exposure to water pollution. In 2005, the Middle Rio Grande Endangered Species Act Collaborative Program (Collaborative Program) requested proposals for monitoring the health conditions of Rio Grande silvery minnow (*Hybognathus amarus*; RGSM) in the mainstem of the Middle Rio Grande. In response, the U.S. Fish and Wildlife Service (Service) designed the RGSM Health Study to monitor and characterize the health conditions of RGSM in the MRG to provide baseline data on diseases and parasites, and document external and internal anomalies and pathologies in fish collected throughout the year. The Collaborative Program also requested that monitoring of RGSM health conditions be conducted in conjunction with a water-quality monitoring program to better link results to possible causes. In particular, the New Mexico Environment Department (2009) implemented (and reported separately) a companion water quality study that overlapped some of the same sites sampled during this RGSM Health Study.

Various agencies participated in the RGSM Health Study including the New Mexico Environment Department (NMED); the University of New Mexico, Museum of Southwestern Biology (Museum); the U.S. Geological Survey (USGS), New Mexico Ecological Services Field Office, and Dexter Fish Health Unit. We conducted the RGSM Health Study from July 2006 to July 2008 (Year 1 and Year 2). Rio Grande silvery minnows (*Hybognathus amarus*) were collected nearly every three months from six sites in the Rio Grande from Bernalillo to San Antonio, New Mexico. We used a suite of standard methods of observation of fish health conditions during necropsy to determine total length, mass, organ condition, the number and type of lesions and anomalies, the number and type of parasites and pathogens, and we analyzed their tissues for a variety of chemicals and genetic conditions. We also measured surface water quality parameters (i.e., dissolved oxygen (DO), oxygen saturation, temperature, pH, specific conductivity).

There are three chapters of this RGSM Health Study Report with three additional reports included as appendices, which describe the different activities undertaken during this RGSM Health Study. Chapter 1 includes introductory materials, selection of study sites, methods of fish and water quality data collection, results, and discussion including the use of oxygen measures to evaluate gross primary productivity (GPP) and ecosystem respiration (ER). Chapter 2 includes the Fish Health Assessment methods, necropsy results, and discussion. Chapter 3 includes the analytical methods, results, and discussion of chemicals in RGSM tissues. Literature cited and data appendices (Appendices 1A-1C, 2A-2K, and 3A-3F) are provided with the first three chapters. Some materials were made available online at http://www.fws.gov/southwest/es/newmexico/EC_reports.cfm. Appendix 4 includes the Fish Histology and Histopathology Report by Papoulias et al. (2009). Appendix 5 includes the Fish Pathogen Assessment Report that included methods of RGSM pathogen data collection, results, and discussion by Woodland (2012). Appendix 6

includes the Genetic Evaluation Report by Osborne and Turner (2009). Each chapter or appendix report also refers to their own figures, tables, and data appendices.
We measured individual fish and dissected them to observe their external and internal conditions (Chapter 2). We measured total length and weight and found fish collected in Year 1 were significantly larger than those collected in Year 2 were. We found a significant relationship between fish length and weight with average annual water temperature. We observed shortened opercula, gill pathologies, liver anomalies, and degenerated kidney tubules as anomalies with the greatest frequency and these anomalies were observed at a greater frequency in Year 2 than in Year 1. Changes in water temperature, nutrition, or discharge appeared to be the most likely factors affecting skeletal development and therefore shortened opercula in silvery minnows. Mean Feeding Index was significantly lower in Year 1 than in Year 2, suggesting that food was more readily available during Year 1. The percent of fish with anomalies or pathological lesions tended to increase from upstream to downstream. Generally, the health of the Rio Grande silvery minnows was moderately affected, indicative of chronic stress, deteriorated from Year 1 to Year 2, from upstream to downstream, and during the summer (as measured during July) (Chapter 2, Appendix 4, and Appendix 5).

Additionally, we collected samples of spleen, gonad, and other tissues for histopathological examination and hematology (Appendix 4). All silvery minnows observed were experiencing chronic stress likely associated with poor water or sediment quality as evidenced by a suite of health indicators. Those silvery minnows collected in July tended to be the least healthy, having more macrophage aggregates, granulomas, lower liver glycogen and increased spleen size with fewer red blood cells. Gill abnormalities (e.g., discoloration, fraying, clubbing, fused lamellae, embolism, and parasites) were commonly observed in over 96 percent of the silvery minnow gills and could be related to bacterial or parasite infestations, or elevated copper.

Female gonads were observed in 58 percent of samples, but percentage of females was not significantly different by sample year, site, or month. However, there was a significant trend of more females in samples collected sites downstream than upstream. We observed some atretic oocytes in females (i.e., ectopic oocytes in liver and kidney tissues); however, no oocytes were positively detected in the testes of males evaluated.

The majorities of livers were low to moderate in glycogen content, and were lowest in silvery minnows collected in July. While gross liver abnormalities were high (e.g., discolored or mushy liver), liver pathologies (e.g., edema, high fat content, pigments and macrophages, granulomas, parasites, etc.) were low. Granulomas and macrophage aggregates were more prevalent in July 2008 samples and hemosiderin and melanin pigments were more common in livers collected in Year 2.

After necropsy, the silvery minnow carcasses were chemically analyzed for a variety of metals, hydrocarbons, organochlorine compounds, stable isotopes, and fire

retardant residues (Chapter 3). Generally, organic chemical concentrations in silvery minnows were low. However, semivolatile hydrocarbons, especially naphthalene and other PAHs, were moderately elevated in silvery minnows. Several organochlorine pesticides, PCBs, and BDEs (flame-retardants), were also elevated in silvery minnows collected from Site 3 and Site 4. The bioaccumulation of chlorinated and brominated organic chemicals at these sites may have been related to silvery minnow size, lipid content, or potential site or dietary differences. Concentrations of inorganic contaminants in Rio Grande silvery minnow were similar to those in other fish species collected from the Rio Grande and were generally low, with the exception of aluminum, copper, nickel, vanadium, and zinc. Additional research was recommended for those contaminants in fish that were elevated.

We measured water quality parameters (e.g., dissolved oxygen, temperature, pH, and conductance) as well as used rates of oxygen change to estimate gross primary productivity and ecosystem respiration (Chapter 1). Average gross primary productivity rates ranged widely, but were generally higher at upstream sites and during summer. Low oxygen conditions were identified and were most likely associated with oxygen demanding substances in sediment. Increasing gross primary productivity and thereby increasing oxygen content will reduce oxygen demand and ecosystem respiration. Improvements in these conditions would likely result in increased populations of fish, increased species richness of benthic invertebrates, and decreased chronic stress reported in Rio Grande silvery minnows.

In a companion study, the New Mexico Environment Department (NMED 2009) evaluated the chemical quality of water, sediment and fish in the Middle Rio Grande. NMED evaluated chemical data in the water column to evaluate exceedances of New Mexico Water Quality Control Commission-approved water quality standards. The NMED (2009) concluded that very few water quality standards impairments were found. The NMED (2009) also evaluated water, sediment and fish tissue data to identify additional water quality issues of concern (i.e., issues that were not considered to exceed New Mexico water quality standards) and identified aluminum, copper, chromium, ammonia, low oxygen, elevated pH in water, zinc and DDT in fish tissues, and several semivolatile compounds (PAHs) in sediment as elevated. The Rio Grande Silvery Minnow Health Study findings were consistent with the NMED (2009) study.

In summary, the health of the Rio Grande silvery minnow was moderately impaired. The silvery minnows had skeletal deformities (i.e., shortened opercula) that suggested a causal association with factors of water temperature, nutrition, and/or discharge. Silvery minnows were generally healthier collected from upstream than from downstream sites. When water quality conditions deteriorated, including higher temperatures, lower oxygen content, and with increased pathogen burdens as were measured during July, the health of silvery minnows also generally declined. Several contaminants were prevalent in fish including hydrocarbons such as PAHs, and certain metals, including aluminum and zinc.

TABLE OF CONTENTS

Disclaimer i
Acknowledgments i
Project Summary iii
Table of Contents vi

Chapter 1. Rio Grande Silvery Minnow Health Study Introduction with Results of Water Quality Parameters Measured and Derivation of Gross Primary Productivity and Ecosystem Respiration in the Middle Rio Grande, New Mexico (2006-2008)

Introduction 1
- Rationale and Purpose 1
- Chapters and Appendices of this Report 2
- Permissions, Land Access, Consultations, and Agreements 2

Methods 3
- Description of the Study Area and Sampling Sites 3
- Sample Site Selection and Frequency of Sampling 3
- Sample Site Characterization 4
- Collection of Rio Grande Silvery Minnow 5
- Measuring Water Quality Parameters 6
- Data Analysis 8
- Derivation of Gross Primary Productivity and Ecosystem Respiration 8

Results 10
- Sampling Site Location and Characterization 10
- Fish Collection 10
- Water Quality during Fish Collection 10
- Continuous Water Quality Monitoring 11

Discussion 14
- Temperature 14
- Specific Conductivity 15
- pH 16
- Oxygen Saturation and DO 17
- GPP, ER, and PR Ratio 21

Literature Cited 22

Chapter 1. Figures
- Figure 1. Location of the Middle Rio Grande Watershed and RGSM Health Study Area in New Mexico 34
- Figure 2. Location of the Six RGSM Health Study Sites along the Middle Rio Grande in New Mexico 35
- Figure 3. Location of RGSM Health Study Sampling Site 1, Rio Grande at Bernalillo, New Mexico 36
- Figure 4. Location of RGSM Health Study Sampling Site 2, Rio Grande at Alameda, New Mexico 37

Figure 5. Location of RGSM Health Study Sampling Site 3, Rio Grande at Los Padillas, New Mexico....38
Figure 6. Location of RGSM Health Study Sampling Site 4, Rio Grande at Los Lunas, New Mexico....39
Figure 7. Location of RGSM Health Study Sampling Site 5, Rio Grande at La Joya, New Mexico....40
Figure 8. Location of RGSM Health Study Sampling Site 6, Rio Grande near San Antonio, New Mexico....41
Figure 9 to Figure 49 – see Appendix 1A....Available online*

Chapter 1. Tables

Table 1. Site number, site name, latitude and longitude (in decimal degrees) of a central point, and description of the RGSM Health Study sampling sites....42
Table 2. Site number, sample date, wetted width, average depth, average velocity, site discharge, and daily discharge reported at the nearest USGS Gage of the sampling sites during 2006 to 2008....43
Table 3. Seine haul event number, date, location, habitat type, number RGSM collected, temperature, ph, dissolved oxygen, and specific conductivity....48
Table 4. Water quality results and RGSM catch results during seine hauls....Available online*
Table 5.1 to Table 5.82 – see Appendix 1C....Available online*
Table 6. Summary statistics for water temperature measurements by sample year, date of deployment, season, and site listed from upstream to downstream....55
Table 7. Summary statistics for specific conductivity measurements by sample year, date of deployment, season, and site listed from upstream to downstream....61
Table 8. Summary statistics for pH measurements by sample year, date of deployment, season, and site listed from upstream to downstream....67
Table 9. Summary statistics for oxygen dissolved in water by sample year, date of deployment, season, and site listed from upstream to downstream....74
Table 10. Summary statistics for oxygen saturation in water by sample year, date of deployment, season, and site listed from upstream to downstream....81
Table 11. Summary statistics for 24-hour ecosystem respiration by sample year, date of deployment, season, and site listed from upstream to downstream....87
Table 12. Summary statistics for gross primary productivity by sample year, date of deployment, season, and site listed from upstream to downstream....93
Table 13. Summary statistics for the ratio of gross primary productivity to ecosystem respiration (PR Ratios) by sample year, date of deployment, season, and site listed from upstream to downstream....99

Chapter 1. Appendices
Appendix 1A. Figure 9 to Figure 48. Mean daily discharge at USGS Gage stations nearby RGSM Health Study sampling sites during 2006 to 2008. And also Figure 49 .....Available online*
Appendix 1B. Plate 1 to Plate 44. Riverscape photography of the RGSM Health Study continuous water quality monitoring sampling sites during 2006 to 2008 .....Available online*
Appendix 1C. Table 5.1 to Table 5.82. Continuous water quality monitoring measurements at RGSM Health Study sites during 2006 to 2008 .....Available online*

Chapter 2. Rio Grande Silvery Minnow Health Assessment

Introduction.....2
Review of Fish Health Studies conducted in the Middle Rio Grande 2
Methods.....5
Fish Health Observations and Necropsy Methods.....5
Calculation of the Health Assessment Index and other Indices.....9
Data Analyses 10
Results.....11
Silvery Minnow Total Length.....11
Silvery Minnow Weight.....12
Splenosomatic Index (SSI) 12
Health Assessment Index (HAI) 15
Feeding Index.....16
Silvery Minnow Opercula.....17
Summary of Silvery Minnow Health Observations.....19
Discussion.....20
Length and Weight.....20
Indices of Fish Health 20
Shortened Opercula or Fish Opercula Deformity Syndrome (FODS).....22
Summary and Recommendations 28
Literature Cited 29

Chapter 2. Figures
Figure 1. Examples of external anomalies.....6
Figure 2. Examples of opercula shortening 7
Figure 3. Examples of (A) male gonads; and, (B) female gonads.....7
Figure 4. Examples of internal anomalies 8
Figure 5. Mean total length of silvery minnows by month and sample year.....11
Figure 6. Mean total length of silvery minnows by site and sample year 12
Figure 7. Mean weight of silvery minnows by month and sample year.....13
Figure 8. Mean weight of silvery minnows by site and sample year.....13
Figure 9. Mean SSI for silvery minnows by month and sample year.....14
Figure 10. Mean SSI for silvery minnow by site and sample year.....14
Figure 11. Mean HAI for silvery minnows by month and sample year 15
Figure 12. Mean HAI for silvery minnow by site and sample year.....15

Figure 13. Mean Feeding Index for silvery minnows by month and sample year 16
Figure 14. Mean Feeding Index for silvery minnows by site and sample year 17
Figure 15. Mean percent of shortened opercula observed in silvery minnows by month and sample year. 18
Figure 16. Mean percent of shortened opercula observed in silvery minnows by site and sample year 18
Figure 17. Mean percent of anomalies observed in silvery minnows by type and sample year 19
Figure 18. Percent shortened opercula in silvery minnows archived at the University of New Mexico, Museum of Southwestern Biology and in this study by year.....24

Chapter 2. Tables and Appendices
Table 1. Site number, site name, latitude and longitude (decimal degrees) of a central point, description of the RGSM Health Study sampling sites.....25
Appendix 2A. U.S. Fish and Wildlife Service Fish Health Examination Sheet.....26
Appendix 2B. Fish health assessment variables and assigned values 28
Appendix 2C. Rio Grande silvery minnow examined during Year 1 and Year 2 30
Appendix 2D. Total Length (in millimeters) of Rio Grande silvery minnow collected from the Rio Grande during 2006-2008.....32
Appendix 2E. Weight (grams) of Rio Grande silvery minnow collected from the Rio Grande during 2006-2008.....34
Appendix 2F. Splenosomatic Index (SSI) of Rio Grande silvery minnow collected from the Rio Grande during 2006-2008.....36
Appendix 2G. Distribution of Health Assessment Index (HAI) scores from Rio Grande silvery minnow collected from Rio Grande during 2006 to 2008 37
Appendix 2H. Percent anomalies observed in Rio Grande silvery minnow during Year 1 (2006-2007) and Year 2 (2007-2008) of the Rio Grande Silvery Minnow Health Study .....Available online*
Appendix 2I. Fish Health Assessment Observations and Scores for the Rio Grande Silvery Minnow Health Study 2006-2008.....Available online*
Appendix 2J. Plates 1-58. Rio Grande Silvery Minnow during Fish Health Assessments for the Rio Grande Silvery Minnow Health Study 38

Chapter 3. Chemical Residues in Rio Grande Silvery Minnow

Introduction.....2
Methods 3
Chemical Analyses, Quality Control, and Methods of Interpretation of Contaminants in Fish 3
Results and Discussion 6
Quality Control of the Chemical Analyses 6
Inorganic Contaminants, Methyl Mercury, and Lipid or Moisture Content.....7
Aliphatic and Aromatic Hydrocarbons 13
Organochlorine (OC) Pesticides, Dioxins, PCBs, and PBDEs.....16
Conclusions.....21

Literature Cited 22

Chapter 3. Tables
Table 1. Site name, site number, latitude and longitude (in decimal degrees) of a central point, and narrative description of the sampling sites 34
Table 2. Chemical names, abbreviations, analytical methods, limits of detection..35
Table 3. Moisture content, methyl mercury, and element concentrations in Rio Grande silvery minnow carcasses collected from six sites along the Rio Grande in New Mexico during 2006 to 2008 49
Table 4. Concentrations of elements and moisture content in whole fish collected from the Rio Grande or collected nationwide compared with those in Rio Grande silvery minnow carcasses collected from six sites along the Rio Grande in New Mexico during 2006 to 2008 52
Table 5. Concentrations of organic chemicals and lipid content in Rio Grande silvery minnow carcasses collected from six sites along the Rio Grande in New Mexico during 2006 to 2008 53

Chapter 3. Appendices
Appendix 3A. Inorganic Analytical Results for Rio Grande Silvery Minnow Health Study Catalog 2020128 by Trace Element Research Laboratory, College Station, Texas .....Available online*
Appendix 3B. Organic Analytical Results for Rio Grande Silvery Minnow Health Study Catalog 2020128 by TDI Brooks International, Inc., College Station, Texas.....Available online*
Appendix 3C. Complete Catalog 2020128 of Rio Grande silvery minnow carcasses and collection information.....Available online*
Appendix 3D. Moisture content and concentrations of elements and methyl mercury in Rio Grande silvery minnow carcasses from all sampling sites expressed as µg/g dry weight. .....Available online*
Appendix 3E. Moisture content, lipid content and concentrations of organic chemicals in Rio Grande silvery minnow carcasses from all sites expressed as micrograms per kilogram (µg/kg) wet weight.....Available online*

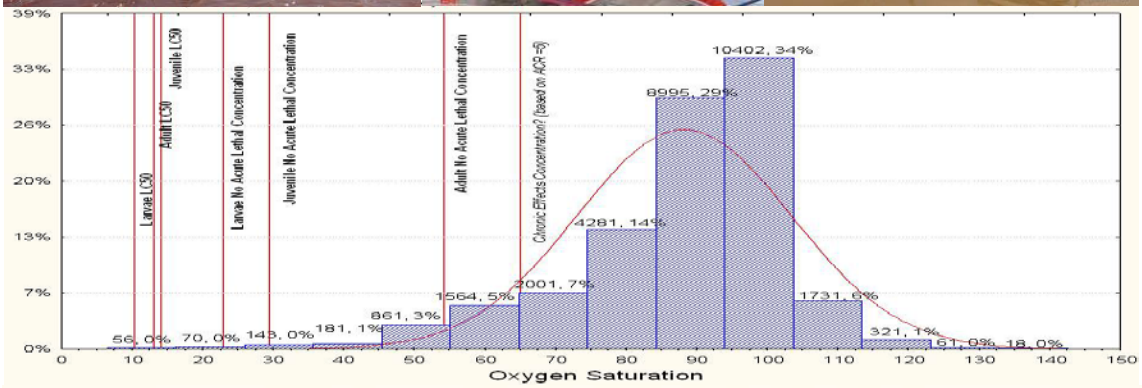
Appendix 4. Papoulias, D. M., et al. 2009. Health and histopathological evaluation of Rio Grande silvery minnow from the Rio Grande, New Mexico. USGS Columbia Environmental Research Center, Columbia, Missouri.....Available online*

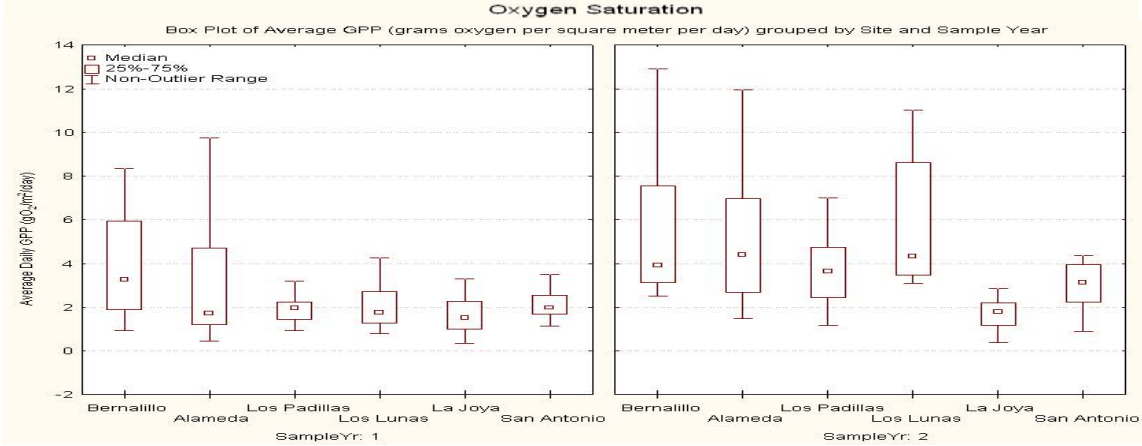
Appendix 5.Woodland, J. 2012. Rio Grande Silvery Minnow Health Study – Fish Pathogen Assessment. U.S. Fish and Wildlife Service, Dexter Fish Health Unit, Dexter, New Mexico.....Available online*

Appendix 6.Osborne, M. and T. F. Turner. 2009. Multi-locus Major Histocompatibility Complex Class IIβ and Parasite Diversity in the Rio Grande Silvery Minnow. University of New Mexico, Department of Biology and Museum of Southwestern Biology, Albuquerque, NM .....Available online*

*Available online at: http://www.fws.gov/southwest/es/newmexico/EC_reports.cfm

Chapter 1: Rio Grande Silvery Minnow Health Study Introduction with Results of Water Quality Parameters Measured and Derivation of Gross Primary Productivity and Ecosystem Respiration in the Middle Rio Grande, New Mexico (2006-2008)





Prepared by: Joel D. Lusk
U.S. Fish and Wildlife Service
New Mexico Ecological Services Field Office
2105 Osuna Road NE, Albuquerque, New Mexico 87113
www.fws.gov/southwest/es/newmexico

December 2012

INTRODUCTION

Rationale and Purpose of Rio Grande Silvery Minnow Health Study

Malnutrition, metabolic disorders, and environmental stressors such as rapid changes in temperature, oxygen levels, suspended solids, salinity, toxic chemicals, or other physical, chemical and biological qualities of a river can stress fish (Heath 1995). Monitoring fish health conditions in conjunction with traditional water quality measures provides biologically relevant information about potential stressors in the environment and their effects on fish (Schmitt and Dethloff 2000, Smith et al. 2002). Fish health conditions are surveyed because fish are regarded as representative indicators of overall water quality conditions and because of their position in the water column and intimate exposure in the environment (Anderson 1990; Adams et al.1993; Heath 1995; Schmitt et al. 2004).

In 2005, the Middle Rio Grande Endangered Species Act Collaborative Program requested proposals (U.S. Bureau of Reclamation [BOR] 2005) for monitoring the health conditions of Rio Grande silvery minnow (*Hybognathus amarus*; RGSM) in the mainstem of the Middle Rio Grande (MRG; Figure 1). In response, the U.S. Fish and Wildlife Service (Service) designed the RGSM Health Study to monitor and characterize the health conditions of RGSM in the MRG. Monitoring the health conditions of RGSM was meant to provide baseline data on diseases and parasites, and document external and internal anomalies and pathologies in fish collected throughout the year. The BOR (2005) also requested that monitoring of RGSM health conditions be conducted in conjunction with a water-quality monitoring program to better link results to possible causes. Various agencies participated in the RGSM Health Study including the New Mexico Environment Department (NMED); the University of New Mexico, Museum of Southwestern Biology (Museum); the U.S. Geological Survey (USGS), New Mexico Ecological Services Field Office, and Dexter Fish Health Unit. In particular, the NMED (2009) implemented (and reported separately) a companion water quality study that overlapped some of the same sites sampled by this RGSM Health Study.

For this RGSM Health Study, we used a suite of standard methods of observation of fish health conditions during necropsy to determine total length, mass, organ condition, the number and type of lesions and anomalies, the number and type of parasites and pathogens, and we analyzed their tissues for a variety of chemicals and genetic conditions. We collected RGSM and evaluated their health conditions, observed disease and pathology, histopathology and other conditions quarterly from July 2006 through July 2008 at six sites in the MRG from Bernalillo to near San Antonio, New Mexico (Figure 1). We also measured surface water quality parameters (e.g., dissolved oxygen (DO), oxygen saturation, temperature, pH, specific conductivity) in conjunction with the NMED (2009) collection and analysis of water and sediment from these or nearby sites.

Chapters and Appendices of this Report

There are three chapters of this RGSM Health Study Report with three additional reports included as appendices, which describe the different activities undertaken during this RGSM Health Study. Chapter 1 includes introductory materials, selection of study sites, methods of fish and water quality data collection, results, and discussion including the use of oxygen measures to evaluate gross primary productivity (GPP), ecosystem respiration (ER). Chapter 2 includes the Fish Health Assessment methods, necropsy results, and discussion. Chapter 3 includes the analytical methods, results, and discussion of chemicals in RGSM tissues. The Project Summary reports all findings of our study and provides recommendations. Literature cited and data appendices (Appendices 1A-1C, 2A-2K, and 3A-3F) are provided with the first three chapters. Some materials were made available online at http://www.fws.gov/southwest/es/newmexico/EC_reports.cfm. Appendix 4 includes the Fish Histology and Histopathology Report by Papoulias et al. (2009). Appendix 5 includes the Fish Pathogen Assessment Report that included methods of RGSM pathogen data collection, results, and discussion by Woodland (2012). Appendix 6 includes the Genetic Evaluation Report by Osborne and Turner (2009). Each chapter or appendix report also refers to their own figures, tables, and data appendices. Additionally, the water quality report by NMED (2009) describes their methods, results, and implications of Rio Grande water quality to RGSM, as well as some of the analytic results from water, sediment, and fish samples at sites concurrently sampled with the RGSM Health Study, except for summer 2006 or summer 2007.

Permissions, Land Access, Consultations, and Agreements

The Service was granted vehicular access to the Middle Rio Grande and adjacent floodplain by issuance of Special Use License and gate key from the Middle Rio Grande Conservancy District (District). Access was also obtained from the City of Albuquerque Open Space Division for activities within the Rio Grande Valley State Park. All fish collections were conducted in accordance with Federal Fish and Wildlife Permit Number TE676811 and New Mexico Department of Game and Fish Authorization Number 3094 for Scientific and/or Educational Purposes. An Environmental Action Statement identifying a categorical exclusion to the National Environmental Policy Act was filed for the RGSM Health Study in June 2006. All consultation and interagency agreements between the BOR and the Service, and between the Service and NMED, the University of New Mexico, and USGS were completed by March 2008.

METHODS

Description of the Study Area and Sampling Sites

The study area was the MRG within the Rio Grande-Albuquerque Watershed (USGS Hydrologic Cataloging Unit 13020203; we term this the MRG Basin) in central New Mexico (Figure 1). The MRG Basin has a drainage area of approximately 8,298 square kilometers (km^2) (3,204 square miles (mi^2)) and in 2000, the land use land cover was approximately 59 percent rangeland, 23 percent forest, 7 percent agricultural, 6 percent urban, 3 percent barren, and less than 2 percent surface water or wetlands (NMED 2002). Within the study area, the District provides irrigation water for agricultural purposes in a narrow band of land along the MRG. The District provides water for flood irrigation of crops by diverting water from the MRG by a system of diversion dams and canals while directing return flows to the MRG through drainage ditches and interior and riverside drains (Langman and Anderholm 2004). The largest urban area in the MRG Basin is the City of Albuquerque with a population of 529,219 (U.S. Census Bureau 2009).

Sample Site Selection and Frequency of Sampling

The BOR (2005) recommended fish health sampling sites be selected in conjunction with the water quality monitoring program and include: 1) locations at or near the Angostura Dam, 2) near the mouth to about 0.4 kilometers (km) (0.25 miles (mi)) downstream of the Albuquerque Metropolitan Area Flood Control Authority (AMAFCA) North Diversion Channel; 3) near the mouth of the City of Albuquerque's Southside Water Reclamation Facility discharge; 4) near the Village of Los Lunas; 5) below the confluence with the Rio Puerco; and, 6) upstream of San Acacia Dam. The six sites selected for conducting sampling for the RGSM Health Study were in these areas (Table 1; Figure 2) and spanned over 171 km (106 mi) of the MRG from the Bosque del Apache National Wildlife Refuge, south of San Antonio, New Mexico, north to Bernalillo, New Mexico. Final site selection was based upon historical monitoring locations, access permissions, logistics, and personnel safety.

Sites selected for the RGSM Health Study (Table 1) included: Site 1, Rio Grande at Bernalillo, New Mexico, was upstream of the City of Albuquerque and was used as a reference site for data comparisons where appropriate (Figure 3). Site 2, Rio Grande at Alameda, New Mexico, was generally below main City of Albuquerque's urban stormwater runoff return through the AMAFCA North Diversion Channel (Figure 4). Site 3, Rio Grande at Los Padillas, New Mexico, was downstream of the City of Albuquerque; including the Southside Water Reclamation Facility discharge contained treated domestic and industrial wastewater (Figure 5). Site 4, Rio Grande at Los Lunas, New Mexico, was approximately 29 km (18 mi) downstream of the City of Albuquerque (Figure 6). Site 5, Rio Grande at La Joya, New Mexico, was approximately 8 km (5 mi) downstream of the confluence of the Rio Puerco (Figure 7). Site 6, Rio Grande near San Antonio, New Mexico, was approximately 6 km (4 mi) south of San Antonio (Figure 8) and downstream of the San Acacia Diversion Dam.

The RGSM Health Study was designed to collect fish health assessment, pathogen, genetic evaluations, and water quality parameters as a means to characterize the health of wild RGSM in relation to water quality measures in the Middle Rio Grande over two years, thus capturing variation longitudinally and across seasons. Sites were sampled during July 2006, October 2006, January 2007 and April 2007 (Year 1) and during October 2007, January 2008, April 2008, and July 2008 (Year 2). That is, eight sampling events were conducted quarterly over these two sample years during summer (July 2006 and 2008), autumn (October 2006 and 2007), winter (January 2007 and 2008) and spring (April 2007 and 2008). No sampling was conducted in July 2007. For quality assurance, a practice session of fish and water quality collection was conducted in June 2006.

Sample Site Characterization

River transect, fish collection, and water quality data were entered by hand onto pre-printed data forms or in field notebooks. Every effort was made to accurately document the conditions present during river transect characterization, fish collection, or water quality data collection events including documenting locations using a hand-held global positioning system (GPS) receiver, time of collection, characterizing general habitat type, and recording observations onto pre-printed forms or in notebooks. The GPS receivers (position accuracy plus or minus [±] 15 meters (m) (50 feet (ft); Garmin Model GPS V, Olathe, Kansas) were used to record the coordinates of fish collection efforts or water quality measurements and the coordinates were formatted using northing and easting (m) using the Universal Transverse Mercator, Zone 13, coordinate system, and the North American Datum of 1983. The coordinates were entered onto field forms by hand and verified through depiction of sampling site location on topographic images using desktop software ArcMap 10 (ArcGIS 10.0, ESRI, Redlands, California) and correcting any erroneous location coordinates noted and during data transferred into spreadsheets.

Where available, site photography was included of a 180 degree (or more) panorama made of individual digital still photographs taken with a Cybershot camera (Sony Corp USA, San Diego, California) and stitched together using Photostitch software (Canon Utilities, Version 3.1.10, Canon, Inc., Tokyo, Japan). Where possible, site photography was conducted during deployment of the continuous water quality monitoring probes at each site. Additional photography was collected of field or laboratory activities and was provided with the other chapters or appendix reports.

River Transects

Measurements of river water column depth, wetted width, and water velocity were made along a single cross-sectional channel transect at each sampling site and for each event (when possible). At each transect site, a tag line was set out along the cross section of the river channel and physical measurements were made in the water column approximately every 8 ft (2.4 m) along the tag line. Water column depth was measured using a top-set wading rod, marked in tenths of ft (or at approximately 3-centimeter (cm) increments). Mean column velocity was measured with a portable velocity meter (FLO-Mate Model 2000, Marsh McBirney, Loveland, Colorado) using the six-tenths depth method for water

depths less than 60 cm (2 ft) and the two point method for depths greater than 60 cm (2 ft). Depth and velocity data were averaged by sampling event and were used in calculations of ER, gross primary productivity, and for statistical analyses. However, we also compiled daily average discharge results at our sites as measured by the nearest upstream USGS gage station for 5-day periods around our fish and water quality data collections to characterize flows during our sampling events.

Occasionally, we were unable to wade safely across the MRG (as in April 2008). Or we required additional data to characterize river width, depth, and velocity at a site, for example, to determine ER rates and these values had to be estimated for missing data. To estimate river width, depth, and velocity at a site without empirical data, we used the average daily discharge data from the nearest upstream USGS gage station on the day of our fish collection. Also, using river transect data from our other sampling events at a site, and the width, length, and velocity measures collected by USGS at the nearest upstream gage station during the period of this study (2006-2008), we developed a series of equations to estimate river width, depth, and velocity based upon the average daily discharge volume reported by USGS during our data collection. These equations and the estimated values were identified below and were reported with our river transect results.

Collection of Rio Grande Silvery Minnow

At random, collections of fish were initiated upon arrival at each river site by 1-2 field teams (each with three or more members lead by fish biologists trained to identify fish species of the MRG). Fish were collected using flat seines (3 m wide x 1-2 m deep with 3.2-millimeter (mm) seine mesh and approximately one lead weight every 15 cm on the bottom line). RGSM were collected in a series of seine hauls events. Multiple attempts were necessary to collect sufficient numbers of fish. However, lack or fish or time restrictions occasionally prevented collection of adequate numbers of fish. Each seine haul containing fish was first processed to remove as much debris as practical, and fish species other than RGSM were returned to the stream, as were specimens of RGSM that were undersized (less than 30 mm total length [TL]) from the final RGSM collection. Up to 90 RGSM, greater than 30 mm TL, were targeted from each site (a river reach approximately 6 km or more in length) during each sampling event. Fish collected through seining were immediately identified by fishery biologists to species (e.g., using Mayden et al. 1992), enumerated, and those of sufficient length were placed in plastic buckets modified with fine mesh screens to allow river water to flow through it.

Once the RGSM were collected, along with adequate river water for their transport, the fish were immediately returned to a motor vehicle where they were transferred into plastic bags and transported to a laboratory for further analyses. Plastic transport bags were filled with river water to approximately two-thirds capacity (approximately 3 liters (L); 0.8 gallons); the remaining volume of the bag was inflated with pure oxygen and its opening sealed to prevent loss of the bag's contents. No additional salts or additives were added. Transport bags with fish and water were packed tight inside ice chests (without ice) to stabilize temperature and prevent sloshing. However, when ambient water temperatures were greater than 25°Celsius (C), small amounts of ice were added around

the bags inside of the chests and sealed. Average time between beginning of seine collections and arrival of fish at the laboratory was approximately 4 hours (hr).

Hatchery-produced RGSM have been stocked at various locations within the MRG (Service 2010). Each batch of hatchery-produced fish is distinguished by a unique Visible Implant Elastomer (VIE) tag attached inside the fish's body. The occurrence of hatchery-produced RGSM was noted during seine haul events. When marked RGSM were collected and observed during seine haul events, the unique attributes of the mark were noted (i.e., color and body location), and fish were collected and evaluated similar to wild RGSM.

Up to 90 RGSM (or more) were collected during each sample event, although some sites also did not yield sufficient numbers of fish to conduct further analyses. Up to 60 fish per site were surveyed for specific pathogens (i.e., bacteria, parasites and viruses) by the Service's Dexter Fish Health Unit (Woodland 2012). All RGSM collected in summer (July 2006 and 2008) for pathogen assessment also had tissues removed and that were provided to the Thomas F. Turner Laboratory of the University of New Mexico Museum, for genetic evaluations (Osborne and Turner 2009). As many as 30 RGSM per site were individually measured and examined for external and internal anomalies during a fish health assessment (Davis and Lusk 2012, Chapter 2). Up to 17 percent of the fish necropsied or their organs and tissues were submitted for further histological and histopathological examination (Papoulias et al. 2009, Appendix 4). As many as 30 fish (or more) per site of the partial body carcasses that remained after necropsy or pathogen assessment were wrapped in foil and frozen. Later, these individual fish were composited by site and date in chemically clean jars, and sent to the Trace Element Research Laboratory, College Station, Texas, for chemical analyses (Lusk 2012). Some of the remaining fish carcasses have also been analyzed for stable isotopes (Cook 2011). Remaining RGSM and tissues were archived at the University of New Mexico Museum for future use. These multiple coordinated analyses help to maximize the scientific information available from the sacrifice of these endangered fish.

Measuring Water Quality Parameters

Water Quality Monitoring during Fish Collection

All field meters used to measure water quality parameters were calibrated in the field (near sampling sites) according to the manufacturer's instructions prior to making measurements. During fish collections, water quality parameters were measured using a hand-held multiprobe meter (YSI Environmental, Model 556, Yellow Springs, Ohio) with a guarded, probe module. In shallow water, the probe module was submerged to just above substrate, while in deeper water, the probe module was submerged approximately to mid-depth of the water column. Stable readings were made by hand onto data forms of water temperature (in degrees Celsius [°C]), dissolved oxygen (in milligrams per liter [mg/l]), percent oxygen saturation, and specific conductivity (microSiemens per centimeter [µS/cm] at 25°C). Specific conductivity was measured using probes that contained automatic temperature compensation circuits to correct the

electrical conductance to 25°C. All data were transferred to Excel 2007 spreadsheets (Microsoft Corporation, Redmond, Washington), and data verified.

Continuous Water Quality Monitoring

The goals of the continuous water quality monitoring was to collect data and describe the range of water temperature, specific conductivity, pH, DO, and oxygen saturation at the sites before and after fish collection events. In addition, we used these continuous water quality measurements together with wetted width, average depth, and average velocities measured or estimated at a river transect to estimate GPP and ER. The focus of this continuous monitoring was on the characteristics and range of water quality parameters and derivation of GPP and ER at six locations by season and sampling year as well as to compare with average daily discharge or suspended sediment concentrations as measured by USGS at nearby gage stations. Another objective of this monitoring was to better identify water quality parameters exhibiting degradation within a reach to help guide RGSM and water quality management efforts.

Sample site selections for continuous water quality monitoring were as described above. Continuous monitoring of water quality was made at or near the transect location at each site. The continuous water-quality monitoring devices were deployed at least 1 day before until at least 2 days after fish collection events and often for 5 days in total. Continuous water quality monitoring was conducted at 15-minute intervals for at least 24 hr using one of four multi-parameter "Sonde" devices (Datasonde or Minisonde Models 4a, Hydrolab Corporation, Austin, Texas). These Sondes used a four-parameter probe monitoring system, which collected water temperature, electrical conductivity, DO, oxygen saturation, and pH data. These Sondes were outfitted with a temperature-compensated, polarographic membrane-type oxygen sensor probes and used a standard membrane in the determination of DO. Water temperature and DO were also measured at 15-minute intervals for at least 24 hr using one of three, non-vented, continuous monitoring multiparameter "Troll" devices (Troll Model 9500, In-Situ Inc., Fort Collins, Colorado). These Trolls were outfitted with a rugged, optical, fluorescence-quenching sensor probes to determine DO. These sensors employ a light-emitting diode to provide incident light that excites the oxygen-sensitive substrate of the sensor. The magnitude of luminescence is measured and is inversely proportional to the DO concentration in the water. Using both these types of oxygen probes allowed for comparison of the two types of methods of DO measurement. However, all DO data measured by different probe types were combined for each site. Prior to deployment, routine calibration and maintenance according to the manufacturer's instructions was conducted on each probe.

The continuous water quality monitoring devices (up to two per site, one of each type) were installed in perforated plastic pipes that were suspended, mid-water column, by cables fastened between iron posts driven into the streambed at the center of flow determined by wading across to estimate the deepest location (i.e., thalweg) accessible at each site. In addition to serial numbers, proper names were given to each of the different probes (Trolls and Sondes) to better track their deployment and retrieval as well as during calibration, data retrieval, and data organization.

Data Analysis

Water quality data were stored on internal memory of the continuous monitoring devices for later downloading. Data were then imported into spreadsheets. Data were amended with date column, reviewed for deployment date and time, removal date and time, notations were removed, and data were plotted. Anomalous data, such as negative values, or values measured when probes were not in water, or when probe had been placed into a calibration solution were discarded.

Data were imported into Excel spreadsheets or imported and analyzed using the statistical software Statistica (version 9.0, StatSoft, Tulsa, Oklahoma) or database software (Microsoft Office Access 2007, Microsoft Corporation, Redmond, Washington) on a desktop computer. Prior to final statistical analysis, the assumptions of normality and equal variance were formally tested by the Shapiro-Wilks test and Levene's test, respectively (Statsoft 2011). Data that did not meet these assumptions were transformed to their natural logarithms and retested, such as for a one-way analysis of variance (ANOVA) or students' t-test (Statsoft 2011). If the natural log-transformation did not satisfy the assumptions, data were transformed to ranks and a Kruskal-Wallis and median test was applied to test the ranks (Statsoft 2011). Other parametric and nonparametric statistical tests were also employed and were so indicated in the text. Statistical significance probability (p) was set at p less than or equal to 0.05 for all statistical tests.

In some cases, continuous monitoring devices were smothered by sediment and were so noted upon their removal. Smothering of devices by sediment could have occurred anytime between deployment and discovery during their removal or during fish collections. After review of all data, those dissolved oxygen saturation data less than 50 percent oxygen saturation were considered suspect from those water quality devices that were found smothered. Therefore, all data (i.e., pH, temperature, dissolved oxygen content and saturation, specific conductivity measures) from those devices identified as smothered were flagged and censored from subsequent analyses and were so noted. Continuous monitoring data were summarized and qualitatively evaluated for comparisons by site, season, or sample year with other observations. General water quality was also assessed by comparing results to water quality standards (NMWQCC 2000; 20.6.1 New Mexico Annotated Code (NMAC)) or other guidelines as cited.

Derivation of Gross Primary Productivity and Ecosystem Respiration

We measured the rate of oxygen change in water over time with the continuous water quality monitoring probes to determine GPP and ER rates at each site that was associated with fish sampling. GPP and ER were determined using an open-system, single-station approach (Owens et al. 1974, Bott 1996). GPP and ER together, are referred to as "whole stream metabolism" (Bott 1996). Oxygen dissolved in water tends to fluctuate on a diurnal (24-hr) basis based on changes in temperature, stream mixing, barometric pressure and aquatic plant productivity. Together, processes like respiration, photosynthesis, water warming and cooling, or aeration typically gives a sinusoidal, diel-

pattern of DO and oxygen saturation that has minima in the early morning and maxima in the late afternoon (Odum 1956). Conversely, the observed oxygen gain and loss patterns from its measurement in stream waters can be used to calculate the component rates of primary production and ER (Odum 1956). Net primary productivity is the rate of formation of organic carbon (matter) from water and inorganic carbon by photosynthesizing organisms, which represents the conversion of solar energy to fixed energy that forms the base of food webs (Bott 1996). At night, some of this fixed energy is lost through plant respiration (i.e., the chemical processes by which plant sugars and starches are converted to energy through oxidation back into inorganic carbon and water). That portion of the fixed energy that remains and is stored as plant biomass is termed net primary productivity. Oxidative processes that may occur in sediment or the water column and respiration by bacteria, invertebrates, fungi, fish, and other aquatic organisms are included in the calculation of ER rates. The total (ER plus net primary productivity) is termed GPP. ER rates, GPP, and gas diffusion interact to produce the daily curve of oxygen change in the segment of flowing water that we measured using the continuous monitoring probes.

We used the continuous monitoring of temperature and dissolved oxygen over 24 hr to relate the rate of GPP, ER, and oxygen gas exchange with the atmosphere, assuming that groundwater inputs were negligible. Groundwater inputs of low DO into the MRG might not be negligible (see Mills 2003), however, we were unable identify methods to detect the relative contribution of groundwater on surface water oxygen content. Oxygen saturation often increases during daylight hours when photosynthesis is occurring and decreases at night when respiration continues and photosynthesis ceases. We used the DO and temperature measured at a site, and barometric pressure at calibration, to calculate the DO expected at saturation for a location using Equation 3 from Munson et al. (2004). From this, we calculated the amount of surplus or deficit oxygen saturation during each DO measurement. River transect characteristics of each site (i.e., average depth and velocity) were also used with the amount of surplus or deficit oxygen saturation to determine the oxygen exchange coefficient according to Owens et al. (1974) and Bott (1996). The area under the reaeration-corrected rate of oxygen change as a curve on standardized plots above a line drawn through the predawn to post dusk points was determined using a roller-type, digital planimeter (Placom Model KP90N, Tokyo, Japan) to estimate daily GPP. Water quality measured during the night (as defined as "civil twilight" between sunset and sunrise). Civil twilight was used as the limit at which illumination was sufficient for terrestrial objects to be clearly distinguished and was assumed to represent the period with most of the photosynthetic activity.

Division of the oxygen exchange rate by 24 hr converts the daily rate to an hourly rate, and hourly rates during civil twilight were averaged to determine average hourly nighttime respiration rates (Bott 1996). ER was then determined by multiplying the average hourly nighttime respiration rate by 24-hr. Whole stream metabolism was estimated from the difference between GPP and ER for those periods where both were measured. However, only GPP and ER rates and their ratios were statistically summarized, compared, and used in subsequent analyses.

RESULTS

Sampling Site Location and Characterization

Location of fish and water quality sampling events are depicted on Figures 3 to 8. Graphs of average daily discharge measured at the nearest upstream USGS gage that depict the fish collection and the deployment or retrieval of continuous water quality monitoring devices are on Figures 9-48 (Appendix 1A). Riverscape photography was used to characterize sampling sites and was provided in Plates 1 to 44 (Appendix 1B).

River Transects

Overall average wetted width at site transects was 257 m (880 ft), with Site 3 being the widest sampled (Table 2). Overall average depth at site transects was 0.45 m (1.5 ft). Site 1 was the deepest on average (0.52 m (1.7 ft)); however, Site 5 was the deepest (0.87 m (2.8 ft)) in April 2008, when stream discharge was measured over 100 cubic meters per second (m^3s^{-1}; 3010 cubic feet per second (ft^3s^{-1})). Overall average velocity at site transects was 0.53 m^3s^{-1} (1.75 ft^3s^{-1}). The swiftest velocity was measured at Site 1 during April 2008, and slowest was measured at Site 4 during July 2006, when the site had begun drying (Table 2). Low river discharge and river drying in July 2006 resulted in the low average depths and velocities at Site 4 to Site 6 (Table 2). Additionally, low river discharge in October 2007 also resulted in low average depth at Site 5 (Table 2).

Fish Collection

Up to 90 RGSM were collected during each sampling event, although we were unable to collect sufficient RGSM fish to conduct all fish health and pathogen analyses at some sites (Table 3). In total, 3,170 RGSM were collected in 957 successful seine hauls ranging from 1 to 56 RGSM per seine haul. Average catch (and standard deviation (SD)) was 3.3 ± 5.0 per seine haul. More RGSM were collected in Year 2 (1,932) than in Year 1 (1,238) and while more seine hauls were conducted in Year 2 (520), the catch rate was also better in Year 2 (3.5 ± 5.8) than Year 1 (2.8 ± 3.5) (Table 3). More RGSM were caught in summer (990) than in winter (752), and along the river's edge (36 percent) or in small channels (36 percent) than in the other habitat types sampled.

Water Quality during Fish Collection

All field water quality measurements were collected during the day only. Water quality measurements were collected only at 90 percent of the RGSM collections due to occasional equipment failures and data omissions. RGSM were collected in a wide range of water temperature (0.6 to 34.6 °C), dissolved oxygen (3.7 to 15.8 mg/L), pH (5.6-9.5) and specific conductivity (232-1,083 µS/cm) (Table 3 and 4). During RGSM capture, overall water temperatures measured were warmer (Kruskal-Wallis ANOVA, $H(1,896)=53.41$, $p<0.05$) during Year 1 (14.0 °C) than Year 2 (11.7 °C). There was a significant negative correlation (Kendall Tau = -0.13, $p<0.5$) between specific conductivity and the number of RGSM collected per seine haul in Year 2. We attributed

this relationship to the high catch rate of RGSM at Site 1 and Site 2 during Year 2 (Table 3). No other significant relationships were found between water quality measures and the number of RGSM captured during successful seine hauls.

Continuous Water Quality Monitoring

Over 30,000 observations of continuous water quality monitoring data are provided in Appendix 1C (Tables 5.1 to 5.82). As water quality data were collected night and day, we used these continuous water quality monitoring data to summarize the site conditions during this study. Water quality measured during the night was indicated in Appendix 1C by gray shading. Occasionally, continuous water quality monitoring devices were found smothered by sediment and were notated in Appendix 1C. Except as noted below, all water quality measures were censored from statistical analyses and interpretation whenever the oxygen saturation was less than 50 percent (a value we associated with the onset of sedimentation and fouling of the water quality monitoring devices). Summary statistics of these data for temperature, specific conductivity, pH, DO, and oxygen saturation by probe type, site and season are provided in Tables 6 to 10. Generally, temperatures were similar as measured by the different probe types, but DO was often lower when measured using a membrane-type sensors on the Sondes.

Temperature

The average water temperature for the Rio Grande during this study was 12.9°C with the range of average site temperatures falling between 2.6 °C in the winter and 26.0 °C in the summer (Table 6). Water temperatures showed the greatest variability in the summer and fall, and were least variable in the winter (Table 6). Site temperatures were colder in Year 2 (11.9±6.7°C) compared to Year 1(14.0±7.3°C) (Kruskal-Wallis $H(1, 30,104) = 872.7$ $p < 0.001$). In Year 1, Site 6 was significantly colder (11.7±8.5 °C) and Site 2 was significantly warmer (15.6±6.5 °C) in ranked temperatures than at the other sites (Kruskal-Wallis $H(5, 14,163) = 331.6$, $p < 0.001$). In Year 2, Site 1 (11.0±6.8 °C) and Site 6 (11.5±7.2 °C) were significantly colder than at Sites 2, 3, and 4, while Site 2 was significantly warmer (13.2±7.2 °C) in ranked temperatures than at the other sites (Kruskal-Wallis $H(5, 15,941) = 180.0$, $p < 0.001$). Site 1, the Rio Grande at Bernalillo, New Mexico, was generally the coldest site, on average, during spring, summer, and winter. Summer temperatures were highest at all sites, with temperatures greater than 38 °C on July 17, 2006, at Site 4, the Rio Grande at Los Lunas, New Mexico, during a period of river drying.

Specific Conductivity

The average specific conductivity for the Rio Grande during this study was 305 µS/cm with the range of average site conductivities falling between 171 and 605 µS/cm. Specific conductivity showed the greatest variability in Fall 2006 at Site 2 and Site 3, and was least variable at Site 1 (Table 7). Conductivity generally increased from upstream sites to downstream sites, and was greater at sites in Year 2 (329±113 µS/cm) compared to Year 1 (299±113 µS/cm) (Kruskal-Wallis $H(1,12,239) = 87.5$, $p < 0.001$).

pH

The overall site average pH of the Rio Grande was 8.2 with the range of average site pH falling between 7.7 and 8.8 (Table 8). The greatest variability in pH was at Site 1 (pH 7.7 to 9.2), and at Site 2 (pH 7.3 to 9.0) (Table 8). The pH was lowest at all sites during the summer, with the exception of Site 3. The least variable pH was measured at Site 3. The average pH (8.0) was generally the lowest at Site 3 compared to other sites measured (Table 8). Average pH was significantly higher (Kruskal-Wallis $H(1,13,978) = 155.6$, $p < 0.001$) at sites measured in Year 2 (8.3±0.3) compared with those in Year 1 (8.2±0.2).

Dissolved Oxygen (DO)

DO concentrations showed the greatest variation in the spring and least variation in the winter (Table 9). The average DO concentration for the Rio Grande during this study was 8.1 mg/L with the range of average site concentrations between 4.1 and 11.6 mg/L (Table 9). The highest DO concentrations were measured at Site 1 in January 2008. The lowest DO concentrations were measured at Site 6, in July 2006. Site 1 was at the highest elevation (of the sites measured) and had low water temperatures, and Site 6 was at the lowest elevation and had some of the highest water temperatures. A decreasing trend in DO from sites upstream (at lower atmospheric pressure and generally colder in temperature) to downstream sites would be expected (Benson and Krause 1980). DO concentrations were significantly and inversely correlated with temperature (Spearman Rank $r = -0.78$, $p<0.05$). We found that a linear relationship between temperature and DO concentration for the sites in the MRG that was best described by the equation: DO (mg/L) = 10.7798 - 0.2106 * Water Temperature (in Celsius). No additional analyses of these DO data were conducted as data were censored when continuous water quality monitoring probes were considered smothered with sediment (i.e., less than 50 percent oxygen saturation).

Oxygen Saturation

Oxygen saturation showed the greatest variation in the summer and least variation in the winter (Table 10). The average oxygen saturation for sites in MRG during this study was 89 percent with the range of average site concentrations between 87 and 94 percent (Table 10). The highest oxygen saturation was measured at Site 4, in July 2007. The lowest oxygen saturations were measured whenever sediment began to smother the oxygen probes of the water quality monitoring devices stationed at various sites. No additional analyses of these oxygen saturation data were conducted as the data were censored when continuous water quality monitoring probes were considered smothered with sediment (i.e., less than 50 percent oxygen saturation).

Ecosystem Respiration (ER)

The average 24-hr ER rate for sites on the MRG during this study was -18.2 grams of oxygen per square meter per day ($gO_2/m^2/day$) with the range of average site respiration

between -9.6 and -20.6 $gO_2/m^2/day$ (Table 11). For all sites, the highest average site respiration was during fall (-20.7 $gO_2/m^2/day$), and it was lowest during winter (-9.4 $gO_2/m^2/day$). Site 1 had the most variation in respiration rates (-15.7±22.5 $gO_2/m^2/day$). During both sample years, Site 1 and Site 6 had significantly lower respiration rates compared with other sites (Kruskal-Wallis H (5, 382) =29.5, $p<0.0001$).

Gross Primary Productivity (GPP)

No useable GPP data were available from several sites in Spring 2007 and Summer 2008 (Table 12). The average GPP for the Rio Grande during this study was 3.5 $gO_2/m^2/day$ with the range of average GPP between 1.8 and 4.8 $gO_2/m^2/day$ (Table 12). For all sites, the lowest average GPP was in spring (3.0±2.5 $gO_2/m^2/day$), and it was highest in summer (4.1±1.9 $gO_2/m^2/day$). Site 2 had the highest GPP (17.6 $gO_2/m^2/day$) and highest variation. Site 5 had the lowest average GPP (1.8 $gO_2/m^2/day$) and lowest variation. GPP for all sites was greater in Year 2 (4.4±3.0 $gO_2/m^2/day$) than in Year 1(2.5±1.9 $gO_2/m^2/day$) (Kruskal-Wallis H (1, 223)=39.3, $p <0.0001$).

PR Ratio

Odum (1956) used the ratio of GPP to ER (the PR ratio) to classify streams as heterotrophic or autotrophic. Streams are heterotrophic (organic matter is imported into the stream) if the PR ratio is less than 1, or autotrophic (organic matter is created in the stream from inorganic compounds and sunlight) if the PR ratio is greater than one.

The average PR ratio for sites on the MRG was 0.1 with average PR ratios for sites ranging from -0.5 at Site 6 to 1.9 at Site 1 (Table 13). For all sites, the lowest average PR ratio was in spring (-1.1), and was highest in winter (1.0). PR ratios were similar by sample year (Kruskal-Wallis H (1, 223) =2.2, $p =0.13$) and season (Kruskal-Wallis H (3, 223) =7.6, $p =0.06$). However, PR ratios were greater at Site 3 and Site 4 than Site 6 in Year 1 (Kruskal-Wallis H (5, 105) =16.6, $p =0.005$), and PR ratios were greater at Site 5 than Site 6 in Year 2 (Kruskal-Wallis H (5, 118) =12.4, $p =0.03$).

DISCUSSION

Temperature

Temperature affects the density of water, the solubility of its constituents (such as oxygen), pH, specific conductivity, the rate of chemical reactions, and biological activity in water (Radtke et al. 2003). Both RGSM hatching and larval development are affected by high temperatures (Platania 2000). Oxygen saturation is also decreased by higher temperatures. During low flows, flow tends to be more stable with reduced stream power, and conditions in pool habitats that have near zero velocity are often more pronounced and have an elevated heating capacity (Service 1994, 2003). Small changes in water temperature are known to have considerable effects on freshwater fishes by affecting a variety of life history, behavioral, and physiological aspects (Morgan et al. 2001; Carveth et al. 2006). Alterations in the temperature regime from natural background conditions negatively affect population viability, when considered at the scale of the watershed or individual stream (McCullough 1999).

Buhl (2007) reported the median 24-hr lethal temperature for 90-day post-hatch RGSM was 36.1°C. Temperatures in excess of this median lethal temperature (up to 38.4°C) were observed 27 times during July 17 to 20, 2006, at Site 4. Temperatures were observed 10 times (up to 37.0 °C) on July 19, 2006, at Site 6. Low flows were reported at both of these sites (Table 2). However, RGSM were found at both sites (some were collected for health assessments and they were found in poor condition; Woodland 2012; Papoulias et al. 2009; Davis and Lusk 2012). The relationship between water temperature measured near the deepest flow (thalweg) and the temperature at the edges where the water is shallow is uncertain. Both Abeyta and Lusk (2004a) and SWCA (2010) have described water temperatures at the river's edge, as measured along transects, or in backwaters and side channel habitats as varying widely (0 to 14 °C) from water temperatures measured near the area of deepest stream flow. While we would expect that water temperatures in edge habitats near those where we measured elevated water temperatures may have been higher than 36.1°C for some period of time. There was not enough information to predict the range of water temperatures in the edge habitats of a river near our measurements of water temperature at the river's thalweg.

The temperature criterion for the main stem of the Rio Grande near these sites is 32.2 °C or less, in any single sample (NMWQCC 2000). Temperatures measured exceeded the 32.2 °C temperature criteria 93 times at Site 2 and 51 times at Site 6 during summer 2006. There are exceptions to the water temperature criterion that include "unusually high ambient air temperatures" (20.6.4.13.I. NMAC) or "when changes in temperature . . . are attributable to . . . the reasonable operation of irrigation and flood control facilities that are not subject to federal or state water pollution control permitting" (20.6.4.11.I.(2) NMAC). In July 2006, the maximum daily ambient air temperature was 40 °C and was not considered unusually high (http://weather-warehouse.com/WeatherHistory/PastWeatherData_BosqueDelApache_Socorro_NM_July.html). Additionally, the effect of operations of the Isleta Diversion Dam (an irrigation

facility) on Site 2 or downstream of the operations of the San Acacia Diversion Dam (an irrigation facility) on Site 6 water temperatures have not been assessed. If the reasonable operation of these irrigation facilities contributed toward water temperatures in excess of the lethal levels observed at these two sites, then exceptions to the temperature criteria in the New Mexico water quality standards might not be protective of RGSM.

Specific Conductivity

Electrical conductivity is a measure of the capacity of water to conduct an electrical current and is a function of the types and quantities of dissolved substances in water (Radtke et al. 2005). As concentrations of dissolved ions increase, specific conductivity of the water also increases. Electrical conductivity measurements can be used to estimate total dissolved solids (TDS) in water by multiplying specific conductivity by 0.584 and adding 22.1 (USDI 1998).

A pulse of water with high conductivity was measured at Site 2 (1,027 µS/cm; compared with the average with this site of 250 µS/cm), and at Site 3 (974 µS/cm versus the average for this site of 332 µS/cm) on October 10, 2006 (Figure 49). The daily discharge reported for the Rio Grande at San Felipe (USGS Gage 08319000), the Jemez River (USGS Gage 08329000), and the North Diversion Channel (USGS Gage 08329900) (Figure 4.2.5.3; Appendix 1B), had all increased during this time period suggesting their contributions influenced the specific conductivity measure at Site 2 during those days. The pulse of high conductivity water travelled approximately 40 km (25 mi) at a rate of over 1.3 ms^{-1} (3 mi hr^{-1}) as peak conductivity was measured at 2 p.m. on October 10, 2006, at Site 2, and 8 hr later at Site 3. Elevated conductivity was then measured for several days thereafter (Figure 49).

Just prior to this peak in conductivity, a low conductivity pulse was also measured and was associated with colder water temperatures (Table 5.10; Appendix 1C). Precipitation, because of its high content of carbon dioxide, normally has a low pH and low mineral content (Hynes 1970). During this time period, precipitation was reported at the Albuquerque International Airport in 2006 on October 7 (1.0 mm), October 8 (3.3 mm), and October 9 (31.2 mm) (NOAA 2006) during the period the low conductivity pulse was measured. Precipitation was also reported in the foothills east of Albuquerque in 2006 on October 8 (2.5 mm), October 9 (14.7 mm), and October 10 (25.4 mm) (NOAA 2006). Precipitation was only reported at the Jemez Dam in 2006 on October 10 (35.6 mm) (NOAA 2006). In response to heavy precipitation, a large amount of stormwater with a low mineral content can directly enter a river without have reached equilibrium with soils, whereas, after exposure to soils over time, stormwater runoff is likely to increase in TDS content (and neutralize the pH) as water passes over and percolates through the soil and dissolves calcium ions and other mineral salts. Therefore, we identified the stormwater runoff through the North Diversion Channel by the initial pulse of cold-water temperature with low conductivity. Following that pulse, the Jemez River, with its elevated conductivity, appeared to have contributed to the conductivity that we measured at Site 2 in October 2006. Pulses of elevated conductivity have been occasionally reported in the Rio Grande below San Marcial, New Mexico, by Hem (1992) and Moore

and Anderholm (2002). Variations in conductivity measured in the Rio Grande have also been associated with stormwater discharges from the Albuquerque metropolitan area by way of the North Diversion Channel (Kelly and Romero 2003; Kelly et al. 2006).

The median conductivity of 250 µS/cm at Site 2 would equate to approximately 168 mg/L TDS, whereas the peak pulse of conductivity measured at Site 2 on October 10, 2006, at 1,027 µS/cm, would approximate a TDS of approximately 622 mg/L. A TDS of 622 mg/L was not considered toxic to fish (USDI 1998). Toxicity due to TDS can result from disruption of organisms' osmotic regulation processes, decreases in bioavailability of essential elements, increases in availability of heavy metal ions, increases in particularly harmful ions, changes in ionic composition, absence of chemical constituents that offset impacts of harmful ions, a combination of the above, or other as yet unknown mechanisms (U.S. Environmental Protection Agency (USEPA) 2010). Increased TDS tends to cause shifts in aquatic community composition rather than acute mortality (USEPA 2010).

Information on toxicity of salinity or TDS on RGSM is generally lacking, presenting a substantial gap in predicting effects. Hoagstrom (2009) described the extirpation of RGSM from portions of the Pecos River with average TDS greater than 4,400 to 10,700 mg/L. Ostrand and Wilde (2001) described concentrations of salinity lethal to 50 percent of a population of plains minnow (*Hybognathus placitus*) as high as 16,000 ± 1,940 mg/L). However, Hoagstrom et al. (2010) described plains minnow as generally more environmentally tolerant than RGSM. Additionally, Cowley et al. (2009) reported that four ‘practical salinity units’ were lethal to approximately 50 percent of RGSM eggs. However, the use of a practical salinity scale by Cowley et al. (2009), does not result in salinity units that are basic to the fields of chemistry and physics, and therefore, cannot be easily interpreted or compared to other sites with conductivity measurements or TDS in units of milligrams solute per liter without additional information on ion composition (United National Educational, Scientific and Cultural Organization 1981, 1985).

The composition of the ions that make up TDS (e.g., sodium, calcium, potassium, sulfate, and other common ions) can make substantial differences in toxicity to fish and invertebrates (Mount et al. 1997; Soucek et al. 2011). For example, Mount et al. (1997) identified the range of sodium chloride (NaCl) concentrations in 48 hr that were lethal to 50 percent of fathead minnows was 6,090 to 7,070 mg/L, and to its invertebrate prey (*Daphnia magna*), which ranged from 3,790 to 5,740 mg/L. Whereas the range of sodium chloride and sodium bicarbonate mixtures that were lethal to 50 percent of fathead minnows was 2,330 to 5,250 mg/L, and to its invertebrate prey, ranged from 2,830 to 3,080 mg/L. Using these toxicity results, the average ratio of fathead minnow-to-invertebrate toxicity test results was 1.35. This suggests that mixtures of different ions can be additive in their toxicity to fish and their prey. Therefore, estimates of acute toxicity to 50 percent of a test species, or using single ions, may not be adequate to characterize the long-term effects of TDS to RGSM and additional study is warranted.

Soucek et al. (2011) described the acute toxicity of TDS to invertebrates (*Ceriodaphnia dubia*) based on a relationship with hardness. Using the Soucek et al (2011) TDS toxicity

relationship, and an average hardness of 141 mg/L in the Rio Grande at Isleta (Buhl 2002), we calculated the average TDS acutely lethal to 50 percent of invertebrates at 9,160 mg/L. Then, using an acute-to-chronic ratio for chlorides to invertebrates of 3.187 (Stephan 2009), and a safety factor of two to account for mixtures (above), we determined that the average chronic toxicity of TDS to invertebrates would be 1,437 mg/L. Assuming the ratio of fathead minnow-to-invertebrates of 1.35 was valid for extrapolating from this invertebrate toxicity estimate, then the average chronic toxicity of TDS to fathead minnow would begin above 1,940 mg/L. Therefore, assuming these relationships are an appropriate surrogate effects analysis for RGSM, then the pulse of TDS of approximately 622 mg/L at Site 2, on October 10, 2006, did not appear to adversely affect fathead minnow (1,940 mg/L), or exceed the monthly average TDS criterion of 1,500 mg/L in the MRG (20.6.4.105 NMAC).

pH

The pH is a measure of the concentration of hydrogen ions in the water. More specifically, pH is a measure that represents the negative base-10 logarithm of hydrogen-ion activity of a solution, in moles per liter (Radtke et al. 2003). Solutions having a pH below 7 are described as acidic, and solutions with a pH greater than 7 are described as basic or alkaline. Plant photosynthesis has also been indicated in raising pH, either by removing calcium content or by increasing activity of hydroxyl ions (Hynes 1970).

Elevated pH was measured at Site 1 and occurred every night between 6:30 p.m. and 6 a.m., during January 26 to January 31, 2008. Elevated pH was most frequently observed on January 27, 2008 and was its highest (pH 9.2) at 1:30 a.m. (Appendix 1C, Table 5.52). That pH increased only during nighttime was unusual, as ER activities (at night) can often release carbon dioxide, which tends to decrease pH, whereas increased primary productivity can increase the hydroxyl ions, which tends to increase pH (Hem 1992). The elevated pH observed at Site 1 occurred when DO concentrations were at their highest during the day. The reason for elevated pH measured at Site 1 during winter is unknown.

Elevated pH was also measured at Site 2 on October 9, 2006, during stormwater runoff that corresponded to the pulse of low conductivity water from the North Diversion Channel, just prior to a peak of elevated conductivity from the Jemez River (described above; Figure 49). The sudden inflow of stormwater to Site 2 in October 2006, may have affected the equilibria of both pH and conductivity in the water column. It is also possible that stormwater runoff (initial pulses of rainwater with low conductivity) did not have the buffering capacity to moderate the changes in pH during these events. Elevated pH measured at Site 2, in October 2006, was not also associated with an increase in DO.

The pH was lowest at all sites during the summer, with the exception of Site 3. The average pH (8.0) was generally the lowest at Site 3 compared to other sites measured. Passell et al. (2001, 2007) also reported that average pH was lowest (7.9) in the Rio Grande at Isleta, New Mexico (just downstream of Site 3) compared to other sites they measured. Wilcox (1997) and Passell et al. (2001, 2007) attributed the drop in pH at the

Rio Grande near Isleta, to the contribution of the treated sewage (which had a lower pH < 7.8) discharged from the Southside Water Reclamation Facility near Albuquerque.

The pH water quality criterion for the main stem Rio Grande in this area (Segments 20.6.105 and 20.6.106 NMAC) is "pH within the range of 6.6 to 9.0 or less, in any single sample." Exceedances of this pH criterion were observed 117 times, mainly at night Site 1, during the night in January 2008. Many biological effects to pH changes are often associated with acidic conditions (pH < 7; see Thurston et al. 1979). However, elevated pH can also cause direct physical damage to fish skin, gills and eyes, and an inability of fish to excrete metabolic wastes (especially when elevated pH occurs in conjunction with exposure to ammonia), or death (Calabrese 1969, Thurston et al. 1979; USEPA 1995). However, some fish species (other than RGSM) have survived over six months at an elevated pH (greater than pH 9, but less than pH 9.5; McCarraher and Thomas 1968; Table 1). McCarraher and Thomas (1968, Table 2) reported that fish exposed to pH 9.2 or greater survived less than six months. Research would be necessary to determine if elevated pH measured in the Rio Grande is associated with adverse effects to RGSM.

Oxygen Saturation and DO

Oxygen is essential to all aerobic aquatic organisms (Davis 1975; BCME 1997). Oxygen solubility, or the amount of DO in the water column is governed by many factors including atmospheric and hydrostatic pressure, temperature, turbulence, salinity, turbulence, groundwater upwelling, ice cover, and biological processes such as the oxygen byproducts of photosynthesis by aquatic plants (Odum 1956; Benson and Krause 1980; Bott 1996; Wagner et al. 2006). The capacity of water to hold oxygen in solution is inversely proportional to the water temperature (Benson and Krause 1980). Increased water temperature lowers the concentration of DO at saturation. Saturation is the maximum quantity of DO that water, in equilibrium with the atmosphere, can contain at a given temperature and pressure (i.e., based on the elevation of the water body). As a result, even when DO decreases as water temperature increases, and increases with increased atmospheric pressure, relative oxygen saturation can be compared more easily across sites and seasons.

DO may also be depleted by oxidation reactions or by biological and chemical processes that also contain dissolved, suspended, or precipitated organic matter or by other oxygen-demanding substances (Odum 1956; Hem 1992; Bott 1996). Diurnal fluctuations in DO concentrations can result from photosynthesis in excess of respiration as a source of oxygen during the day. At night, when photosynthesis ceases, respiration continues to consume oxygen and reduces the DO concentrations in the water column (Ignjatovic 1968; Bott 1996). Oxygen depletion is usually associated with excessive temperature, heavy growth of aquatic plants, algal blooms, or high concentrations of organic matter and nutrients (USEPA 1995). Oxygen depletions in the MRG have been associated with stormwater discharges from tributaries and urban areas, and floodplains inundation with high concentrations of organic matter (Abeyta and Lusk 2004b; Valett et al. 2005; Van Horn 2008; DBS&A 2009, Service 2011).

Fish may compensate for low DO conditions by behavioral responses, such as increased use of aquatic surface respiration, changes in activity level or habitat use, and reflexive avoidance behaviors, though these activities are known to come at a higher energy cost (Davis 1975; Kramer 1987; BCME 1997). Below some threshold oxygen saturation, fish will be expending energy to maintain homeostasis and some degree of physiological stress will occur (Davis 1975; Heath 1995). Ventilation rates are often increased, reduced feeding and movement activity are decreased and increased glycolysis and cortisol release can be induced even by short-term low DO conditions (Kramer 1987; Heath 1995; BCME 1997). Additionally, low DO conditions may also cause a wide range of chronic effects and behavioral responses in fish (Downing and Merkens 1957; Hughes 1973; Kramer 1987; Breitburg 1992). For example, chronic toxic effects have been reported in fish at concentrations that range from four to seven times those concentrations reported lethal the 50 percent of a test population (Davis 1975; Matthews and Hill 1977; Matthews and Maness 1979; USEPA 1995; Balfour 2000).

Buhl (2007, 2011) reported 50 percent mortality of a test population of adult RGSM exposed to water containing DO from 0.8 mg/L (6.7 to 13.2 percent oxygen saturation) for a 3-hr exposure without allowing RGSM to access the water surface (and respiring the thin layer of DO at the air-water interface). Buhl (2011) reported that the highest DO concentration observed without acute mortality to larval RGSM (i.e., those that had no access to the water surface) was 2.4 mg/L (i.e., 29.8 percent saturation). Buhl (2011) reported that the highest DO concentration observed without acute mortality to adult RGSM (i.e., those that had no surface access) was 4.4 mg/L (54.3 percent saturation).

We assumed that RGSM in water of DO less than or equal to 4.4 mg/L (i.e., 54.3 percent saturation), will begin to experience adverse effects such as changes in ventilation rates, increased surface water respiration, lack of feeding activity, metabolism changes, increased risk of predation (due to fish condition or position), and some (approximately 10 percent, see Buhl 2011) will begin to experience mortality. We also assumed that DO concentrations at or below 2.4 mg/L (29.8 percent oxygen saturation) are lethal to larval RGSM. As temperature and pressure, as well as other factors (above) can affect the solubility of DO in water, in the MRG (as compared to the temperature and pressure reported by Buhl 2011); we used oxygen saturation values (of 29.8 and 54.3 percent respectively) to describe the onset of acute adverse effects to larval and adult RGSM. Therefore, oxygen saturations (i.e., censored values) we measured at MRG sites were less than 54.3 percent saturation (adult RGSM adverse effect level) for approximately 67 days (17.9 percent of the time) and less than 29.8 percent saturation (larval RGSM adverse effect level) for approximately 33 days (8.8 percent of the time) in cumulative duration during the 374 days of continuous monitoring during 2006 to 2008. However, it is possible, that even though we used only censored oxygen saturation data, that some of the low oxygen saturation values measured were nonetheless associated with the *onset* of sediment fouling of the oxygen sensors. Sediment as oxygen demand is described below.

The majority of low oxygen saturation measurements were observed in spring (38 percent), during high runoff events and they occurred least in winter (8 percent). We also compared our daily oxygen saturation values with the average daily discharge as

measured by USGS (at the nearest gages), and found a significant linear relationship, that being: lnDischarge (in cubic feet per second) = 106.7004 - 1.3797*oxygen saturation ($F(1,77)=5.6$, $r=-0.26$, $p=0.02$). This suggested that higher flow events tended to reduce oxygen saturation measured at these sites, perhaps through the suspension of sediment in the water column. Kreutzberger et al. (1980) reported that low DO in the Milwaukee River was attributable to sediment oxygen demand (SOD) churned up by stormwater discharges that scoured sediment into the water column.

Veenstra and Nolen (1991) also noted that sediment can play an important role in the rate of oxygen depletion in the water column by providing oxygen demand from recalcitrant compounds (e.g., iron, manganese, ammonia, sulfides, etc.) as well as particulate organic matter (e.g., algae, bacteria, debris, etc.) and other sources of organic matter that decompose and oxidize. Buhl (2005) reported chemical oxygen demand in sediment collected from a stormwater inlet at 2100 mg/kg (wet weight) and in sediment from the MRG at 760 mg/kg (wet weight). Sources of SOD can include erosion from stream banks and sediment resuspended with increased flow (Fillos and Molof 1972; Kreutzberger et al. 1980; Wang 1980; Walker and Snodgrass 1986, Caldwell and Doyle 1995). Precipitation events of sufficient intensity can result in increased turbidity and increased input of SOD and other oxygen demanding substances (Huggins and Anderson 2005). In the MRG, increased velocity and scouring can disturb or smother sessile organisms (algae, bacteria, some invertebrates; SWCA Environmental Consultants 2007), and increase turbidity, which can shade light levels and reduce algal production (Bixby and Burdett 2009). Other indicators of low DO conditions in the MRG were the high percentage of fly larvae and worms (two year combined average of 81 percent; SWCA Environmental Consultants 2007). Low DO conditions can also release ammonia from organic matter, which can reduce habitat quality for fish and their prey (Merkens and Downing 1957; Fillos and Molof 1972; Thurston et al. 1981; Caldwell and Doyle 1995). Plummer et al. (2004) indicated that groundwater in alluvial sediment below the MRG from Cochiti Reservoir towards La Joya, New Mexico, had DO at 0.5 mg/L. Therefore, groundwater upwelling or erosion of alluvial sediment containing anoxic groundwater could also be sources of low DO in the MRG. SOD appears to be factor in observation of low DO conditions observed in the MRG in this study. However, it is unclear how the variation in water and sediment discharges and SOD inputs are affected by high and low flows, poor land management, flooding, drought, or other activities in the MRG Basin (Graf 1994; Scurlock 1998; Julien et al. 2005; Massong et al. 2007). Moderate to large changes in any one of these factors as a result of a single or multiple events that can affect the oxygen saturation level in the MRG and affect RGSM.

The State of New Mexico dissolved oxygen criterion for this portion of MRG (Segments 20.6.105 and 20.6.106 NMAC) is expressed as mass per volume units (mg/L) in tables based on elevation and temperature (20.6.4.900.N.1). NMED (2009) provided additional criteria guidance based on the instantaneous percent oxygen saturation for warm waters, such as the Rio Grande at a minimum of 75 percent saturation. Using our censored oxygen saturation values, fifteen percent ($n=4,394$) of our observations at all sites exceed this criterion with 25 percent occurring in summer and 5 percent occurring in winter.

GPP, ER, and PR Ratio

A wide range of ER was observed, and average GPP and PR ratios were generally low. The average PR ratio for sites on the MRG was 0.1, with only 3 sites (Site 1, Site 3, and Site 4) having PR ratios greater than 1 in Year 1, and 2 sites (Site 1 and Site 2) having PR ratios greater than 1 in Year 2. Odum (1956) suggested that rivers with PR ratios less than 1 were heterotrophic and may have little free energy available in organic matter to build large populations of fish and other aquatic organisms. Average PR ratios greater than 1 occurred most during winter (at Sites 1 to 3) when ER was low. On average, ER was five times greater than average GPP, suggesting that the major sources of carbon in the MRG likely come from terrestrial plants in the watershed and not from aquatic plants.

Duffer and Dorris (1966) reported that ER exceeded GPP in a sandbed river in Oklahoma and suggested that the substrate provided less opportunity for benthic producers. Houser et al. (2005) identified that watershed disturbance (i.e., erosion) as negatively affecting ER but not GPP. It is possible that sites with fine sediment are less stable than those with coarse sediment and are more easily mobilized along the bottom and suspended in the water column. Algae associated with sediment can be physically scoured, often damaged and are transported downstream, thus limiting algal growth and production at a particular stream site or reach. Sharp changes in discharge and velocity may have directly or indirectly affected DO, GPP and ER rates, and PR ratios in the MRG, thereby reducing its potential productivity and subsequently its populations of fish, including RGSM.

Summary

The most common degraded water quality condition in the MRG was low oxygen content, likely associated with oxygen demand in sediment. Increasing primary productivity and thereby increasing oxygen saturation could decrease oxygen demand and therefore, ER. Increased oxygen and GPP (e.g., through enhancement of productive aquatic habitats), and reduced SOD (e.g., through erosion control measures) would likely result in increased fish growth and distribution, increased species richness of benthic invertebrates (Odum 1956; Hynes 1970; Davis 1975; Breitburg 1992; Barfour 2000; USEPA 1995, 2010), and decreased chronic stress reported in RGSM (Sykes 2003; Abeyta and Lusk 2004a; Papoulias et al. 2009; Davis and Lusk 2012).

LITERATURE CITED

Abeyta, C. G., and J. D. Lusk. 2004a. Hydrologic and biologic data for the water-quality assessment in relation to Rio Grande silvery minnow habitats, Middle Rio Grande, New Mexico, 2002-2003. U.S. Fish and Wildlife Service. New Mexico Ecological Services Field Office, Albuquerque, New Mexico. http://www.middleriogrande.com/LinkClick.aspx?fileticket=2q3NVvv0wG0%3D&tabid=272&mid=676. Accessed April 28, 2011.

Abeyta, C. G., and J. D. Lusk. 2004b. A water-quality assessment in relation to Rio Grande silvery minnow habitats in the Middle Rio Grande, New Mexico, December 7, 2004. Presentation to the Middle Rio Grande Endangered Species Act Collaborative Program Advisory Panel Workshop. http://www.middleriogrande.com/LinkClick.aspx?fileticket=rgg72DuHkPs%3d&tabid=216&mid=554. Accessed April 28, 2011.

Adams, S. M., A. M. Brown, and R. W. Goede. 1993. A quantitative health assessment index for rapid evaluation of fish condition in the field. Transactions of the American Fisheries Society 122:63-73.

Anderson, D. 1990. Immunological indicators: effects of environmental stress on immune protection and disease outbreaks. American Fisheries Society Symposium 8:38-50.

Balfour, D. L. 2000. Ontogenetic changes and environmental hypoxia: responses of two fish speceies to low oxygen concentrations at early life stages. Virginia Polytechnic Institute and State University Dissertation, Blacksburg, Virginia.

Benson, B. B., and D. Krause. 1980. The concentration and isotopic fractionation of gases dissolved in freshwater in equilibrium with the atmosphere. 1. Oxygen. Limnology and Oceanography 25:662-671.

Bixby, R., and A. Burdett. 2009. Effects of nutrient availability on periphyton growth and diversity in the Middle Rio Grande: top-down and bottom up factors. Annual Report 2007-2008. University of New Mexico, Albuquerque, New Mexico. http://www.middleriogrande.com/LinkClick.aspx?fileticket=aoRNvRt%2FM%2Bw%3D&tabid=272&mid=678. Accessed April 27, 2011.

BOR (U.S. Bureau of Reclamation). 2005. Middle Rio Grande Endangered Species Act Collaborative Program Request for Proposals (RFP), Science (Research and Monitoring) 06-SF-40-2452. U.S. Bureau of Reclamation, Salt Lake City, Utah.

Bott, T. 1996. Primary productivity and community respiration. Pages 533-556 in R. Hauer and G. Laberti, editors, Methods in Stream Ecology. Academic Press, New York, New York.

Breitburg, D. L. 1992. Episodic hypoxia in Chesapeake Bay: interacting effects of recruitment, behavior, and physical disturbance. Ecological Monographs 62:525–546.

British Columbia Ministry of the Environment (BCME). 1997. Water Quality: Ambient water quality criteria for dissolved oxygen. Technical Appendix. Government of British Columbia, British Columbia, Canada. http://www.env.gov.bc.ca/wat/wq/BCguidelines/do/index.html. Accessed April 28, 2011.

Buhl, K. 2002. The relative toxicity of inorganic contaminants to the Rio Grande silvery minnow (*Hybognathus amarus*) and fathead minnow (*Pimephales promelas*) in a water quality simulating that in the Rio Grande, New Mexico. United States Geological Survey Report, Yankton, South Dakota.

Buhl, K. J. 2005. Preliminary results of the on-site acute toxicity test with stormwater and Rio Grande silvery minnow. U.S. Geological Survey, Columbia Environmental Research Center, Yankton, South Dakota.

Buhl, K. J. 2007. Toxicity of adverse water quality conditions to Rio Grande silvery minnow. Presentation, U.S. Geological Survey, Columbia Environmental Research Center, Yankton Field Research Station, Yankton, South Dakota.

Buhl, K. J. 2011. Preliminary results of studies on the relative tolerance of Rio Grande silvery minnows to low dissolved oxygen concentrations. In-house working draft, March 2011. U.S. Geological Survey, Columbia Environmental Research Center, Yankton Field Research Station, Yankton, South Dakota.

Calabrese, A. 1969. Effects of acids and alkalies on survival of bluegills and largemouth bass. U.S. Bureau of Sport Fisheries and Wildlife Technical Paper 42, Washington, DC.

Caldwell, J. M., and M. C. Doyle. 1995 Sediment oxygen demand in the lower Willamette River, Oregon, 1994. USGS Water-Resources Investigations Report 95-4196, Portland, Oregon.

Carveth, C. J., A. M. Widmer and S. A. Bonar. 2006. Comparison of upper thermal tolerances of native and nonnative fishes in Arizona. Transaction of the American Fisheries Society 135:1433–1440.

Cook, B. A. 2011 Spatial and temporal variation of $\delta^{15}N$ and $\delta^{13}C$ isotopes in the Rio Grande silvery minnow (*Hybognathus amarus*). U.S. Geological Survey, New Mexico Cooperative Fish and Wildlife Research Unit, Las Cruces, New Mexico.

Cowley, D. E., J. C. Alleman., R. Sallenave, R. R. McShane, and P. D. Shirey. 2009. Effects of salinity on specific gravity and viability of eggs of a North American minnow (Cyprinidae). Scientia Marina 73S1:45-58 (Barcelona, Spain).

Daniel B. Stevens & Associates, Inc. (DBS&A). 2009. Investigation of dissolved oxygen in the North Diversion Channel, Embayment, and Rio Grande. Albuquerque Metropolitan Arroyo Flood Control Authority, Albuquerque, New Mexico.

Davis, J. C. 1975. Minimal dissolved oxygen requirements of aquatic life with emphasis on Canadian species: A review. Journal of the Fishery Research Board of Canada 32:2295-2332.

Davis, A. P. and J. D. Lusk. 2012. Evaluation of the Rio Grande silvery minnow health in relation to changes in water quality, pathogens and other environmental stressors: A fish health assessment. U.S. Fish and Wildlife Service, New Mexico Ecological Services, Albuquerque, New Mexico.

Downing, K. M., and J. C. Merkens. 1957. The influence of temperature on the survival of several species of fish in low tensions of dissolved oxygen. Annals of Applied Biology 45:261–267.

Duffer, W. R., and T. C. Dorris. 1966. Primary productivity in a southern Great Plains stream. Limnology and Oceanography 11:143-151.

Fillos, J., and A. H. Molof. 1972. Effect of benthal deposits on oxygen and nutrient economy of flowing waters. Journal of the Water Pollution and Control Federation 44:644–662.

Graf, W. L. 1994. Plutonium and the Rio Grande: environmental change and contamination in the nuclear age. Oxford University Press, New York, New York.

Heath, A.G. 1995. Water Pollution and Fish Physiology, Second Edition. CRC Press, Inc., Boca Raton, Florida.

Hem, J. D. 1992. Study and interpretation of the chemical characteristics of natural water. U.S. Geological Survey Water-Supply Paper 2254, Washington, D.C.

Hoagstrom, C. W. 2009. Causes and impacts of salinization in the lower Pecos River. Great Plains Research 19:27-44.

Hoagstrom, C. W., N. D. Zymonas, S. Davenport, D. L. Propst, and J. E. Brooks. 2010. Rapid species replacements between fishes of the North American plains: a case history from the Pecos River. Aquatic Invasions 5:141-153.

Houser, J. N., P. J. Mulholland, and K. O. Maloney. 2005. Catchment disturbance and stream metabolism: patterns in ecosystem respiration and gross primary productivity along a gradient of upland soil and vegetation disturbance. Journal of the North American Benthological Society 24:538-552.

Huggins, D., and J. Anderson. 2005. Dissolved oxygen fluctuation regimes in streams of the Western Corn Belt Plains Ecoregion. University of Kansas, Central Plains Center for Bioassessment, Report No. 130, Lawrence, Kansas. http://www.cpcb.ku.edu/datalibrary/assets/library/KBSreports/KBSRept130_DO.pdf. Accessed April 28, 2011.

Hughes, G. M. 1973. Respiratory responses to hypoxia in fish. American Zoologist 13:475–489.

Hynes, H. B. N. 1970. The Ecology of Running Waters. University of Toronto Press, Toronto, Ontario.

Ignjatovic, L. R. 1968. Effect of photosynthesis on oxygen saturation. Journal of the Water Pollution Control Federation 40:R151–R161.

Julien, P., R. Gigi, and J. Albert. 2005. Stream restoration and environmental river mechanics. International Journal of River Basin Management 3:191–202.

Kelly, T., and O. Romero. 2003. Rainfall, runoff, and water-quality data for the urban storm-water program in the Albuquerque, New Mexico, metropolitan area, Water Year 2001. U.S. Geological Survey, Open-File Report 03-169, Albuquerque, New Mexico. http://pubs.usgs.gov/of/2003/ofr03-169/. Accessed April 28, 2011.

Kelly, T., O. Romero, and M. Jimenez. 2006. Rainfall, runoff, and water-quality data for the urban storm-water program in the Albuquerque, New Mexico, metropolitan area, water year 2004. Open-File Report 2006-1105. U.S. Geological Survey, Albuquerque, New Mexico. http://pubs.usgs.gov/of/2006/1105/. Accessed April 28, 2011.

Kramer, D. L. 1987. Dissolved oxygen and fish behavior. Environmental Biology of Fishes 18:81–92.

Kreutzberger, W. A., R. A. Race, T. L. Meinholz, M. Harper and J. Ibach. 1980. Impact of sediments on dissolved oxygen concentrations following combined sewer overflows. Journal of the Water Pollution Control Federation 52:192–201.

Langman, J.B., and S.K. Anderholm. 2004. Effects of reservoir installation, San Juan-Chama Project water, and reservoir operations on streamflow and water quality in the Rio Chama and Rio Grande, Northern and Central New Mexico, 1938-2000. USGS Scientific Investigations Report 2004-5188, Albuquerque, New Mexico.

Lusk, J. D. 2012. Chapter 3: Chemical Residues in Rio Grande Silvery Minnows collected from the Middle Rio Grande, New Mexico, 2006-2008. U.S. Fish and Wildlife Service Draft Report, Albuquerque, New Mexico.

Massong, T., P. Makar, and T. Bauer. 2007. Geomorphic summary of the Middle Rio Grande: Velarde to Caballo. U.S. Bureau of Reclamation, Albuquerque, New Mexico. http://www.middleriogrande.com/LinkClick.aspx?fileticket=LQ6pzOneklU%3D&tabid=467&mid=1132. Accessed April 28, 2011.

Matthews, W. J., and L. G. Hill. 1977. Tolerance of the red shiner, *Notropis lutrensis* (Cyprinidae) to environmental parameters. The Southwestern Naturalist 22:89-98.

Matthews, W. J., and J. D. Maness. 1979. Critical thermal maxima, oxygen tolerances and success of cyprinid fishes in a Southwestern river. American Midland Naturalist 102:374-377.

Mayden, R. L., B. M. Burr, L. M. Page, and R. R. Miller. 1992. The native freshwater fishes of North America. Pages 827-863 in: R.L. Mayden (editor), Systematics, Historical Ecology, and North American Freshwater Fishes. Stanford University Press, Stanford, California.

McCarraher, D. B., and R. Thomas. 1968. Some ecological observations on the fathead minnow, Pimephales promelas, in the alkaline waters of Nebraska. Transactions of the American Fisheries Society 97: 52-55.

McCullough, D. A. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to Chinook salmon. EPA 910-R-99-010. U.S. Environmental Protection Agency. Seattle, Washington. http://www.critfc.org/tech/EPAreport.pdf. Accessed January 21, 2011.

Merkens, J. C., and K. M. Downing. 1957. The effect of tension of dissolved oxygen on the toxicity of un-ionized ammonia to several species of fish. Annals of Applied Biology 45:521–527.

Mills, S. K. 2003. Quantifying salinization of the Rio Grande using environmental tracers. New Mexico Institute of Mining and Technology Master's Thesis, Socorro, New Mexico.

Moore, S. J., and S.K. Anderholm. 2002. Spatial and Temporal Variations in Streamflow, Dissolved Solids, Nutrients, and Suspended Sediment in the Rio Grande Valley Study Unit, Colorado, New Mexico, and Texas, 1993-95. U.S. Geological Survey Water-Resources Investigations Report 02-4224, Albuquerque, New Mexico.

Morgan, I. J., D. G. McDonald, and C. M. Wood. 2001. The cost of living for freshwater fish in a warmer, more polluted world. Global Change Biology 7:345–355.

Mount, D. R., D. D. Gully, J. R. Hockett, T.D. Garrison, and J. M. Evans. 1997. Statistical models to predict the toxicity of major ions to *Ceriodaphnia dubia*, *Daphnia magna* and *Pimephales promelas* (fathead minnows). Environmental Toxicology and Chemistry 16:2009-2019.

Munson, B.H., R. Axler, C. Hagley, G. Host, G. Merrick, and C. Richards. 2004. Understanding: Water Quality: Parameters Dissolved Oxygen-Why is it important? Webpage in Water on the Web - Monitoring Minnesota Lakes on the Internet and Training Water Science Technicians for the Future - A National On-line Curriculum using Advanced Technologies and Real-Time Data. University of Minnesota-Duluth, Duluth, Minnesota. http://www.waterontheweb.org/under/waterquality/oxygen.html

NMED (New Mexico Environment Department). 2002. Middle Rio Grande Total Maximum Daily Load (TMDL) for Fecal Coliform. NMED Surface Water Quality Bureau, Santa Fe, New Mexico.

NMED (New Mexico Environment Department). 2009. Water quality monitoring of the Middle Rio Grande, Annual baseline condition and trends of key water quality parameters, October 2006-July 2008. New Mexico Environment Department, Surface Water Quality Bureau Final Report, Santa Fe, New Mexico. ftp://ftp.nmenv.state.nm.us/www/swqb/MAS/Surveys/MiddleRioGrande-2009.pdf. Accessed April 28, 2011.

NMWQCC (New Mexico Water Quality Control Commission). 2000. State of New Mexico Standards for Interstate and Intrastate Streams. 20 NMAC 6.1. New Mexico Environment Department, Santa Fe, New Mexico.

National Oceanic and Atmospheric Administration (NOAA). 2006. Climatological Data, New Mexico. October 2006, Volume 110, Number 10. National Climatic Data Center, Asheville, North Carolina.

Odum, H. T. 1956. Primary production in flowing waters. Limnology and Oceanography 1:102–117.

Osborne, M. and T. F. Turner. 2009. Collaborative Research and Monitoring: Evaluation of the Rio Grande Silvery Minnow Health in Relation to Changes in Water Quality, Pathogens and Other Environmental Stressors: Multi-locus Major Histocompatibility Complex Class IIβ and Parasite Diversity in the Rio Grande Silvery Minnow. University of New Mexico, Department of Biology and Museum of Southwestern Biology, Albuquerque, New Mexico.

Ostrand, K. G., and G. R. Wilde. 2001. Temperature, dissolved oxygen, and salinity tolerances of five prairie stream fishes and their role in explaining fish assemblage patterns. Transactions of the American Fisheries Society 130:742-749.

Owens, M., R.W. Edwards, and J. W. Gibbs. 1974. Some reaeration studies in streams: International Journal of Air and Water Pollution 8:469-486. As cited in Bott, Thomas, 1996, Primary Productivity and Community Respiration, Chapter 25, pages 533-556 in Richard Hauer and Gary Laberti, editors, Methods in Stream Ecology, Academic Press, New York, New York.

Papoulias, D. M., M. L. Annis, D. K. Nicks, and D. E. Tillitt. 2008. Fish Health Evaluation for the Middle Rio Grande - Administrative Report. U.S. Geological Survey, Columbia Environmental Research Center, Final Laboratory Report FY 2008–01, Columbia, Missouri.

Papoulias, D. M., et al. 2009. Health and histopathological evaluation of Rio Grande silvery minnow from the Rio Grande, New Mexico. USGS Columbia Environmental Research Center, Columbia, Missouri.

Passell, H.D., C.N. Dahm, and E.J. Bedrick. 2001. Water-Quality Trends and Patterns in the Upper and Middle Rio Grande, 1975-1999. Proceedings of the 2001 Aquatic Science Meeting. The American Society of Limnology and Oceanography, 12-16 February 2001, Albuquerque, New Mexico.

Passell, H. D., C. N. Dahm, and E. J. Bedrick. 2007. Ammonia modeling for assessing potential toxicity to fish species in the Rio Grande, 1989–2002. Ecological Applications 17:2087–2099.

Platania, S. P. 2000. Effects of four water temperatures treatments on survival, growth, and developmental rates of Rio Grande silvery minnows, *Hybognathus amarus*, eggs and larvae. Report to U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Plummer, N., L. M. Bexfield, S. K. Anderholm, W. E. Standford, et al. 2004. Geochemical characterization of ground-water flow in the Santa Fe Group aquifer system, Middle Rio Grande Basin, New Mexico. U.S. Geological Survey Water-Resources Investigation Report 03-4131, Reston, Virginia.

Radtke, D. B., E. Busenberg, F. D. Wilde, and J. K. Kurklin. 2003. Chapter A6.4 pH. U.S. Geological Survey, National Field Manual for the Collection of Water-Quality Data, Reston, Virginia.

Radtke, D. B., J. V. Davis, and F. D. Wilde. 2005. Chapter A6.3 specific electrical conductance. U.S. Geological Survey, National Field Manual for the Collection of Water-Quality Data, Reston, Virginia.

Schmitt, C. J., and G. M. Dethloff (editors). 2000. Biomonitoring of Environmental Status and Trends (BEST) Program: selected methods for monitoring chemical contaminants and their effects in aquatic ecosystems. U.S. Geological Survey Information and Technology Report USGS/BRD-2000-0005, Columbia, Missouri.

Schmitt, C. J., et al. 2004. Biomonitoring of Environmental Status and Trends (BEST) program: environmental contaminants and their effects on fish in the Rio Grande Basin. U.S. Geological Survey Scientific Investigations Report 2004-5108, Columbia, Missouri. http://www.cerc.usgs.gov/pubs/center/pdfdocs/BEST-RioGrande.pdf. Accessed April 28, 2011.

Scurlock, D. 1998. From the Rio to the Sierra: an environmental history of the Middle Rio Grande Basin. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado. http://www.fs.fed.us/rm/pubs/rmrs_gtr005.html. Accessed April 28, 2011.

Seaber, P. R., F. P. Kapinos, and G. L. Knapp. 1987. Hydrologic Unit Maps. USGS Water-Supply Paper No. 2294, Denver, Colorado. http://pubs.usgs.gov/wsp/wsp2294/. Accessed May 2, 2011.

Service (U.S. Fish and Wildlife Service). 1994. Endangered and threatened wildlife and plants; Final rule to list the Rio Grande silvery minnow as an endangered species. Federal Register 59:36988–37001.

Service (U.S. Fish and Wildlife Service). 2003. Biological and Conference Opinions on the Effects of Actions Associated with the Programmatic Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operation, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico. Memorandum From Regional Director, Region 2 to Area Manager, Albuquerque Area Office, Bureau of Reclamation, March 17, 2003. U.S. Fish and Wildlife Service, Region 2, Albuquerque, New Mexico.

Service (U.S. Fish and Wildlife Service). 2007. Biological opinion on the effects of the authorization of the discharge of pollutants in stormwater and certain nonstormwater discharges from the Large Municipal Stormwater Sewer Systems (MS4) in the Albuquerque urbanized area in Bernalillo County, New Mexico proposed by the U.S. Environmental Protection Agency. U.S Fish and Wildlife Service, New Mexico Ecological Services Office, Albuquerque, New Mexico.

Service (U.S. Fish and Wildlife Service). 2010. Revised Rio Grande Silvery Minnow (*Hybognathus amarus*) recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Service (U.S. Fish and Wildlife Service). 2011. Biological opinion on U.S. Environmental Protection Agency's (EPA) action authorizing the discharge of pollutants in stormwater and certain nonstormwater discharges from the Large Municipal Stormwater Sewer Systems (MS4) in the Albuquerque urbanized area in Bernalillo County, New Mexico (Albuquerque MS4 permit or Albuquerque stormwater permit). U.S Fish and Wildlife Service, New Mexico Ecological Services Office, Albuquerque, New Mexico.

Smith, S. B., et al. 2002. Illustrated field guide for assessing external and internal anomalies in fish. U.S. Geological Survey, Information and Technology Report, 2002-0007, Columbia, Missouri.

Soucek, D. J., T. K. Linton, C. D. Tarr, A. Dickinson, N. Wickramanayake, et al. 2011. Influence of water hardness and sulfate on the acute toxicity of chloride to sensitive freshwater invertebrates. Environmental Toxicology and Chemistry 30:930-938.

StatSoft. 2011. Electronic Statistics Textbook. StatSoft, Inc., Tulsa, Oklahoma. Available at http://www.statsoft.com/textbook/.

Stephan, C. E. 2009. Calculation of aquatic life criteria for chloride. U. S. Environmental Protection Agency, 09FebChlorideCriteria.wpd, Duluth, Minnesota.

SWCA Environmental Consultants. 2007. Survey of aquatic food resources in the Middle Rio Grande, New Mexico (2005-2006). Report to New Mexico Interstate Stream Commission, Albuquerque, New Mexico.

SWCA Environmental Consultants. 2010. Pueblo of Albuerque area riverine habitat restoration project. Biological assessment. Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico.

Thurston, R. V., R.C. Russo, C.M. Fetterolf, T.A. Edsall, and Y.M. Barber. 1979. A review of the EPA Red Book: Quality criteria for water. American Fisheries Society, Bethesda, MD.

Thurston, R. V., G. R. Phillips, R. C. Russo, and S. M. Hinkins. 1981. Increased toxicity of ammonia to rainbow trout (*Salmo gairdneri*) resulting from reduced concentrations of dissolved oxygen. Canadian Journal of Fisheries and Aquatic Sciences 38:983–988.

United National Educational, Scientific and Cultural Organization (UNESCO). 1981. Background papers and supporting data on the Practical Salinity Scale 1978. UNESCO Joint Panel on Oceanographic Tables and Standards, Paris, France.

United National Educational, Scientific and Cultural Organization (UNESCO). 1985. The International System of Units (SI) in Oceanography. UNESCO Technical Papers in Marine Science No. 45, International Association for the Physical Sciences of the Oceans, Paris, France.

US Census Bureau. 2009. Table 1. Annual Estimates of the Resident Population for Incorporated Places Over 100,000, Ranked by July 1, 2009 Population: April 1, 2000 to July 1, 2009. US Census Bureau Population Division, Suitland, Maryland.

USDI (United States Department of the Interior). 1998. Guidelines for interpretation of the biological effects of selected constituents in biota, water, and sediment. National Irrigation Water Quality Program Information Report 3, Bureau of Reclamation, Denver, CO.

USEPA (U.S. Environmental Protection Agency). 1995. Technical guidance manual for developing total maximum daily loads. Book II: Streams and Rivers Part 1: Biochemical oxygen demand/dissolved oxygen and nutrients/eutrophication. EPA Report 823-B-95-007. U.S. Environmental Protection Agency, Washington, D.C. http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=200055WG.txt. Accessed April 28, 2011.

USEPA (U.S. Environmental Protection Agency). 1999. Aquatic life criteria – Ammonia 1999 update. U.S. Environmental Protection Agency Report EPA 822-R-99-014, Washington, D. C.

USEPA (U.S. Environmental Protection Agency). 2010. Causal Analysis/Diagnosis Decision Information System (CADDIS) Volume 2: Sources, Stressors & Responses-Ionic Strength. Office of Research and Development, Washington, DC. Available online at http://www.epa.gov/caddis.

USGS (U.S. Geological Survey). 2010. Gage data for the USGS 08330000 Rio Grande at Albuquerque, New Mexico. National Water Information Service http://waterdata.usgs.gov/nwis/inventory/?site_no=08330000&agency_cd=USGS &amp. Accessed April 28, 2011.

USGS (U.S. Geological Survey). 2010. Gage data for the USGS 08319000 Rio Grande at San Felipe, New Mexico. National Water Information Service: Web Interface. http://waterdata.usgs.gov/nwis/inventory/?site_no=08319000&agency_cd=USGS &amp. Accessed April 28, 2011.

USGS (U.S. Geological Survey). 2010. Gage data for the USGS 08329000 Jemez River below Jemez Canyon Dam, New Mexico. National Water Information Service: http://waterdata.usgs.gov/nm/nwis/inventory/?site_no=08329000&agency_cd=US GS&. Accessed April 28, 2011.

USGS (U.S. Geological Survey). 2010. Gage data for the USGS 08329900 North Floodway Channel near Alameda, New Mexico. National Water Information Service: Web Interface. http://waterdata.usgs.gov/nm/nwis/inventory/?site_no=08329900&agency_cd=USGS&. Accessed April 28, 2011.

Valett, H. M., et al. 2005. Biogeochemical and metabolic responses to the flood pulse in a semiarid floodplain. Ecology 86:220–234.

Van Horn, D. 2008. Water quality in the Middle Rio Grande. Rio Grande seminar series presentation, May 2, 2008. University of New Mexico, Biology Department, Albuquerque, New Mexico. http://bioannexlabs.unm.edu/BIOL/DVH_Rio_Grande_Seminar_Final_2.pdf. Accessed April 28, 2011.

Van Metre, P.C., B.J. Mahler, and E. Callender. 1997. Water-quality trends in the Rio Grande/Rio Bravo Basin using sediment cores from reservoirs. U.S. Geological Survey Fact Sheet FS-221-96, Austin, Texas.

Veenstra, J. N., and S. L. Nolen. 1991. In-situ sediment oxygen demand in five southwestern U.S. lakes. Water Research 25:351–354.

Wagner, R. J., R. W. Boulger, C. J. Oblinger, and B. A. Smith. 2006. Guidelines and standard procedures for continuous water-quality monitors: station operation, record computation, and data reporting. U.S. Geological Survey Techniques and Methods 1-D3, Reston, Virginia. Available at http://pubs.water.usgs.gov/tm1d3.

Walker, R. R., and W. J. Snodgrass. 1986. Model for sediment oxygen demand in lakes. Journal of Environmental Engineering 112:25–43.

Wang, W. 1980. Fractionation of sediment oxygen demand. Water Research 14:603–612.

Wilcox, R. 1997. Concentrations of Selected Trace Elements and Other Constituents in the Rio Grande and in Fish Tissue in the Vicinity of Albuquerque, New Mexico, 1994 to 1996. U.S. Geological Survey Open-File Report 97-667, Albuquerque, New Mexico.

Woodland, J. 2012. Rio Grande Silvery Minnow Health Study - Fish Pathogen Assessment. U.S. Fish and Wildlife Service, Dexter Fish Health Unit, Dexter, New Mexico.

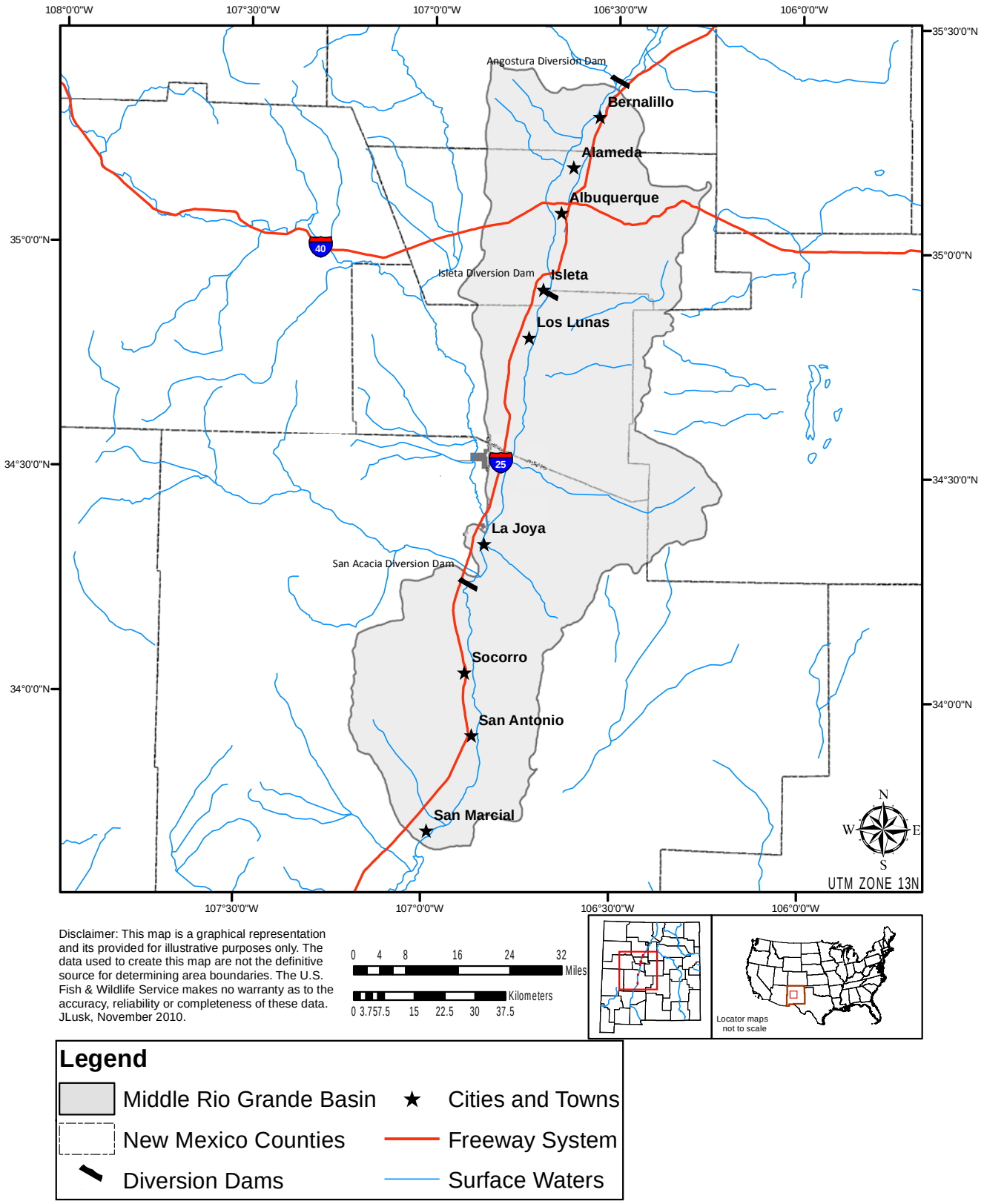


Figure 1. Location of the Middle Rio Grande Watershed and RGSM Health Study Area in New Mexico.

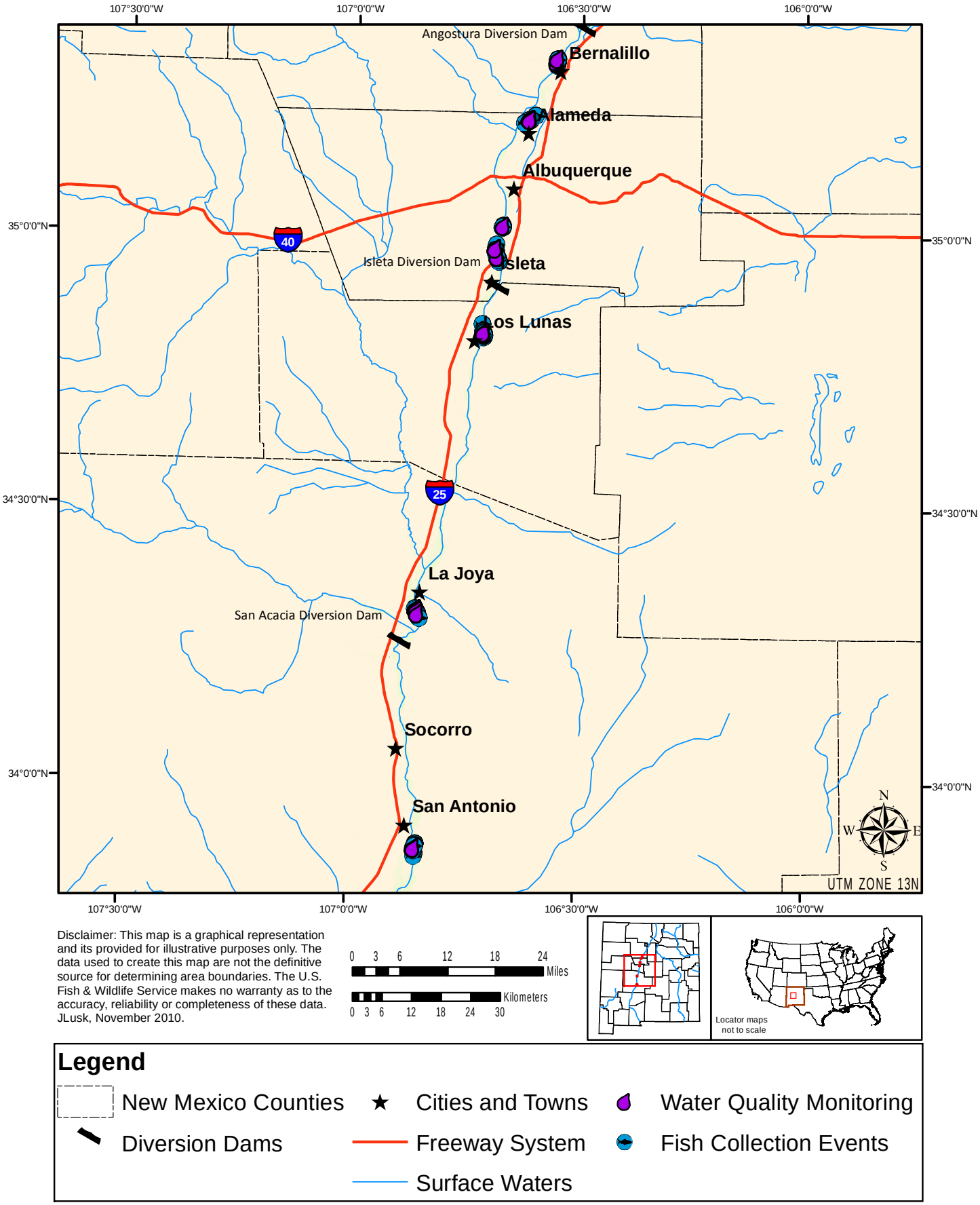


Figure 2. Location of the Six RGSM Health Study Sites along the Middle Rio Grande in New Mexico.

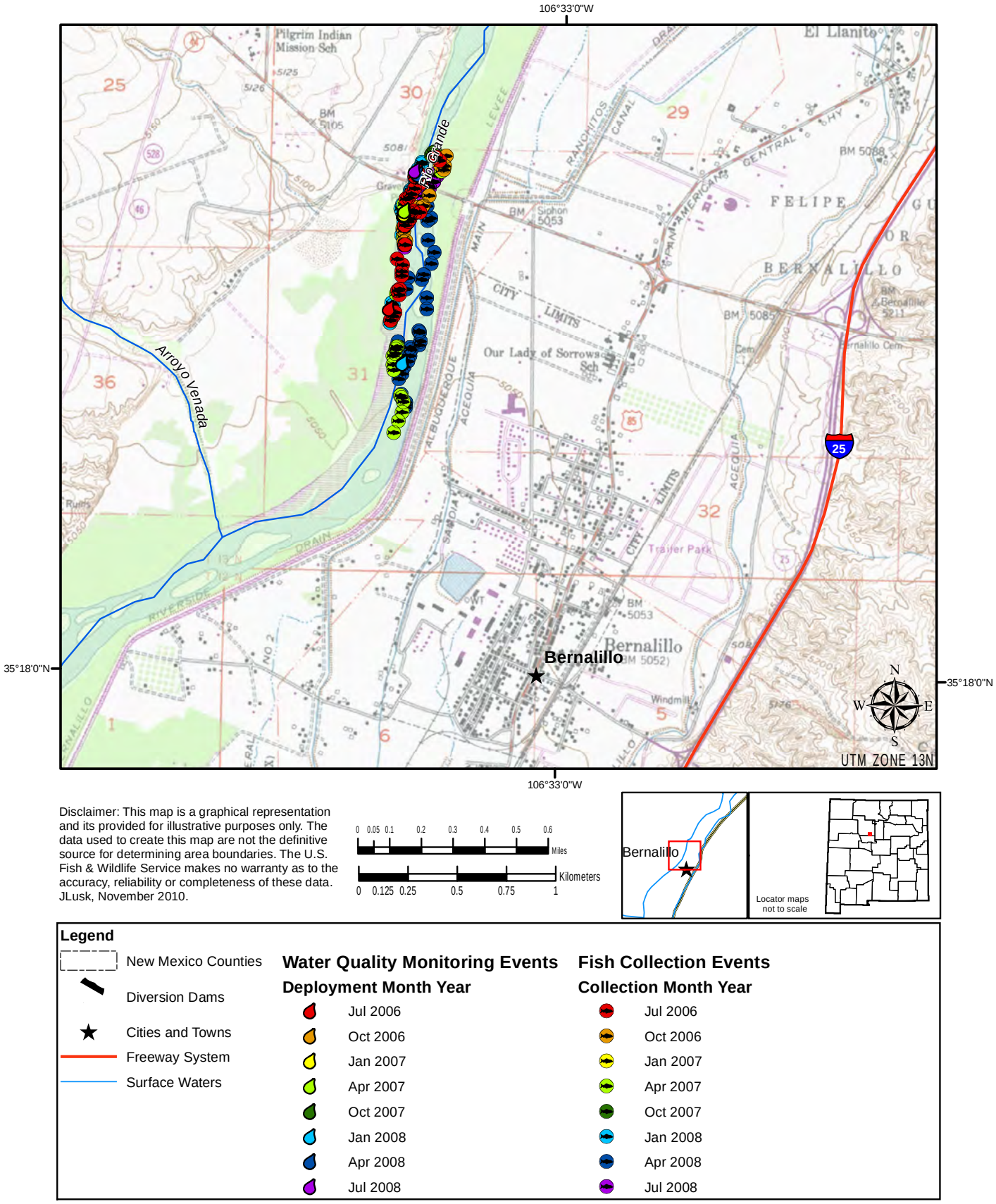


Figure 3. Location of RGSM Health Study Sampling Site 1, Rio Grande at Bernalillo, New Mexico.

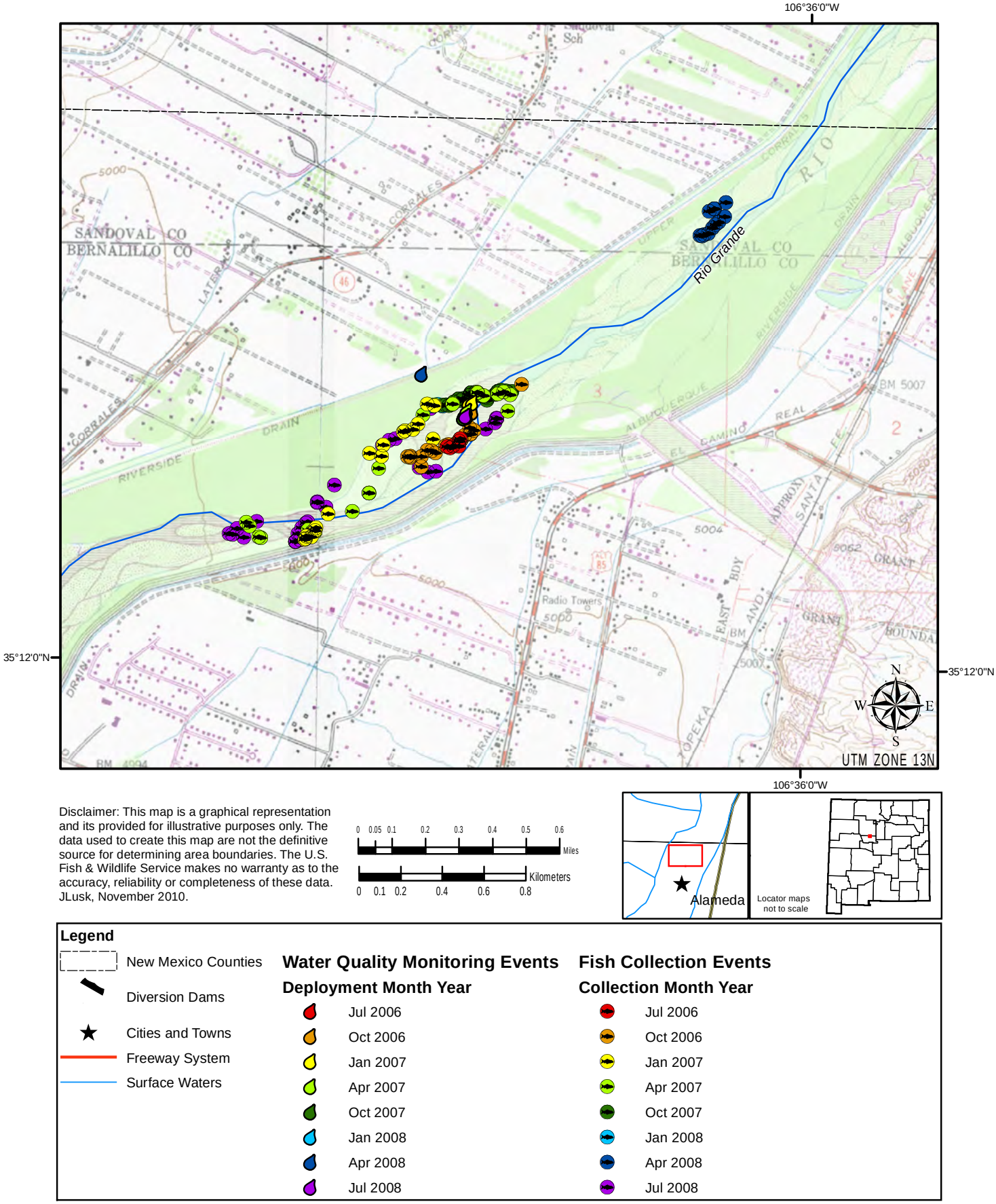


Figure 4. Location of RGSM Health Study Sampling Site 2, Rio Grande at Alameda, New Mexico.

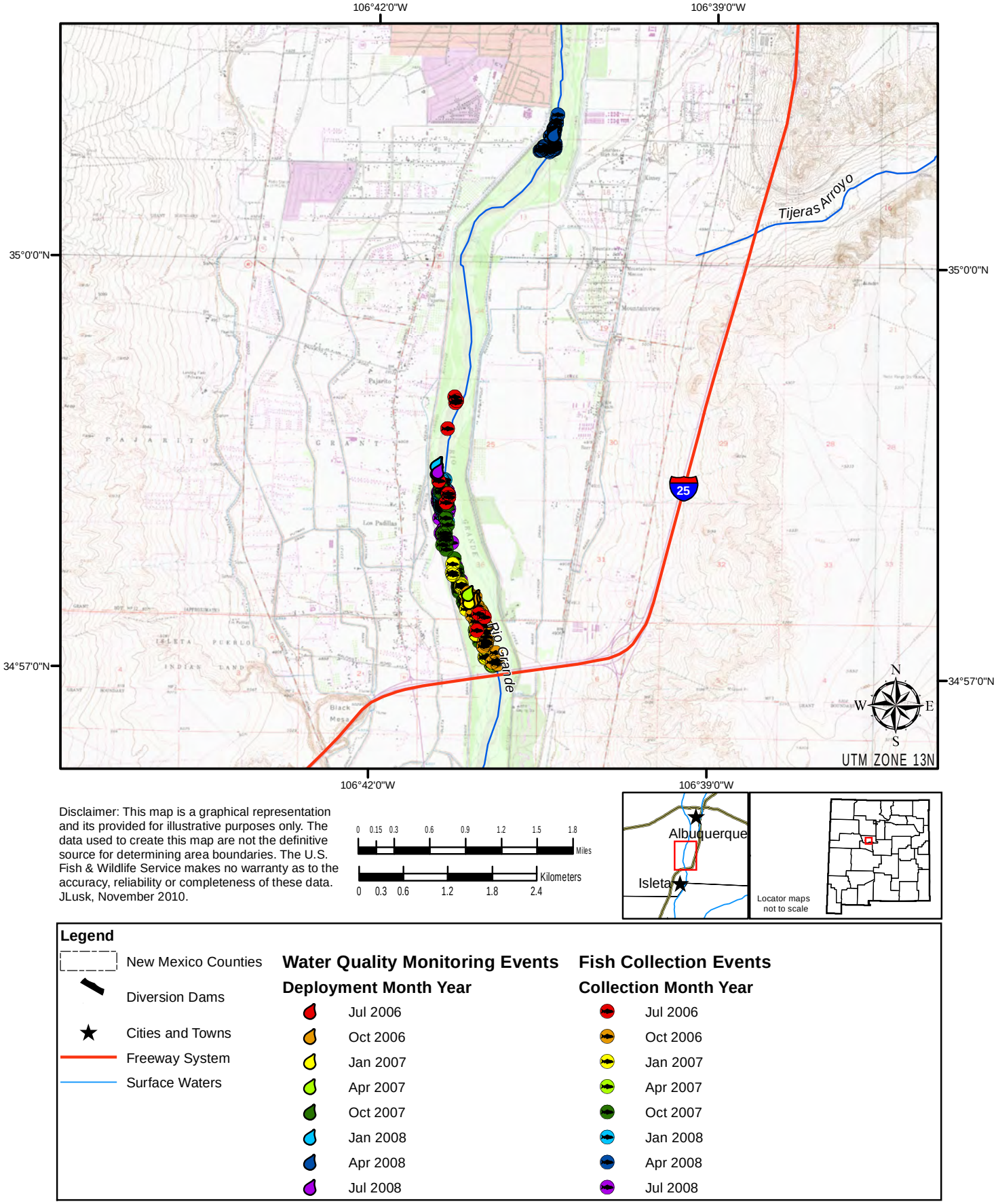


Figure 5. Location of RGSM Health Study Sampling Site 3, Rio Grande at Los Padillas, New Mexico.

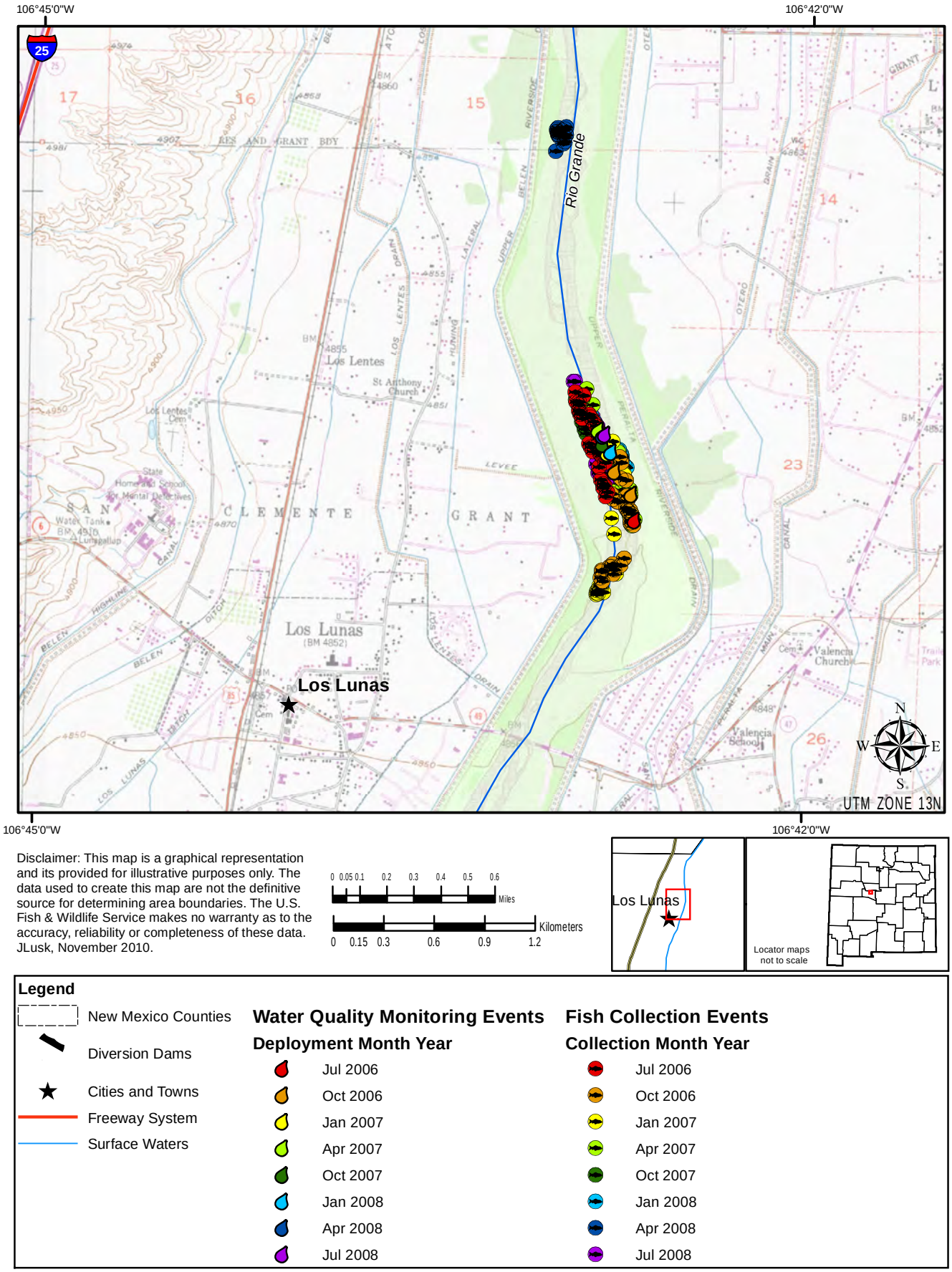
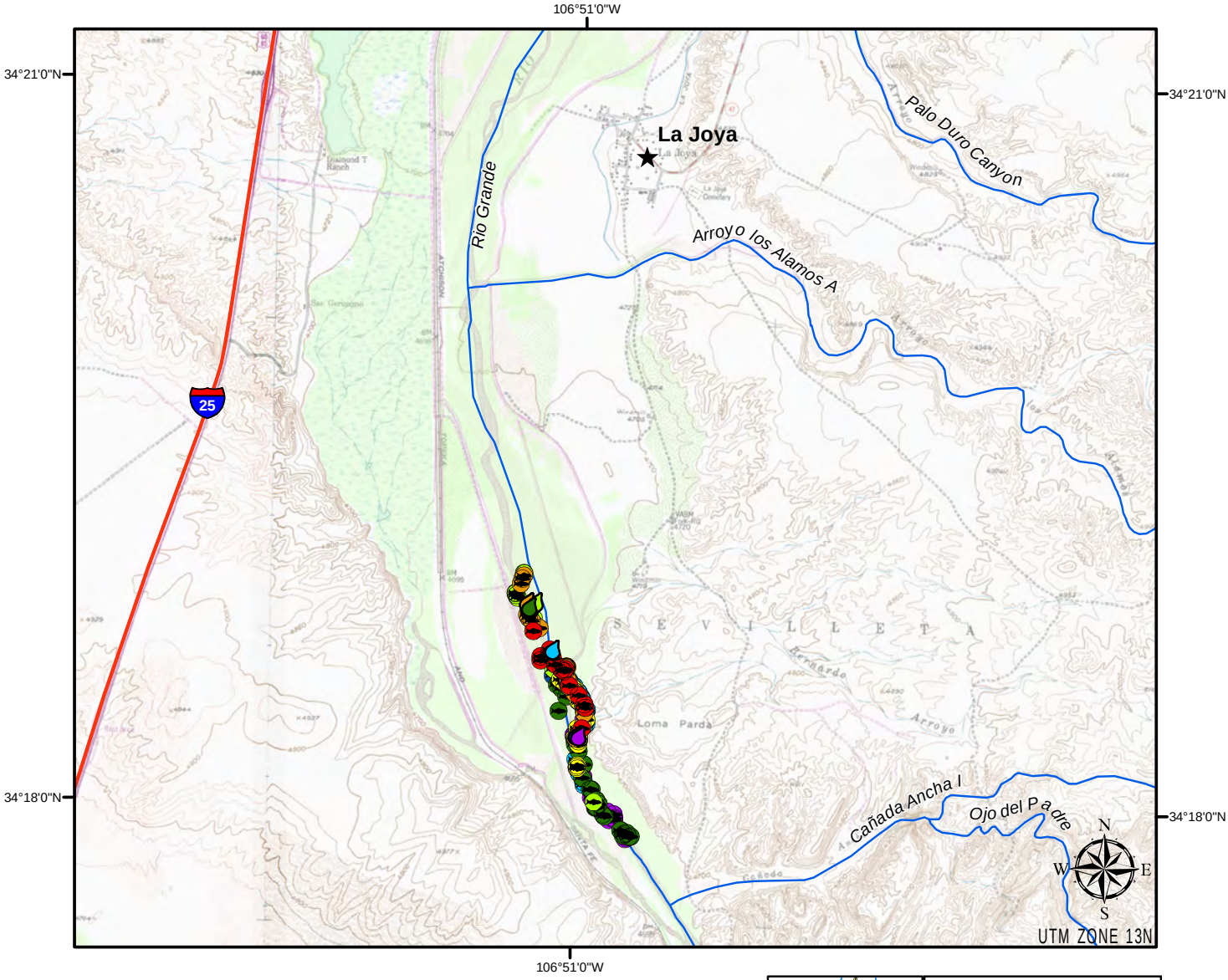
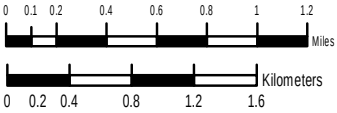
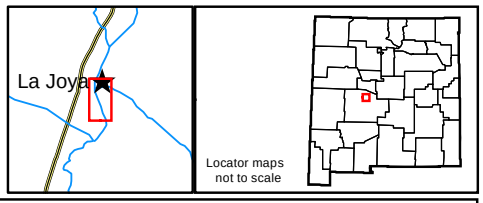


Figure 6. Location of RGSM Health Study Sampling Site 4, Rio Grande at Los Lunas, New Mexico.



Disclaimer: This map is a graphical representation and its provided for illustrative purposes only. The data used to create this map are not the definitive source for determining area boundaries. The U.S. Fish & Wildlife Service makes no warranty as to the accuracy, reliability or completeness of these data. JLusk, November 2010.





Legend

- New Mexico Counties
- Diversion Dams
- Cities and Towns
- Freeway System
- Surface Waters

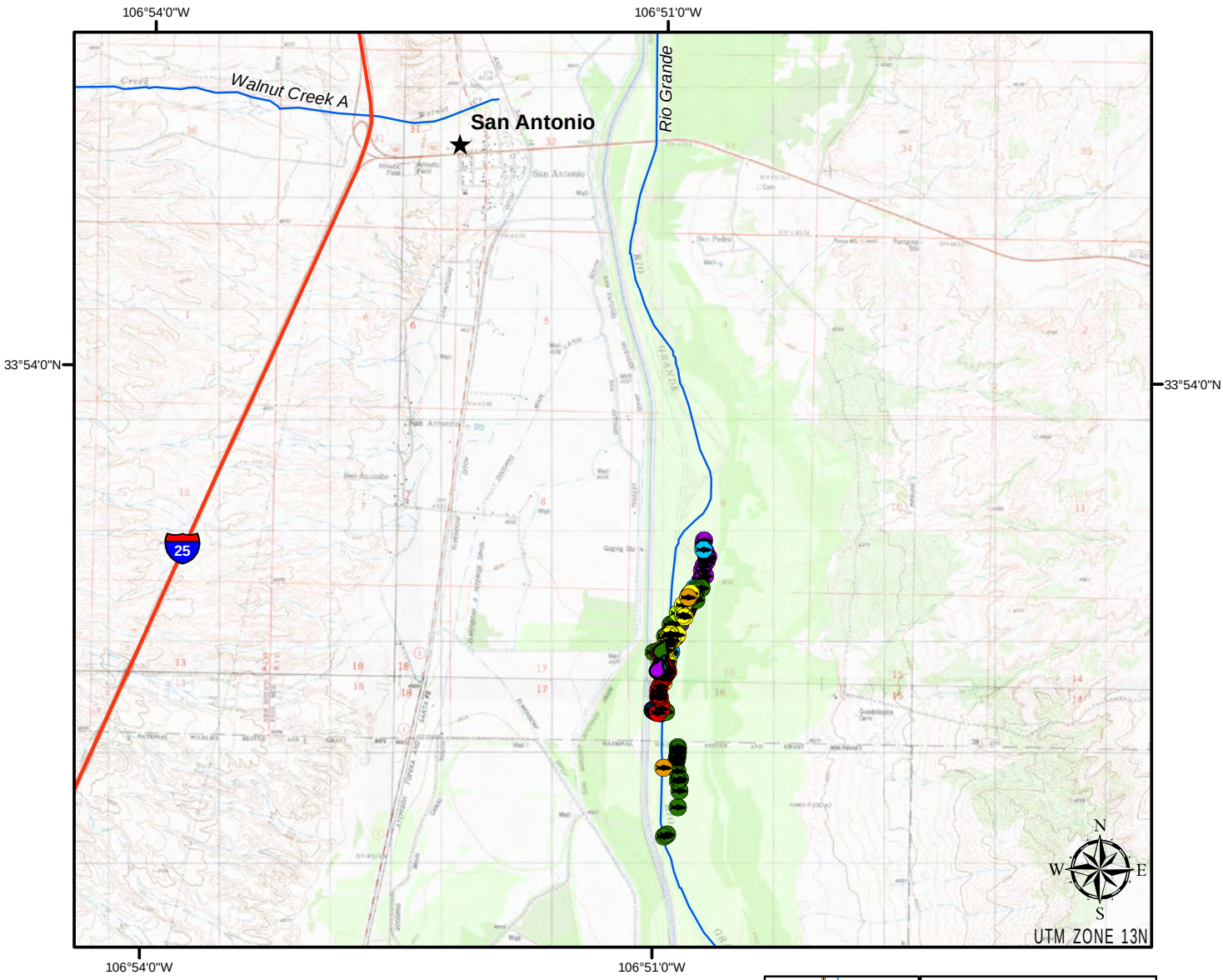
Water Quality Monitoring Events
Deployment Month Year

- Jul 2006
- Oct 2006
- Jan 2007
- Apr 2007
- Oct 2007
- Jan 2008
- Apr 2008
- Jul 2008

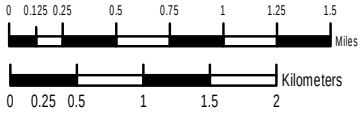
Fish Collection Events
Collection Month Year

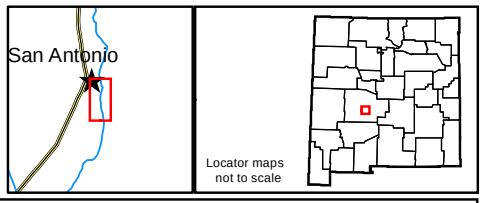
- Jul 2006
- Oct 2006
- Jan 2007
- Apr 2007
- Oct 2007
- Jan 2008
- Apr 2008
- Jul 2008

Figure 7. Location of RGSM Health Study Sampling Site 5, Rio Grande at La Joya, New Mexico.



Disclaimer: This map is a graphical representation and its provided for illustrative purposes only. The data used to create this map are not the definitive source for determining area boundaries. The U.S. Fish & Wildlife Service makes no warranty as to the accuracy, reliability or completeness of these data. JLusk, November 2010.





Legend

- New Mexico Counties
- Diversion Dams
- Cities and Towns
- Freeway System
- Surface Waters

Water Quality Monitoring Events
Deployment Month Year

- Jul 2006
- Oct 2006
- Jan 2007
- Apr 2007
- Oct 2007
- Jan 2008
- Apr 2008
- Jul 2008

Fish Collection Events
Collection Month Year

- Jul 2006
- Oct 2006
- Jan 2007
- Apr 2007
- Oct 2007
- Jan 2008
- Apr 2008
- Jul 2008

Figure 8. Location of RGSM Health Study Sampling Site 6, Rio Grande near San Antonio, New Mexico.

Figure 9. Mean Daily Discharge at USGS Gage 08329918, Rio Grande at Alameda Bridge at Alameda, NM, during Summer 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 1, Rio Grande at Bernalillo, NM, and Site 2, Rio Grande at Alameda, NM.]

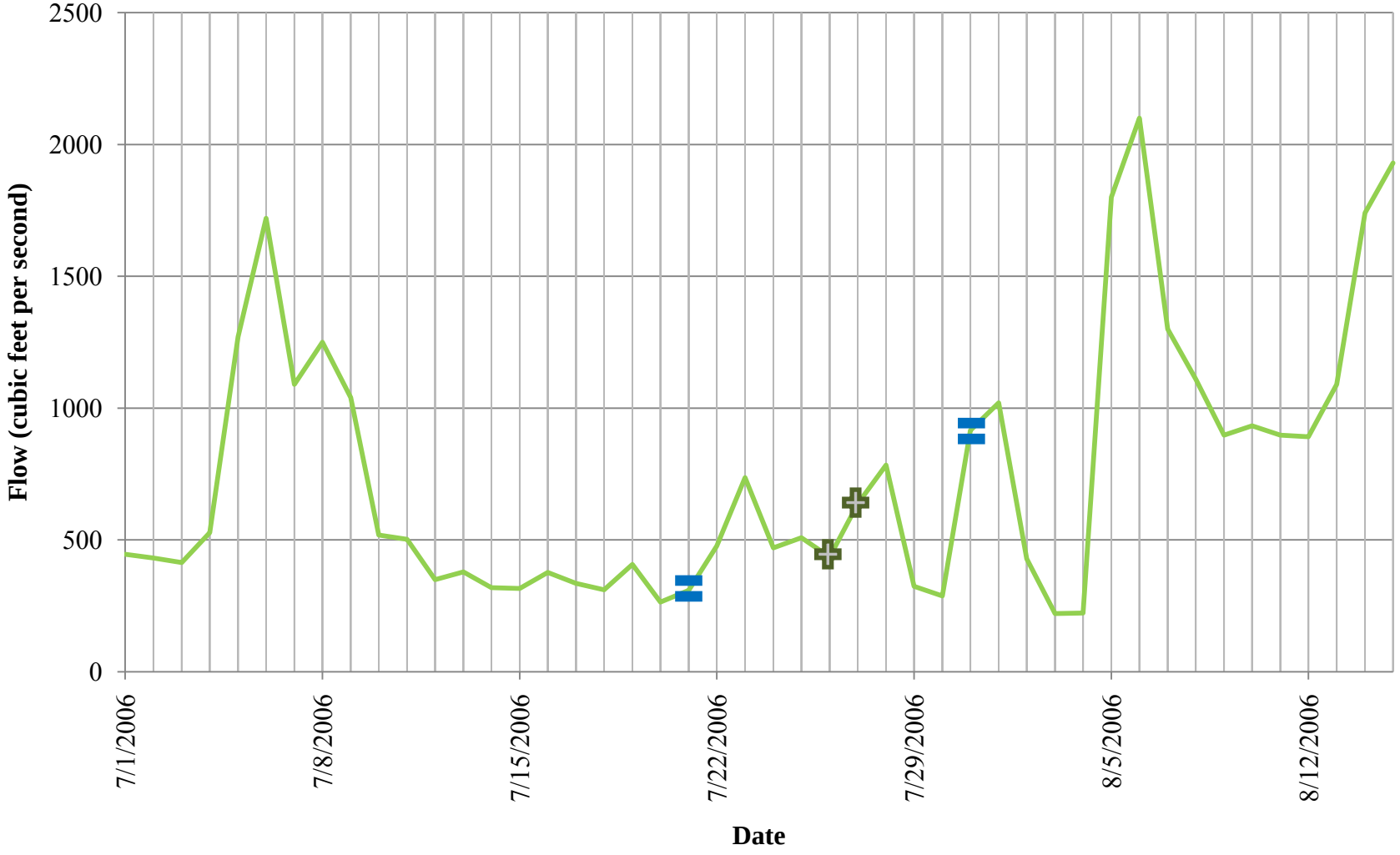


Figure 10. Mean Daily Discharge at USGS Gage 08329918, Rio Grande at Alameda Bridge at Alameda, NM, during Fall 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 1, Rio Grande at Bernalillo, NM, and Site 2, Rio Grande at Alameda, NM.]

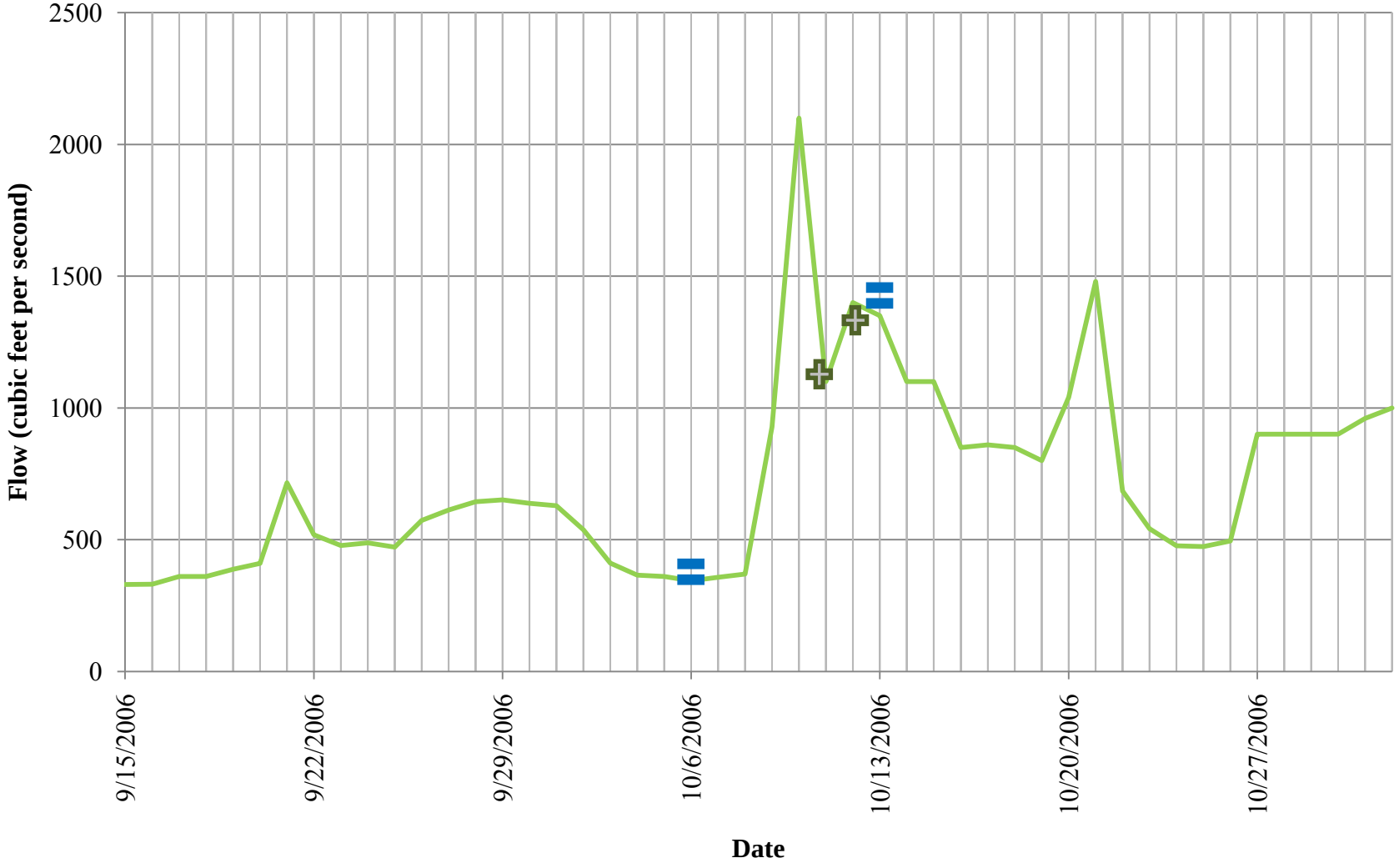


Figure 11. Mean Daily Discharge at USGS Gage 08329918, Rio Grande at Alameda Bridge at Alameda, NM, during Winter 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 1, Rio Grande at Bernalillo, NM, and Site 2, Rio Grande at Alameda, NM.]

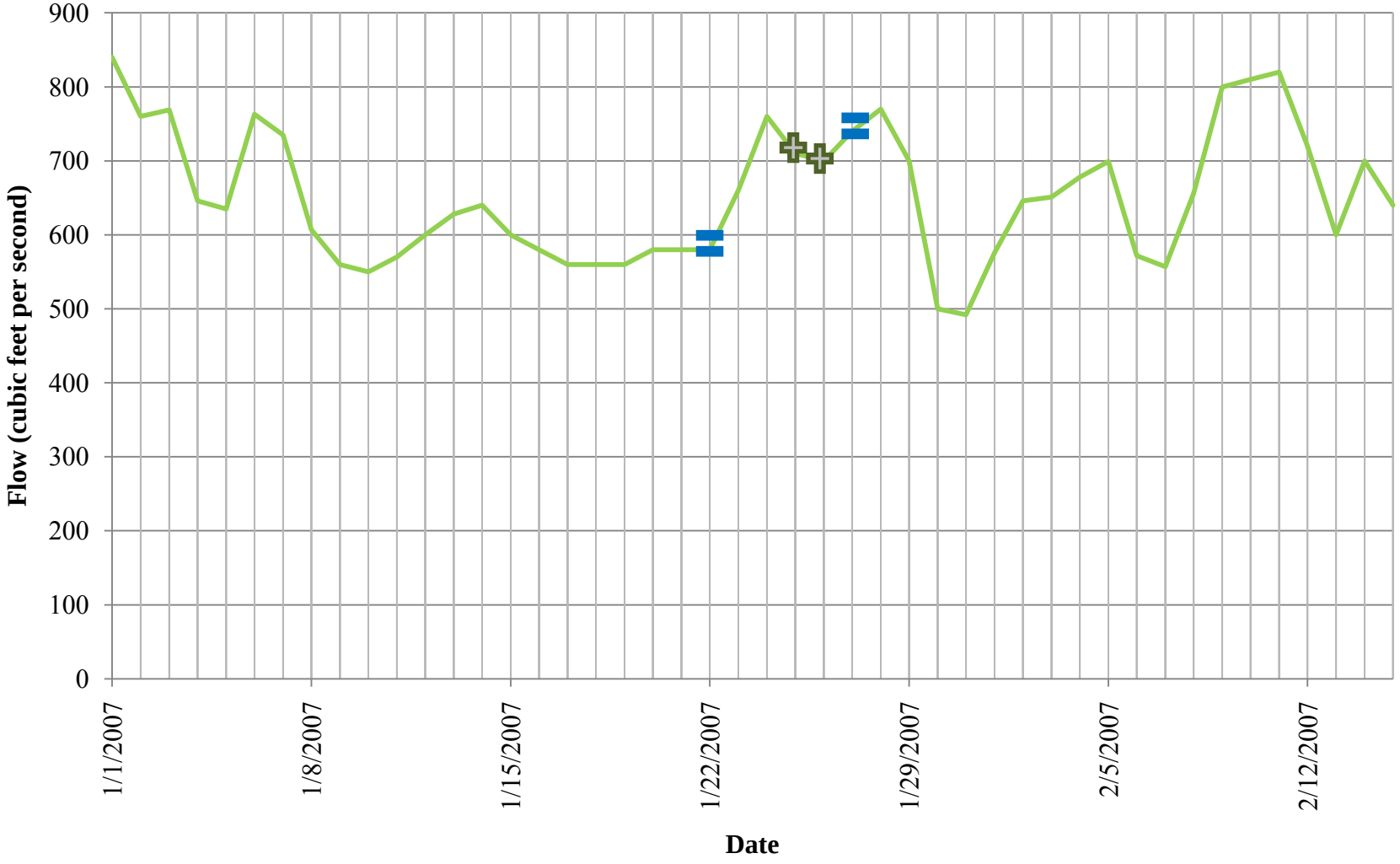


Figure 12. Mean Daily Discharge at USGS Gage 08329918, Rio Grande at Alameda Bridge at Alameda, NM, during Spring 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 1, Rio Grande at Bernalillo, NM, and Site 2, Rio Grande at Alameda, NM.]

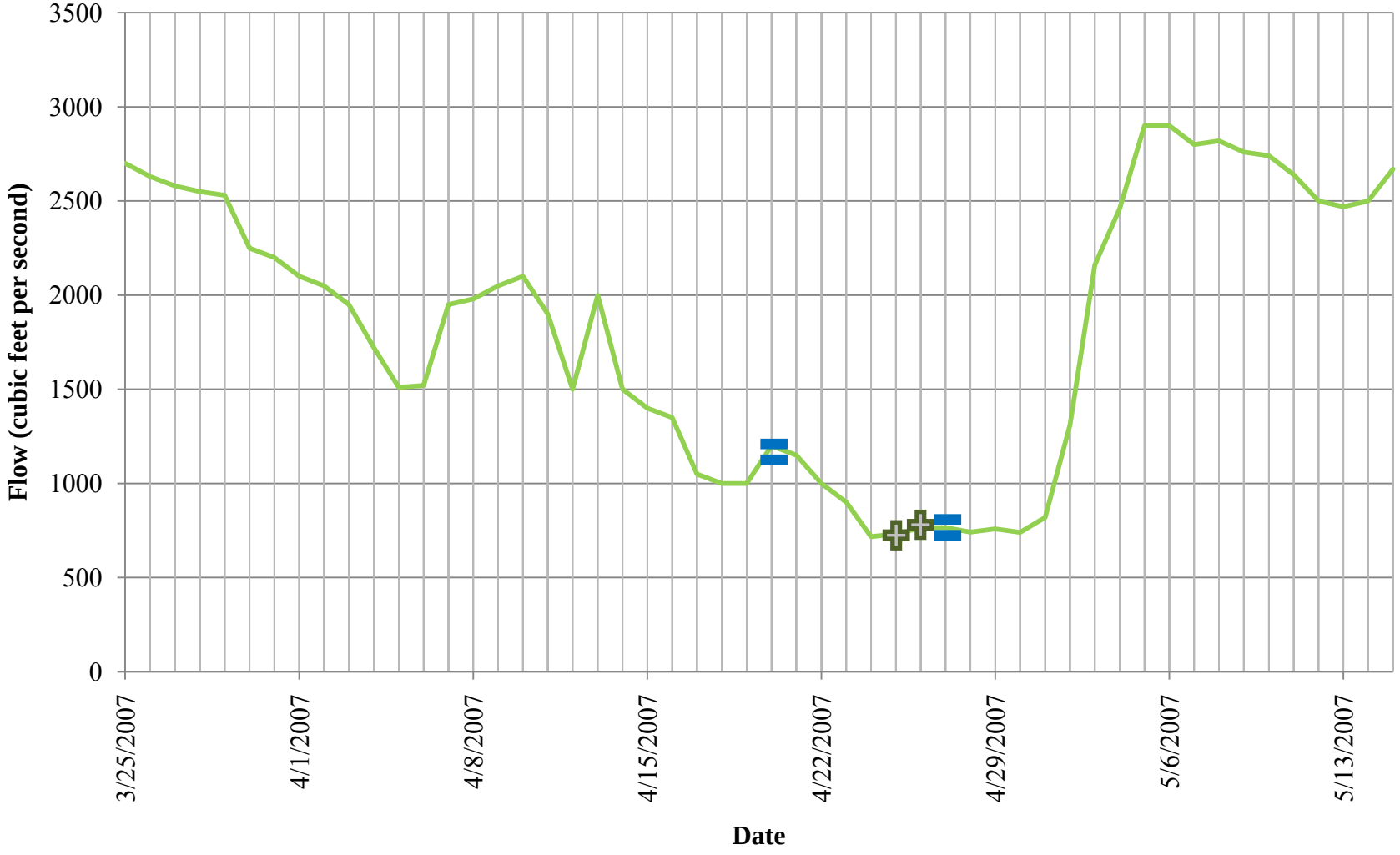


Figure 13. Mean Daily Discharge at USGS Gage 08329918, Rio Grande at Alameda Bridge at Alameda, NM, during Fall 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 1, Rio Grande at Bernalillo, NM, and Site 2, Rio Grande at Alameda, NM.]

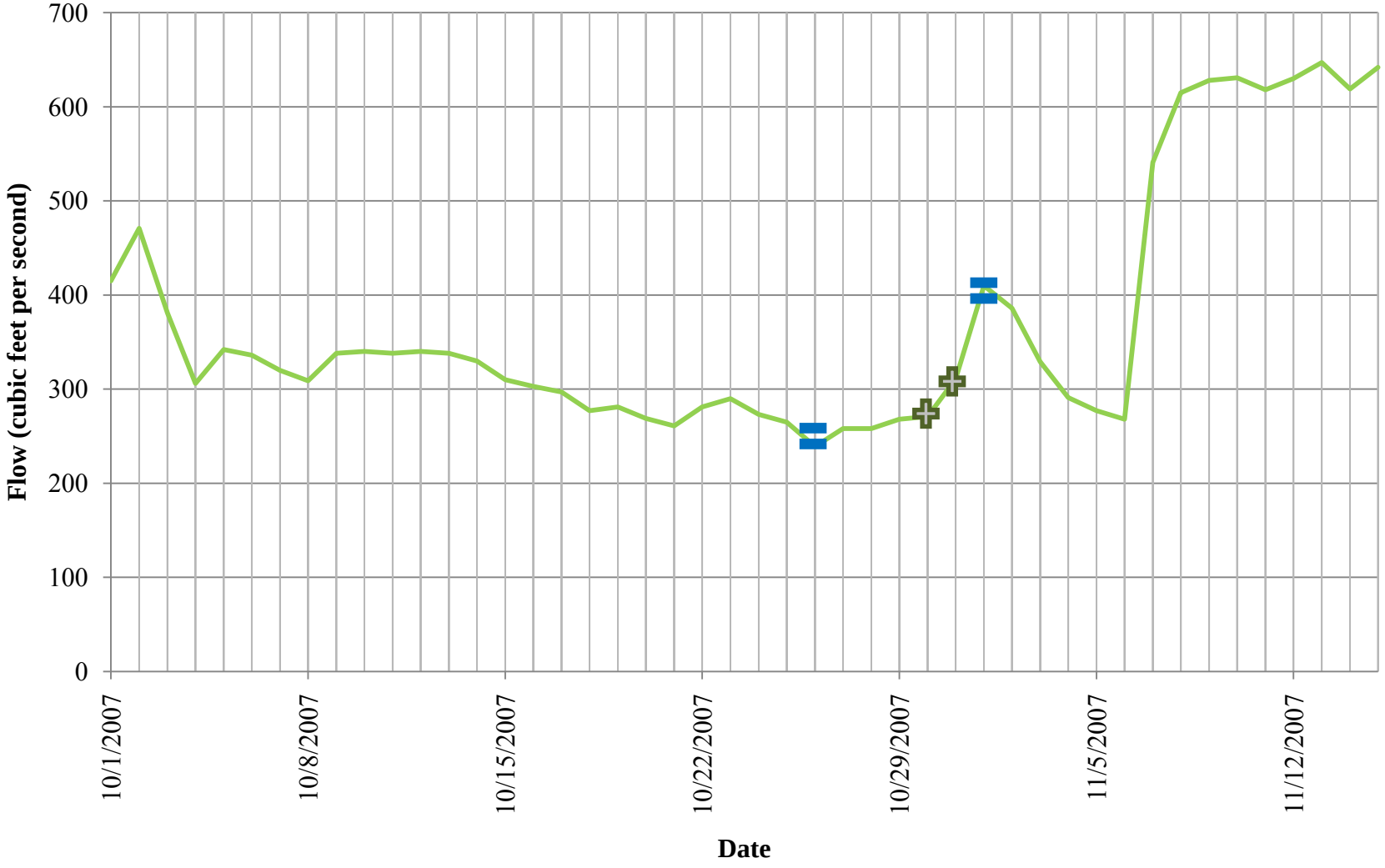


Figure 14. Mean Daily Discharge at USGS Gage 08329918, Rio Grande at Alameda Bridge at Alameda, NM, during Winter 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 1, Rio Grande at Bernalillo, NM, and Site 2, Rio Grande at Alameda, NM.]

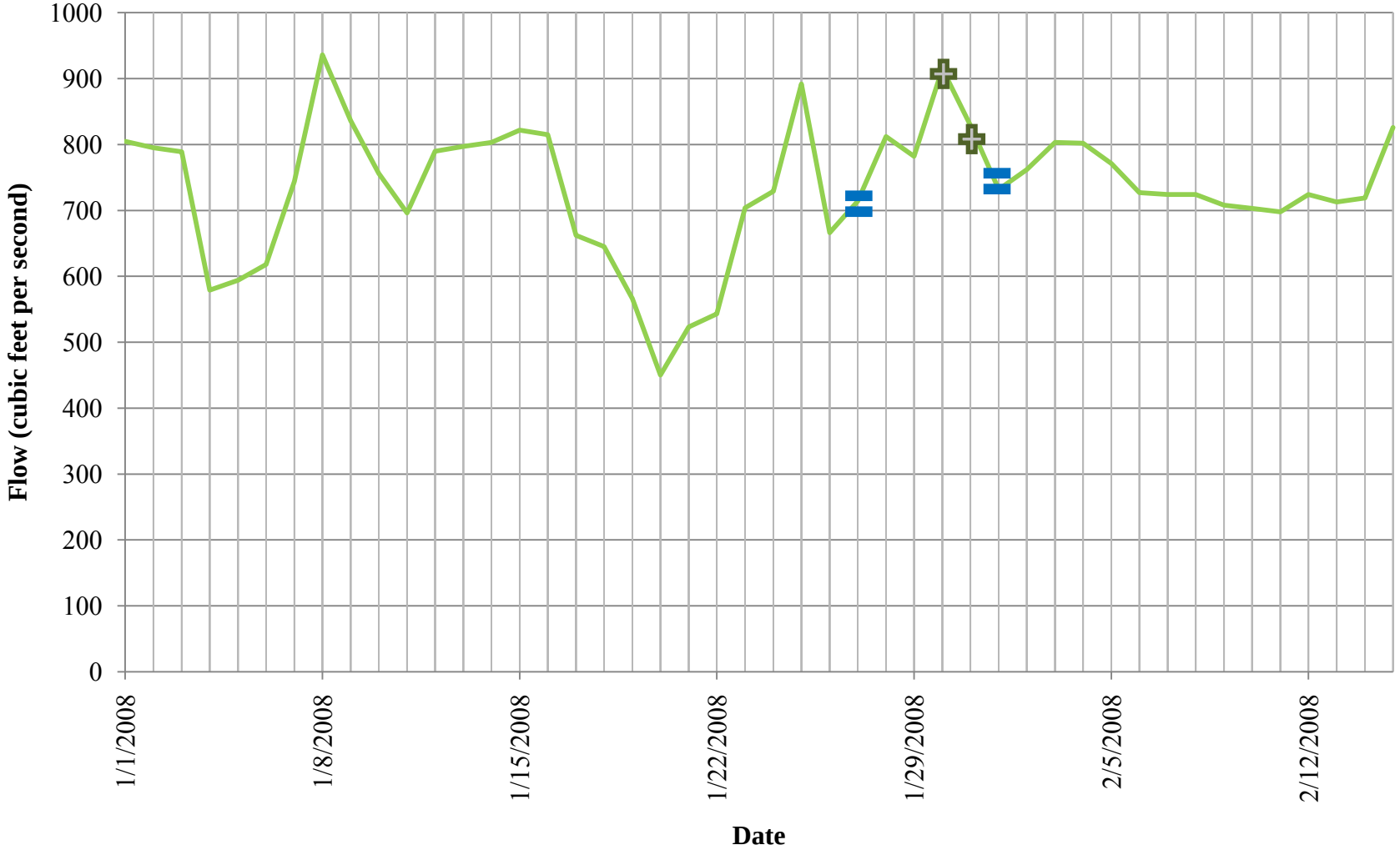


Figure 15. Mean Daily Discharge at USGS Gage 08329918, Rio Grande at Alameda Bridge at Alameda, NM, during Spring 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 1, Rio Grande at Bernalillo, NM, and Site 2, Rio Grande at Alameda, NM.]

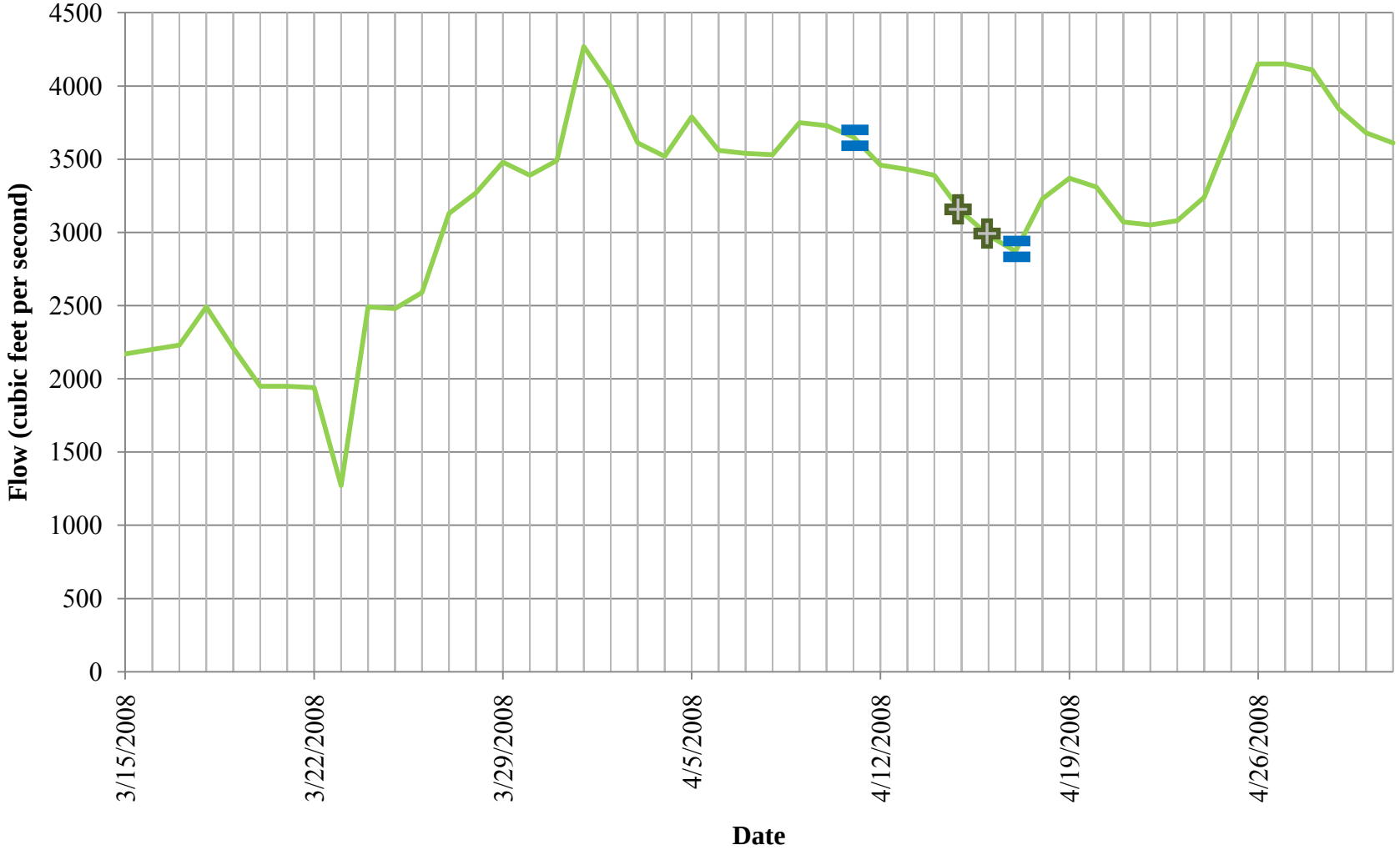


Figure 16. Mean Daily Discharge at USGS Gage 08329918, Rio Grande at Alameda Bridge at Alameda, NM, during Summer 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 1, Rio Grande at Bernalillo, NM, and Site 2, Rio Grande at Alameda, NM.]

Figure 17. Mean Daily Discharge at USGS Gage 08330875, Rio Grande at Isleta Lakes near Isleta, NM, during Summer 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 3, Rio Grande at Los Padillas, NM.]

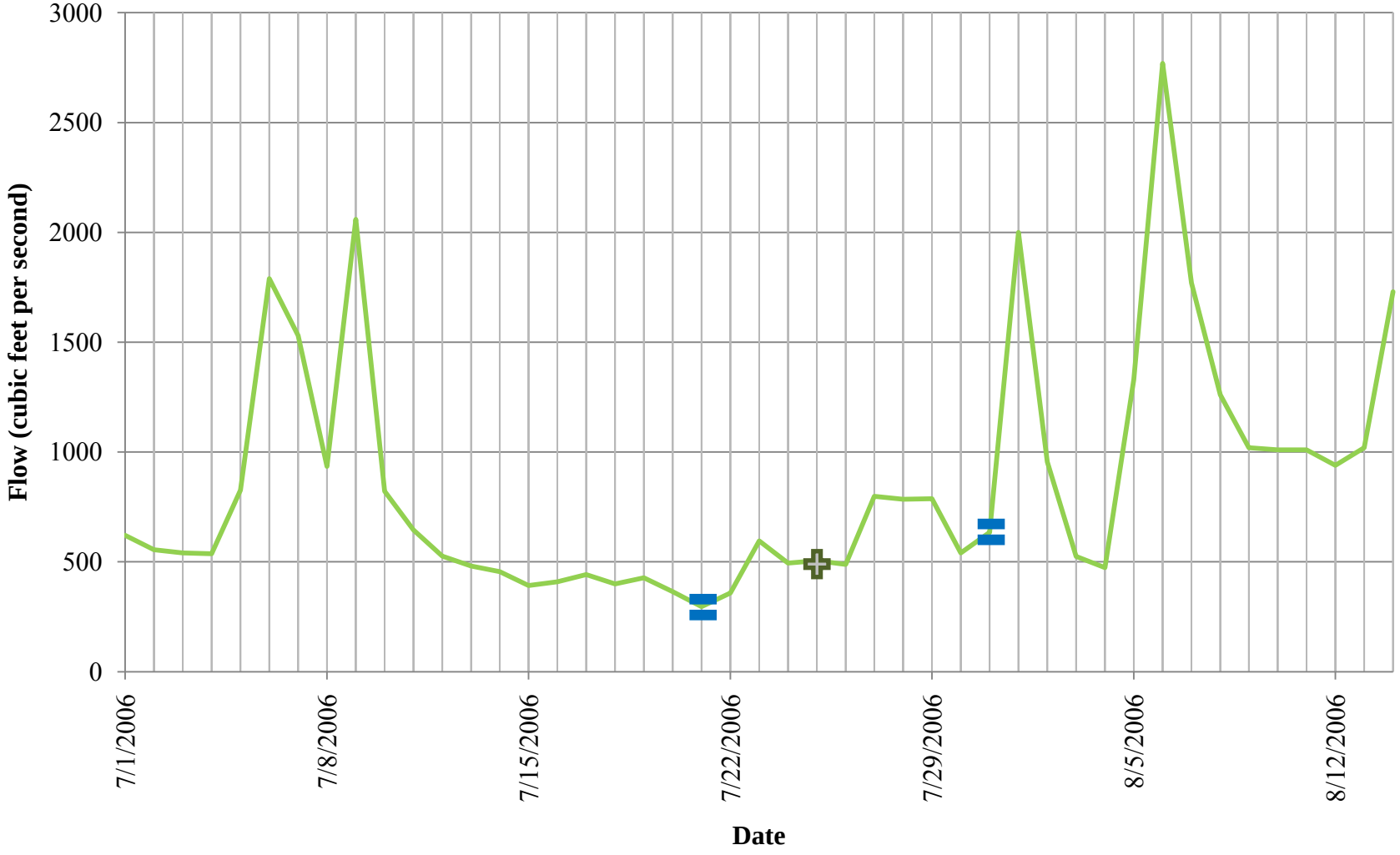


Figure 18. Mean Daily Discharge at USGS Gage 08330875, Rio Grande at Isleta Lakes near Isleta, NM, during Fall 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 3, Rio Grande at Los Padillas, NM.]

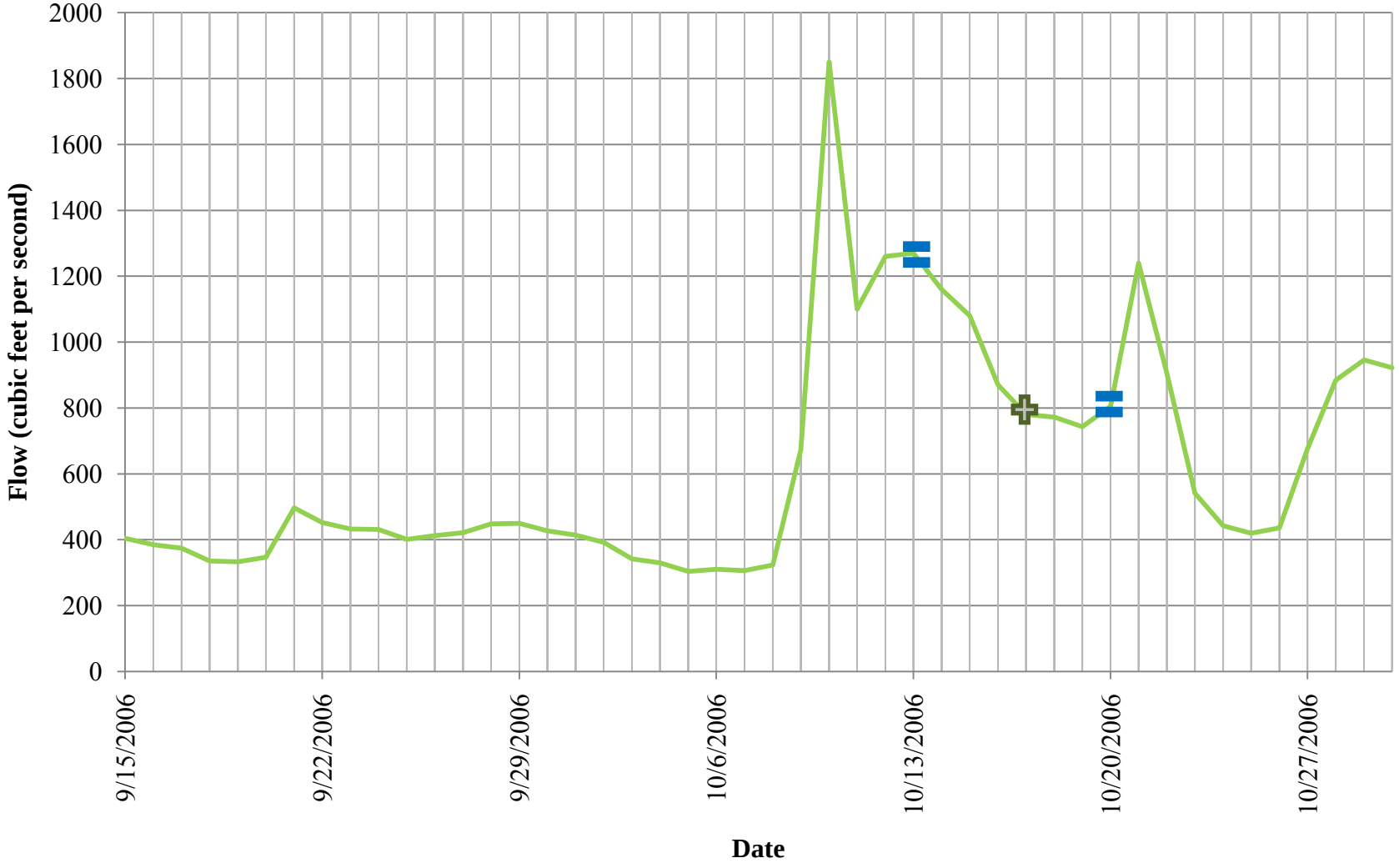


Figure 19. Mean Daily Discharge at USGS Gage 08330875, Rio Grande at Isleta Lakes near Isleta, NM, during Winter 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 3, Rio Grande at Los Padillas, NM.]

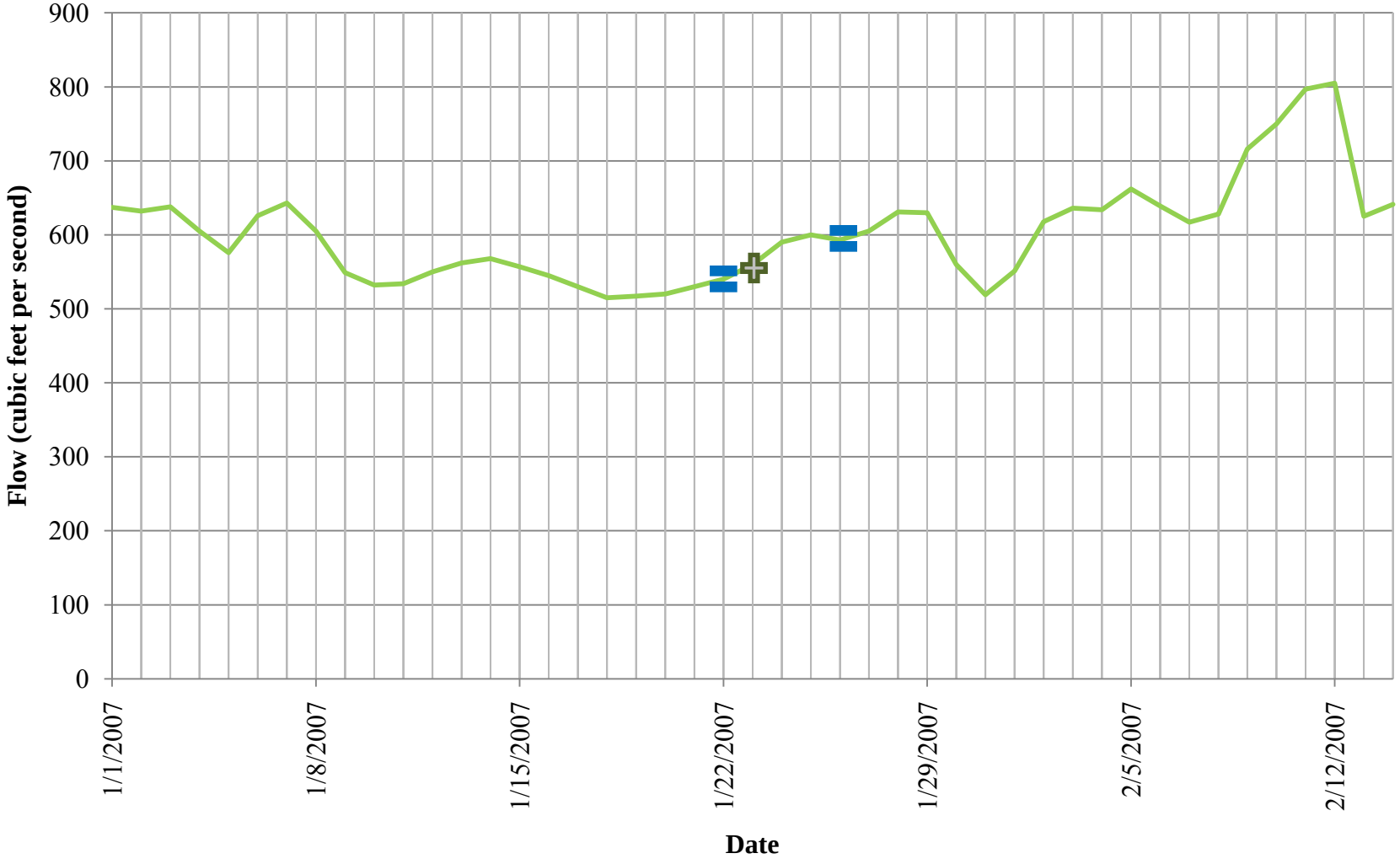


Figure 20. Mean Daily Discharge at USGS Gage 08330875, Rio Grande at Isleta Lakes near Isleta, NM, during Spring 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 3, Rio Grande at Los Padillas, NM.]

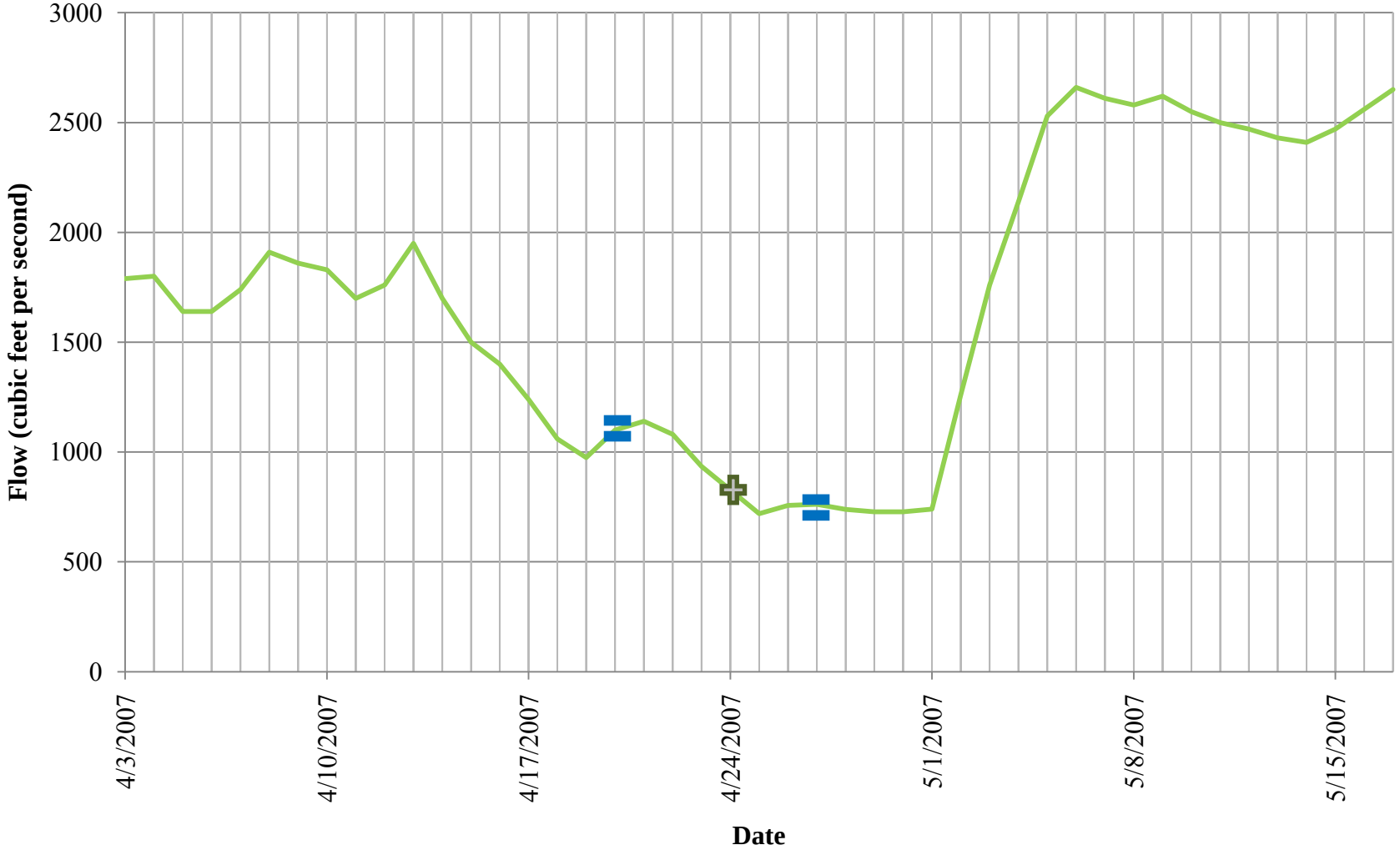


Figure 21. Mean Daily Discharge at USGS Gage 08330875, Rio Grande at Isleta Lakes near Isleta, NM, during Fall 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 3, Rio Grande at Los Padillas, NM.]

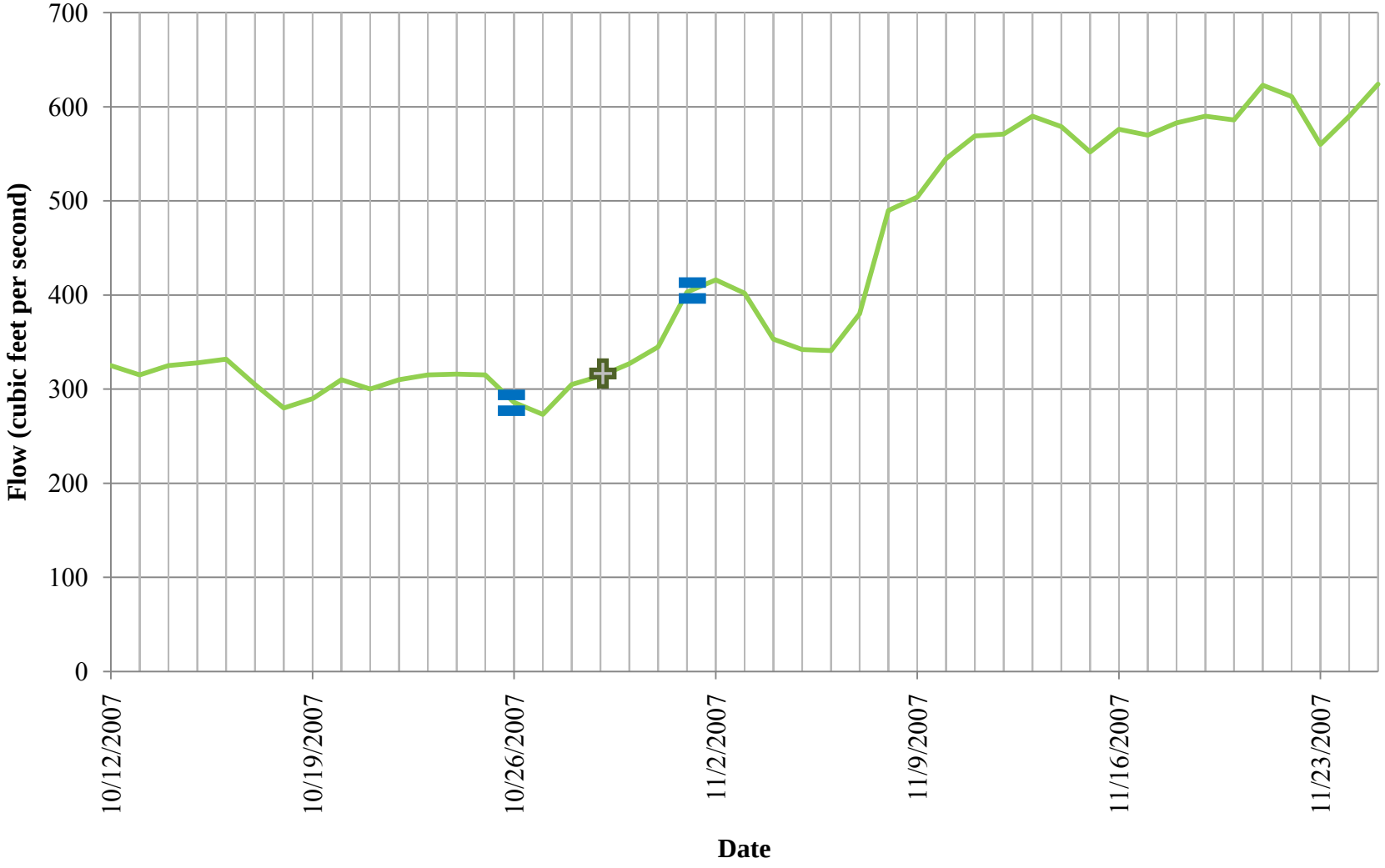


Figure 22. Mean Daily Discharge at USGS Gage 08330875, Rio Grande at Isleta Lakes near Isleta, NM, during Winter 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 3, Rio Grande at Los Padillas, NM.]

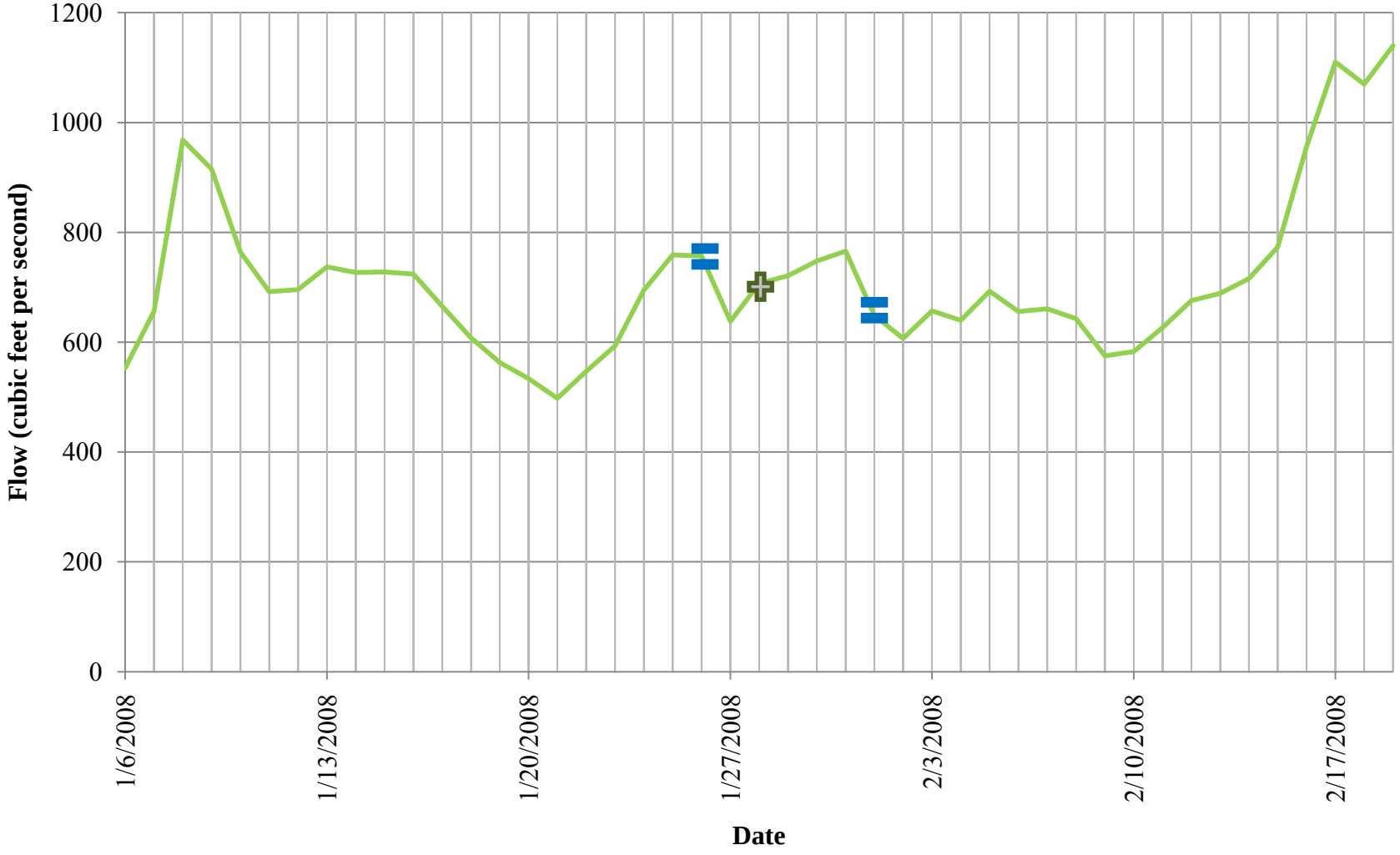


Figure 23. Mean Daily Discharge at USGS Gage 08330875, Rio Grande at Isleta Lakes near Isleta, NM, during Spring 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 3, Rio Grande at Los Padillas, NM.]

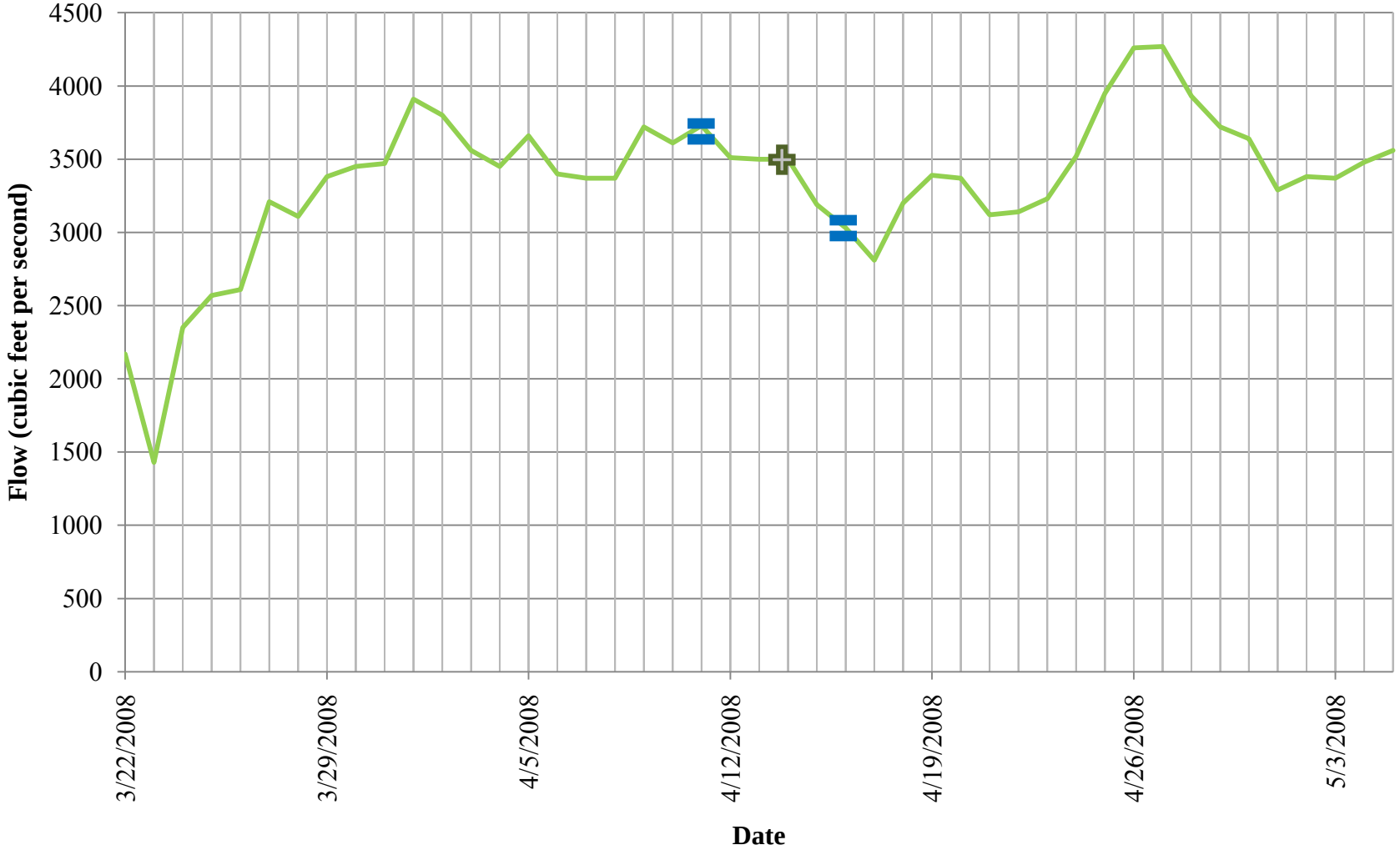


Figure 24. Mean Daily Discharge at USGS Gage 08330875, Rio Grande at Isleta Lakes near Isleta, NM, during Summer 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 3, Rio Grande at Los Padillas, NM.]

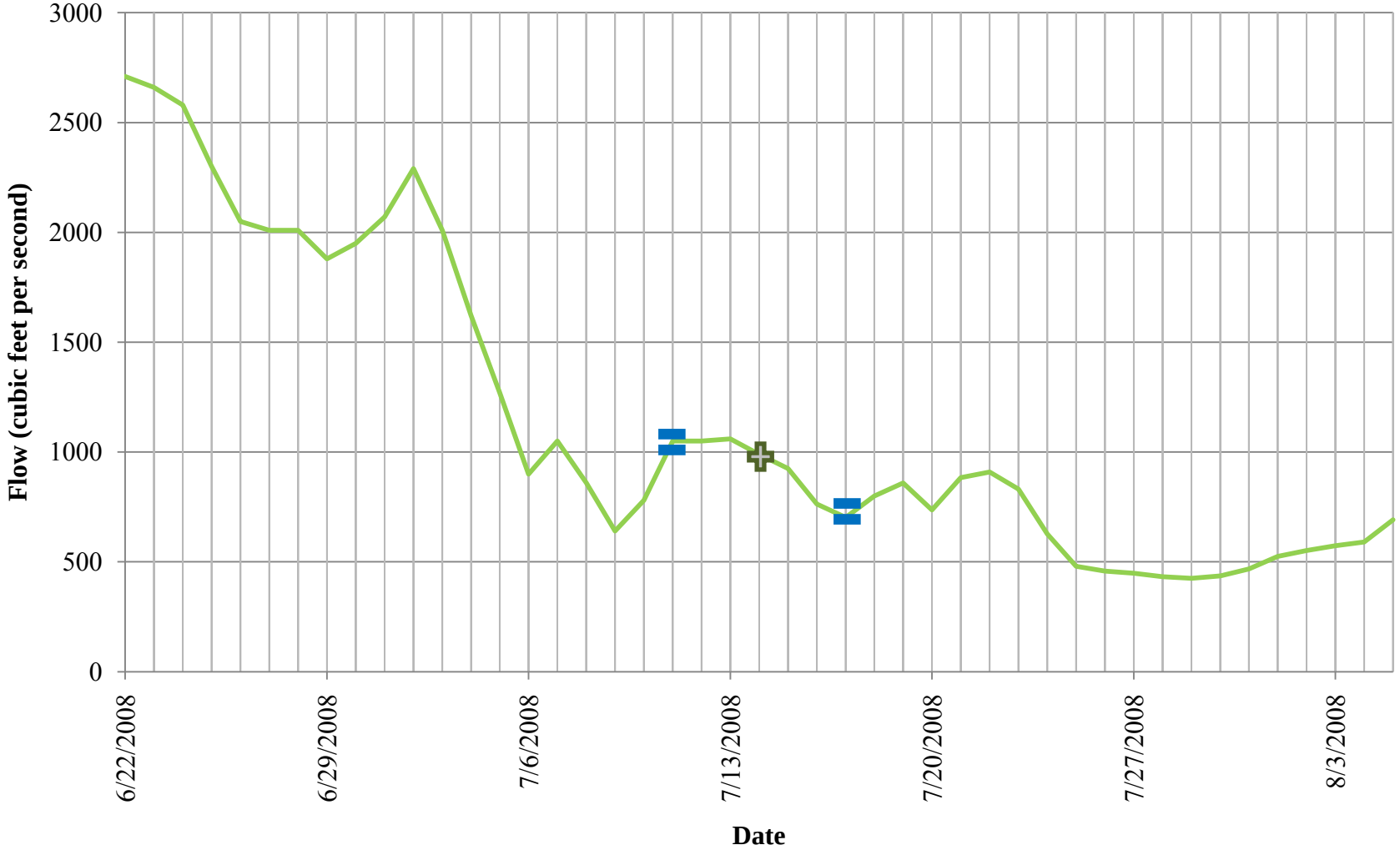


Figure 25. Mean Daily Discharge at USGS Gage 08331160, Rio Grande near Bosque Farms, NM, during Summer 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 4, Rio Grande at Los Lunas, NM.]

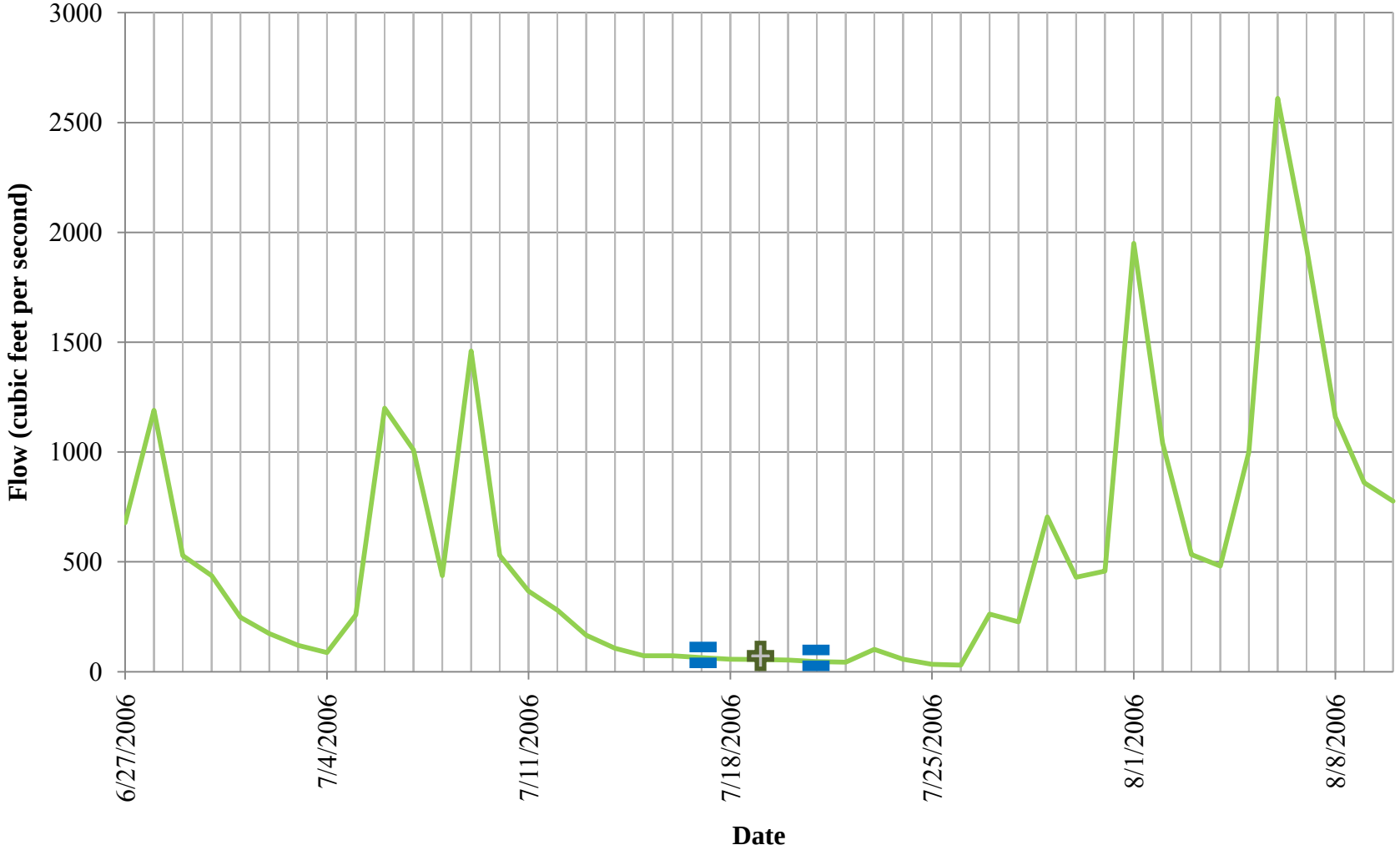


Figure 26. Mean Daily Discharge at USGS Gage 08331160, Rio Grande near Bosque Farms, NM, during Fall 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 4, Rio Grande at Los Lunas, NM.]

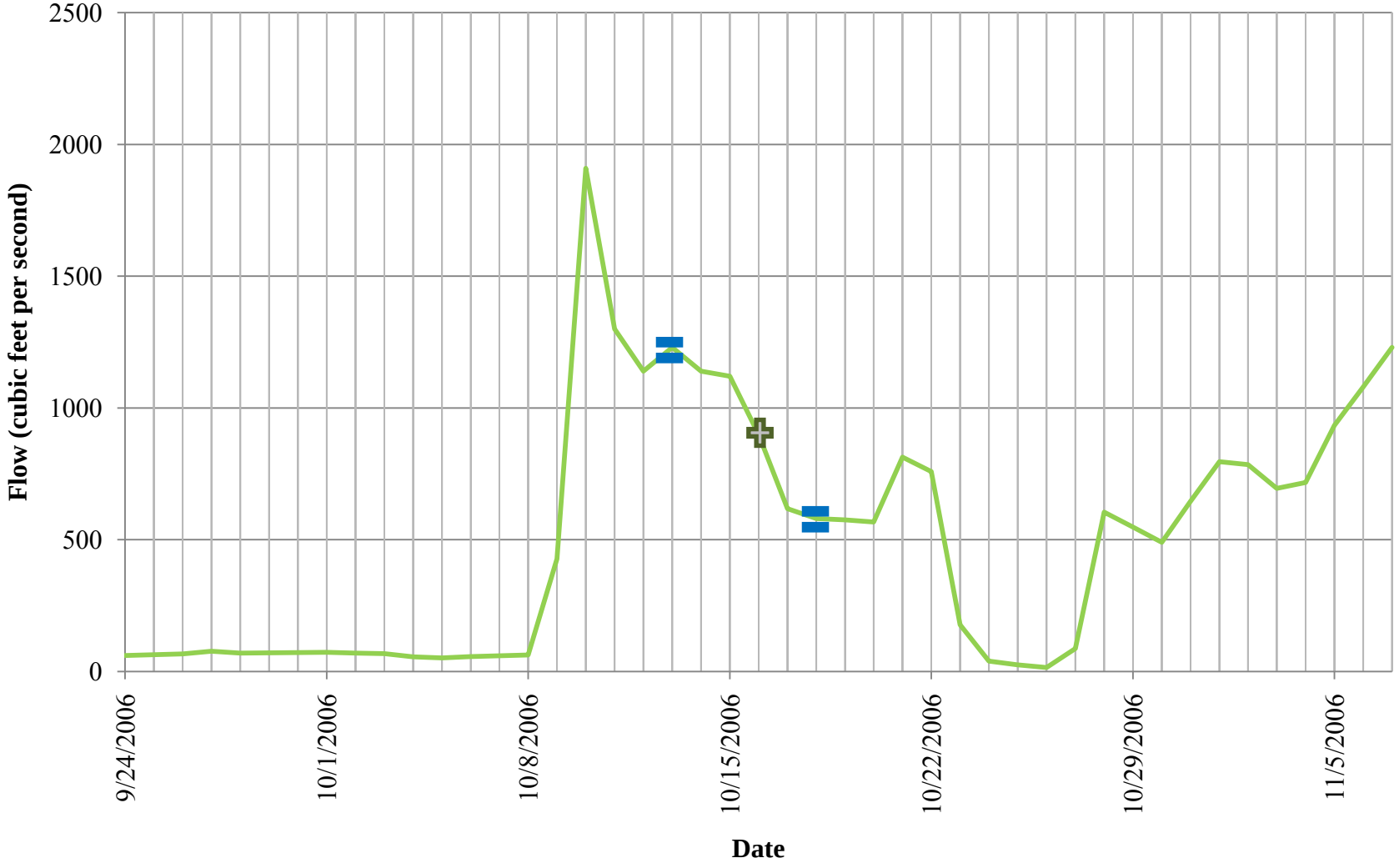


Figure 27. Mean Daily Discharge at USGS Gage 08331160, Rio Grande near Bosque Farms, NM, during Winter 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 4, Rio Grande at Los Lunas, NM.]

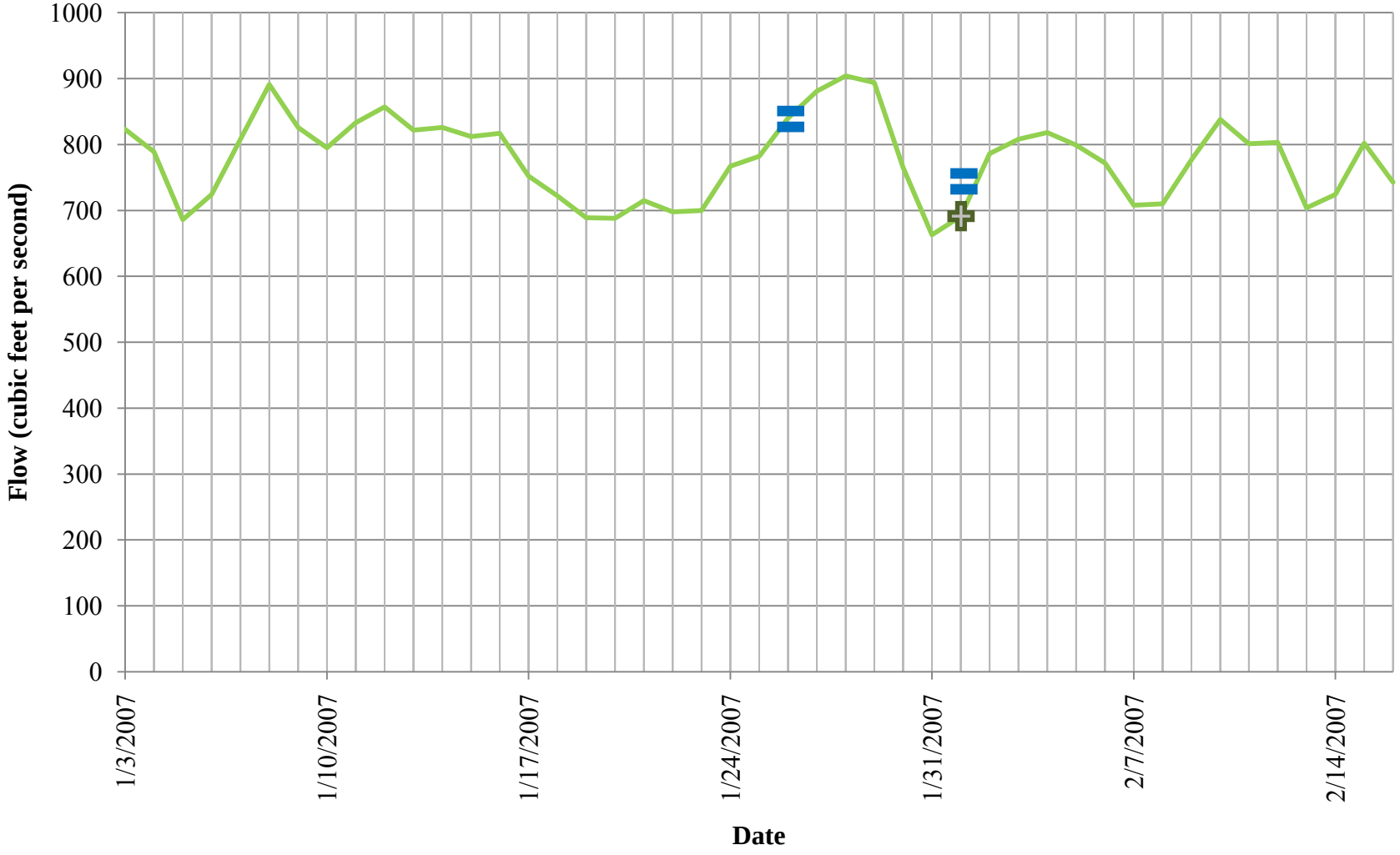


Figure 28. Mean Daily Discharge at USGS Gage 08331160, Rio Grande near Bosque Farms, NM, during Spring 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 4, Rio Grande at Los Lunas, NM.]

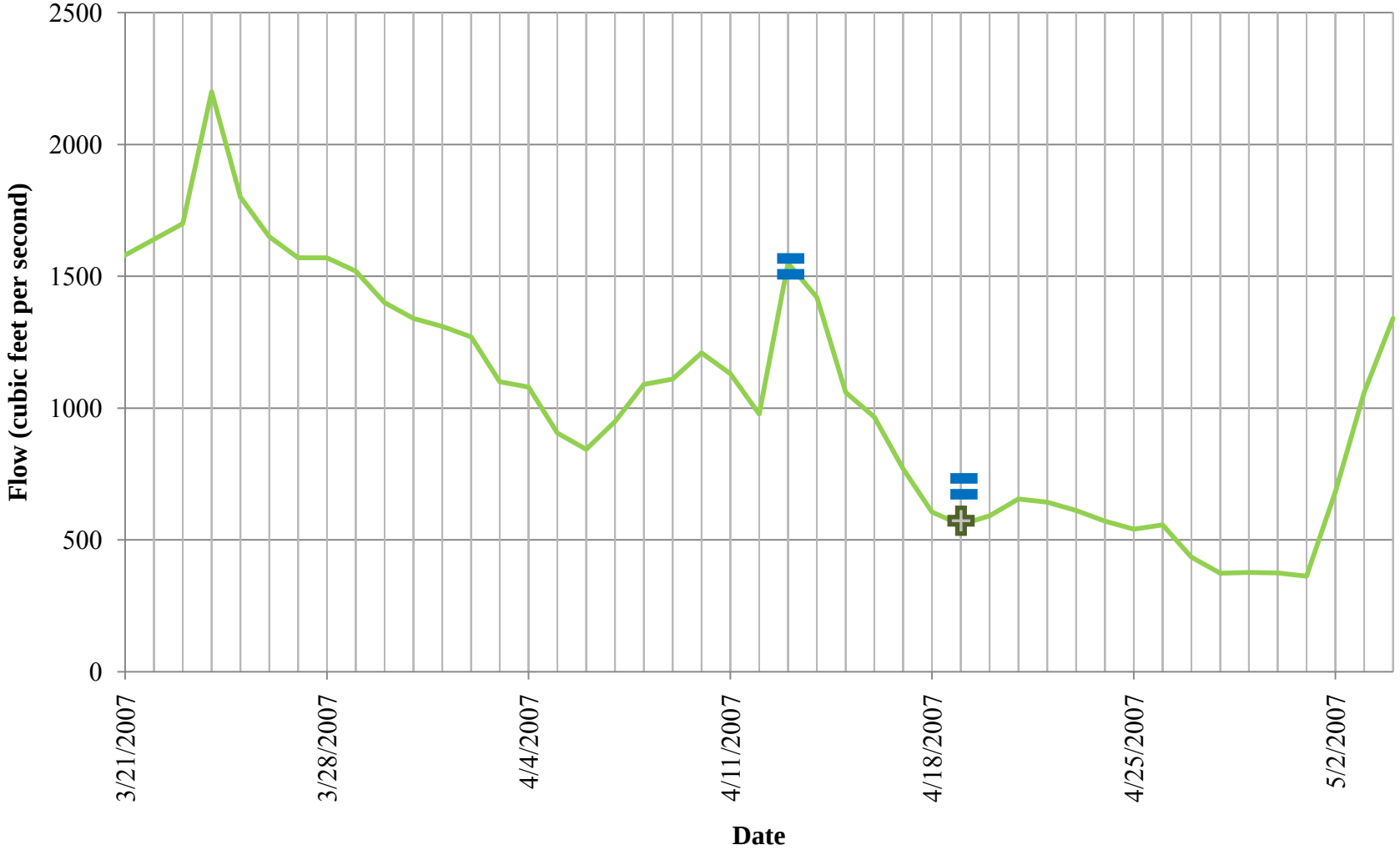


Figure 29. Mean Daily Discharge at USGS Gage 08331160, Rio Grande near Bosque Farms, NM, during Fall 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 4, Rio Grande at Los Lunas, NM.]

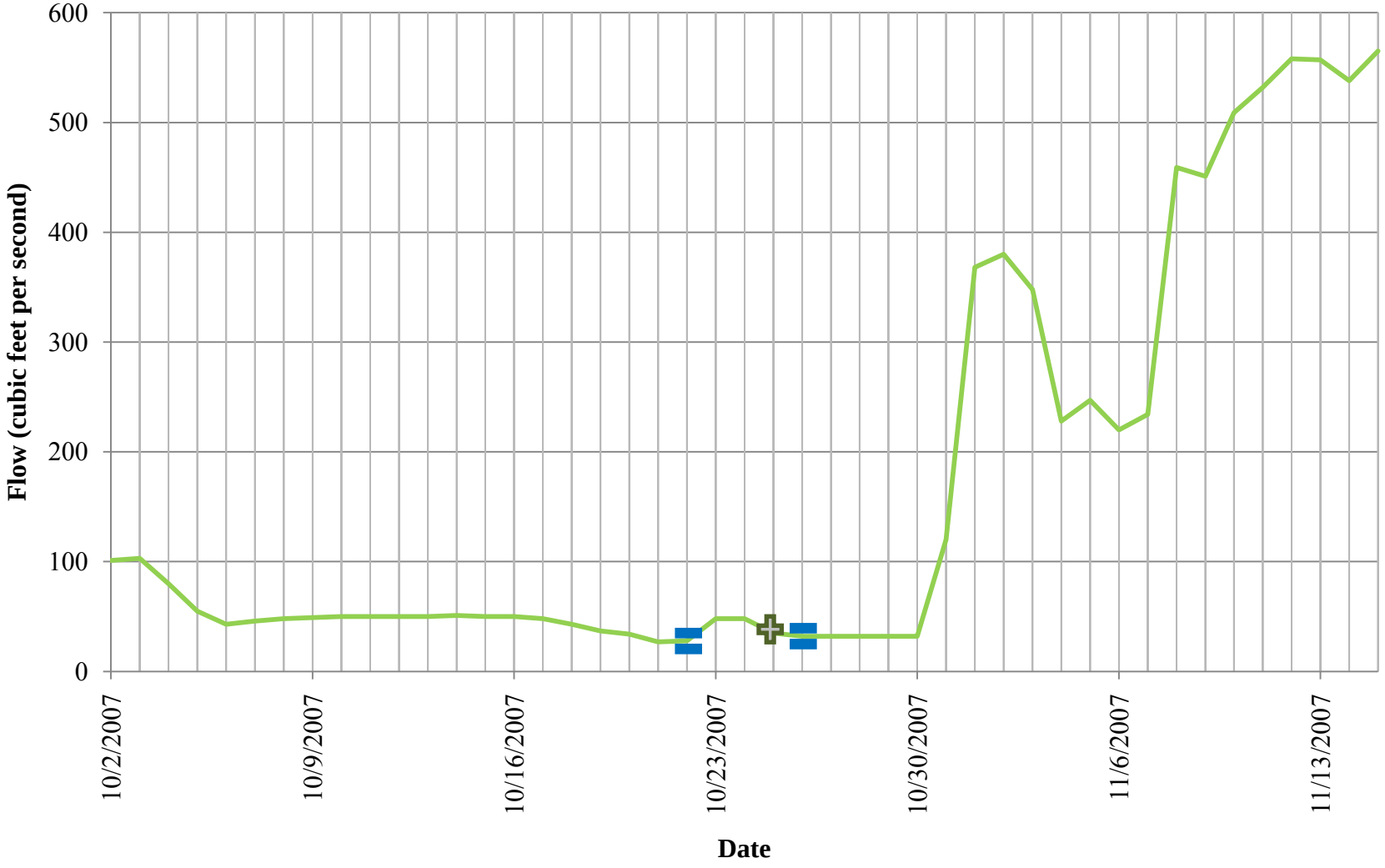


Figure 30. Mean Daily Discharge at USGS Gage 08331160, Rio Grande near Bosque Farms, NM, during Winter 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 4, Rio Grande at Los Lunas, NM.]

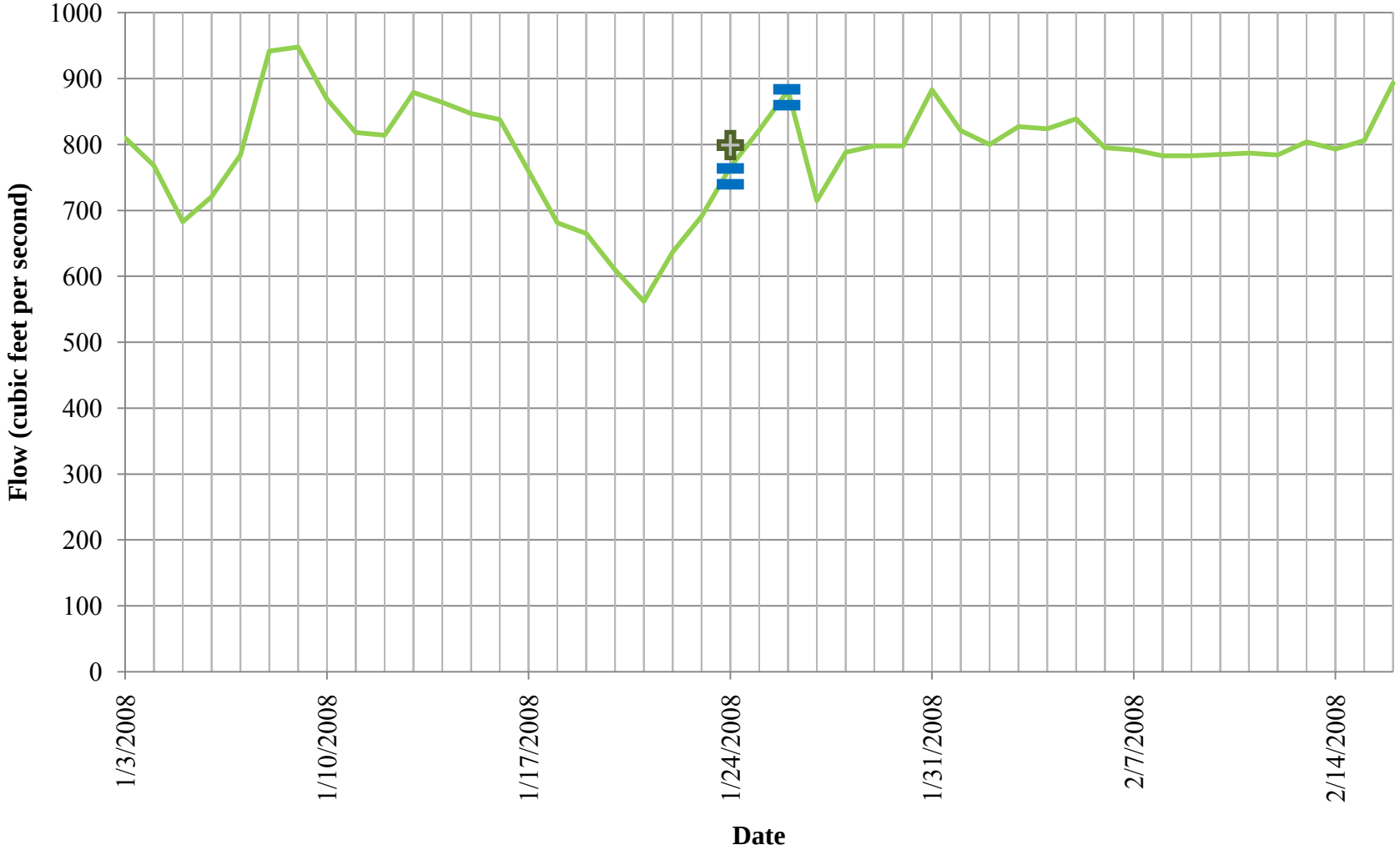


Figure 31. Mean Daily Discharge at USGS Gage 08331160, Rio Grande near Bosque Farms, NM, during Spring 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 4, Rio Grande at Los Lunas, NM.]

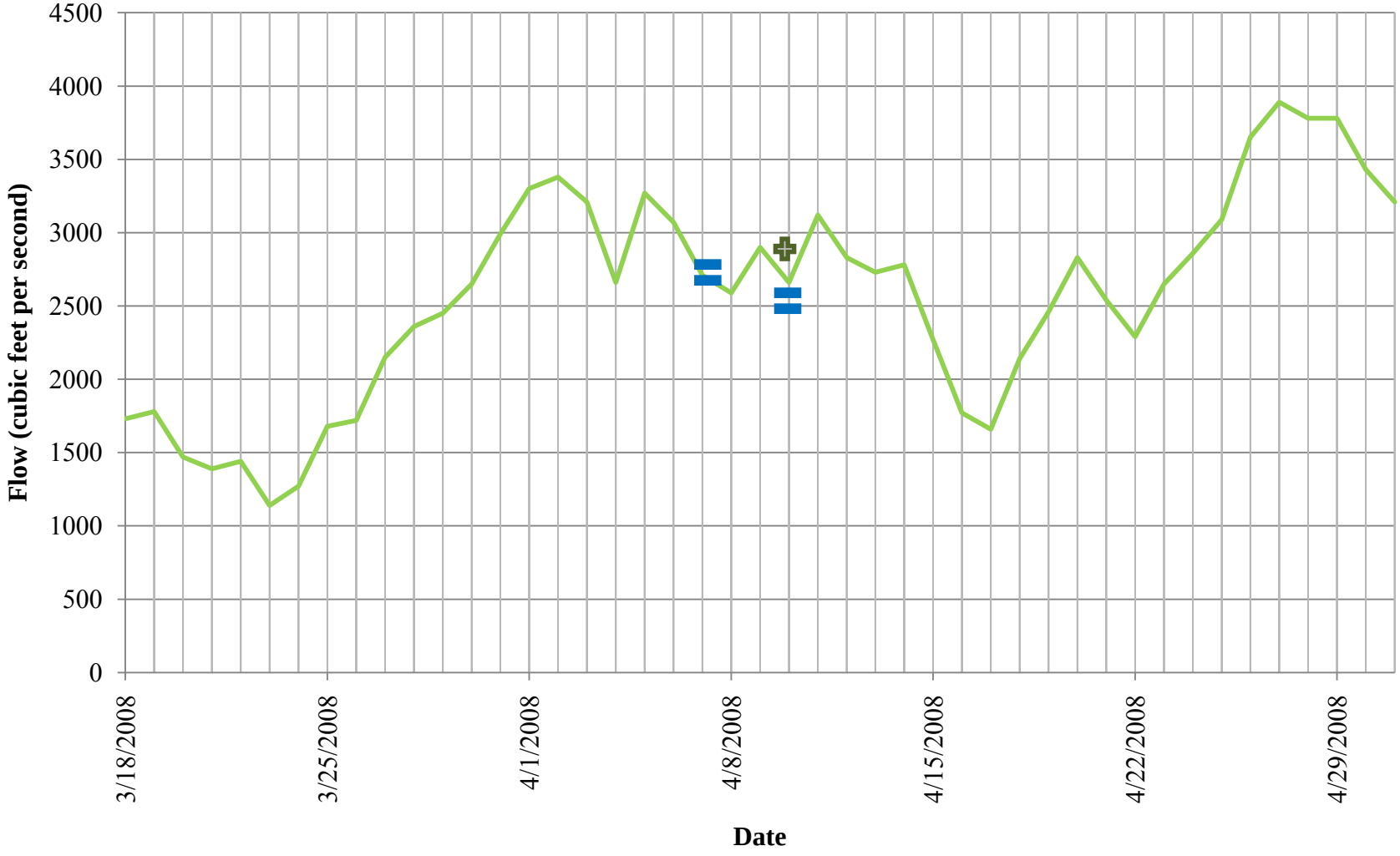


Figure 32. Mean Daily Discharge at USGS Gage 08331160, Rio Grande near Bosque Farms, NM, during Summer 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 4, Rio Grande at Los Lunas, NM.]

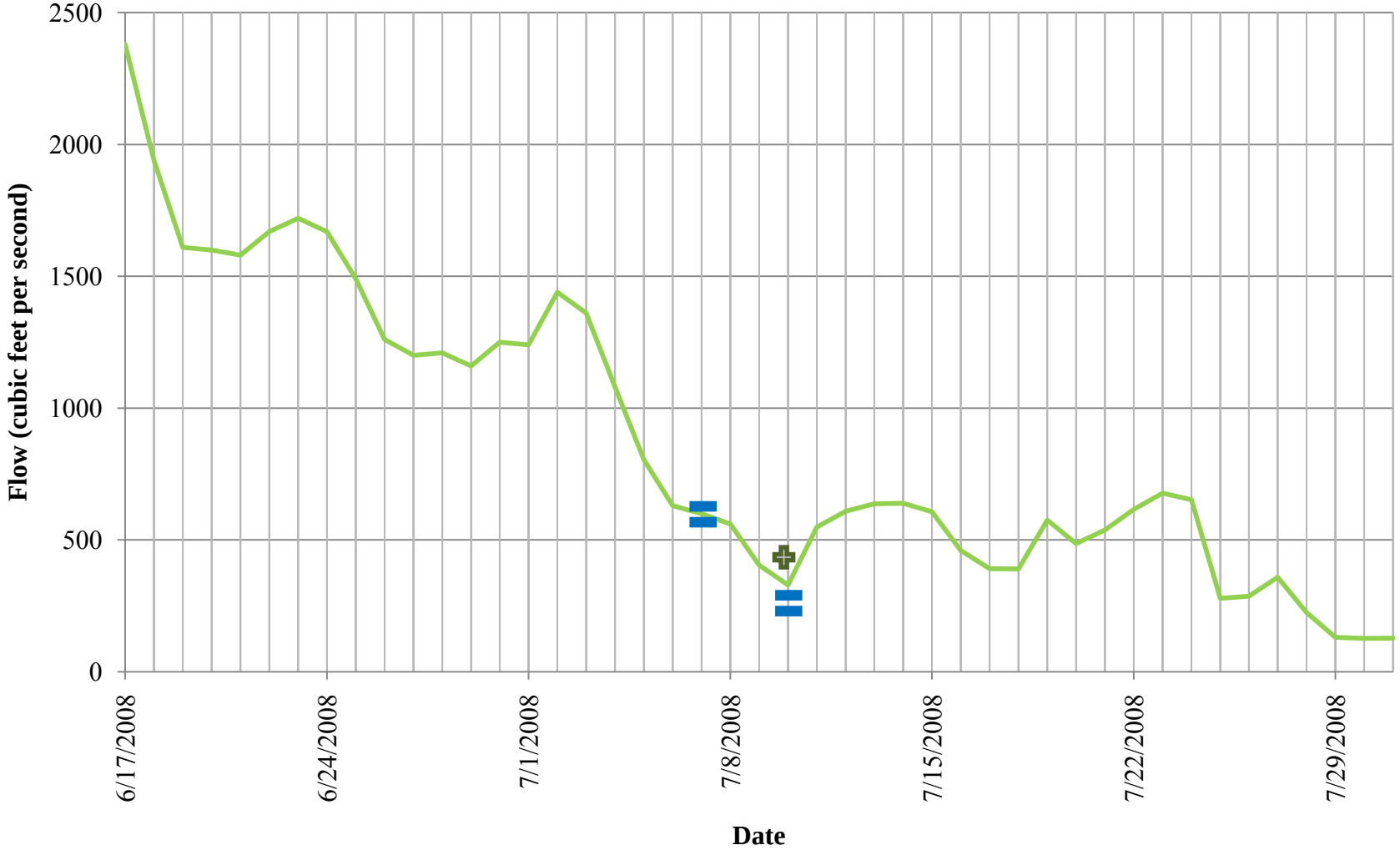


Figure 33. Sum of the Mean Daily Discharge at USGS Gage 08331510, Rio Grande at State Highway 346 near Bosque, NM, and USGS Gage 08353000 Rio Puerco near Bernardo, NM, during Summer 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 5, Rio Grande at La Joya, NM.]

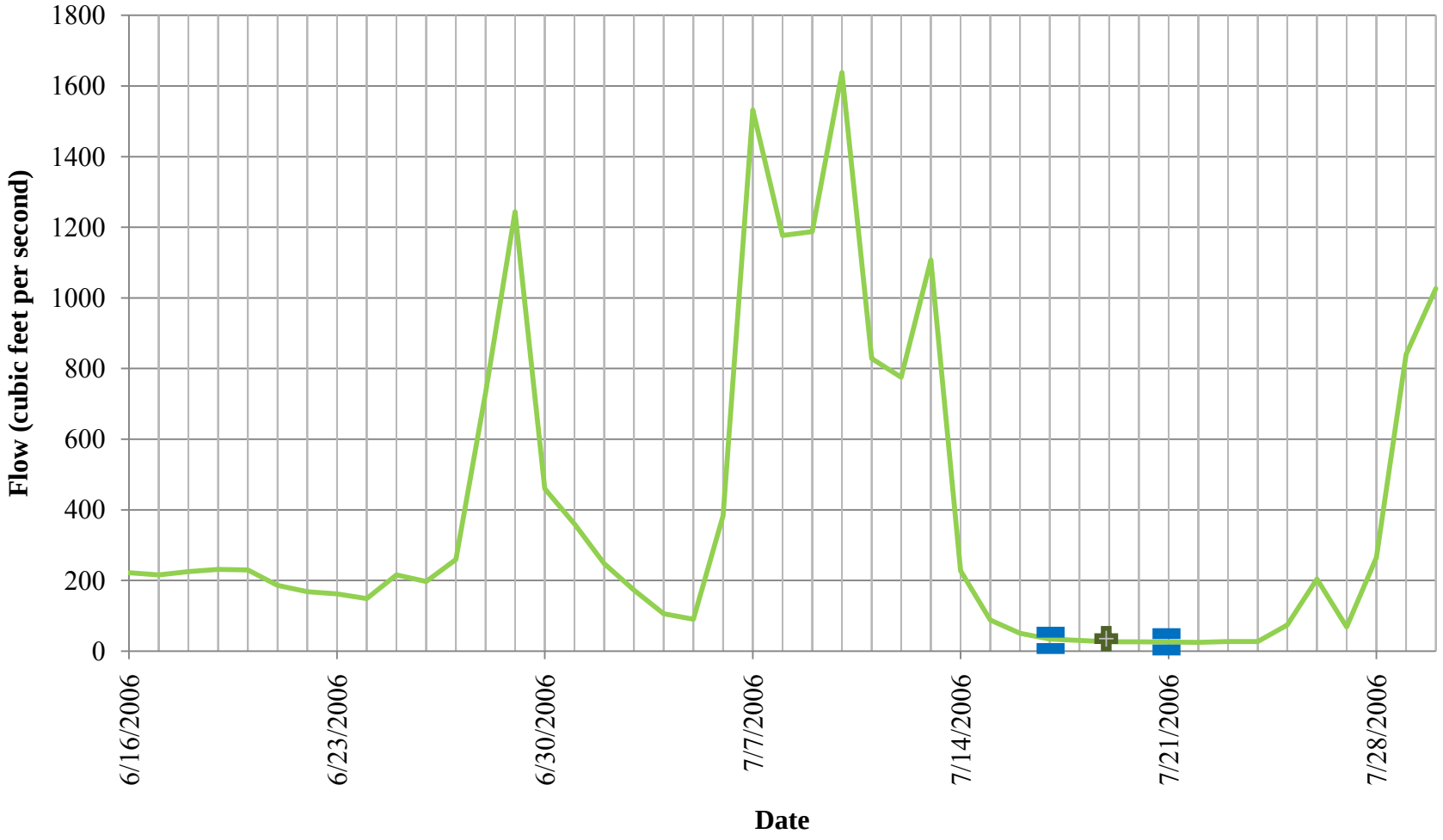


Figure 34. Sum of the Mean Daily Discharge at USGS Gage 08331510, Rio Grande at State Highway 346 near Bosque, NM, and USGS Gage 08353000 Rio Puerco near Bernardo, NM, during Fall 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 5, Rio Grande at La Joya, NM.]

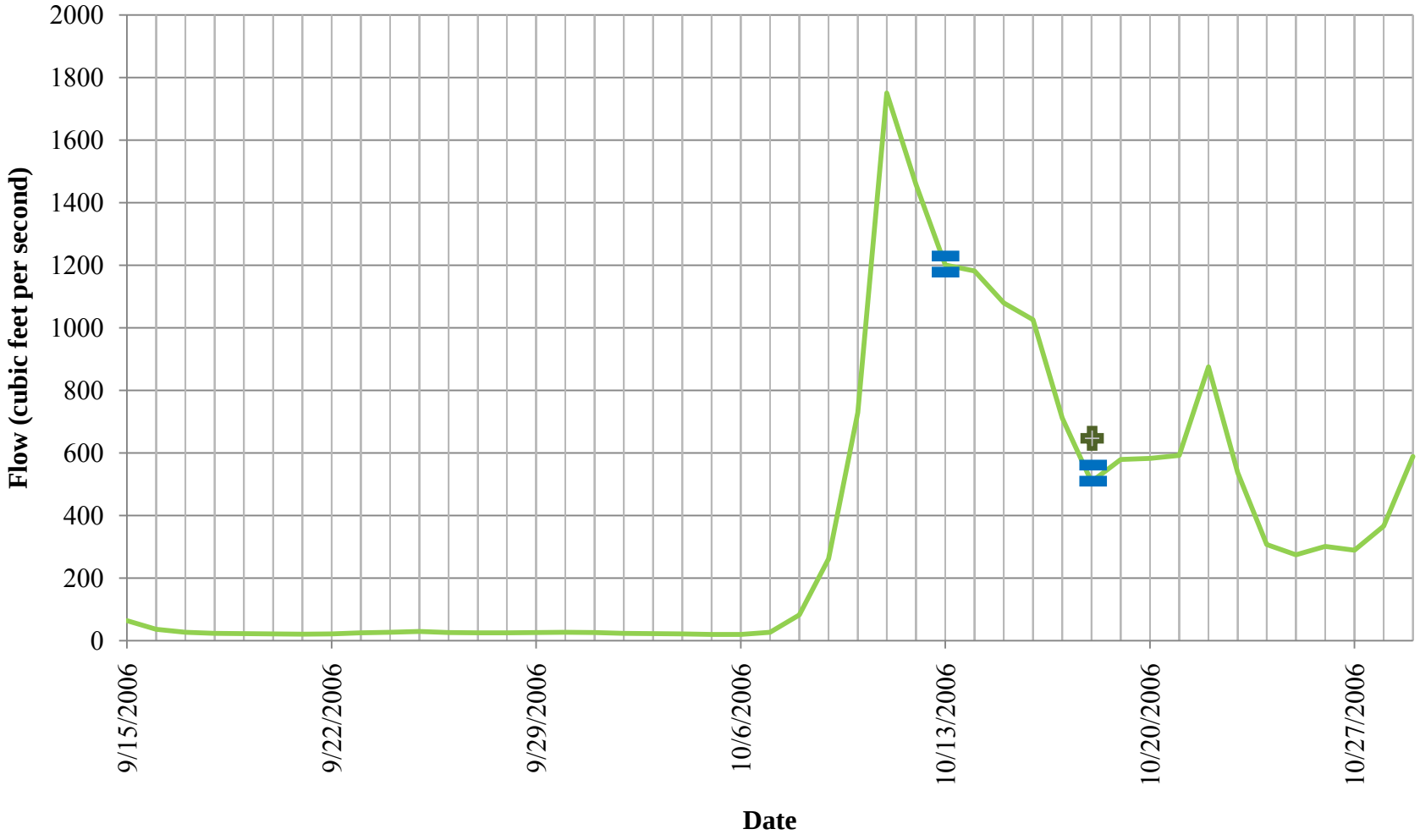


Figure 35. Sum of the Mean Daily Discharge at USGS Gage 08331510, Rio Grande at State Highway 346 near Bosque, NM, and USGS Gage 08353000 Rio Puerco near Bernardo, NM, during Winter 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 5, Rio Grande at La Joya, NM.]

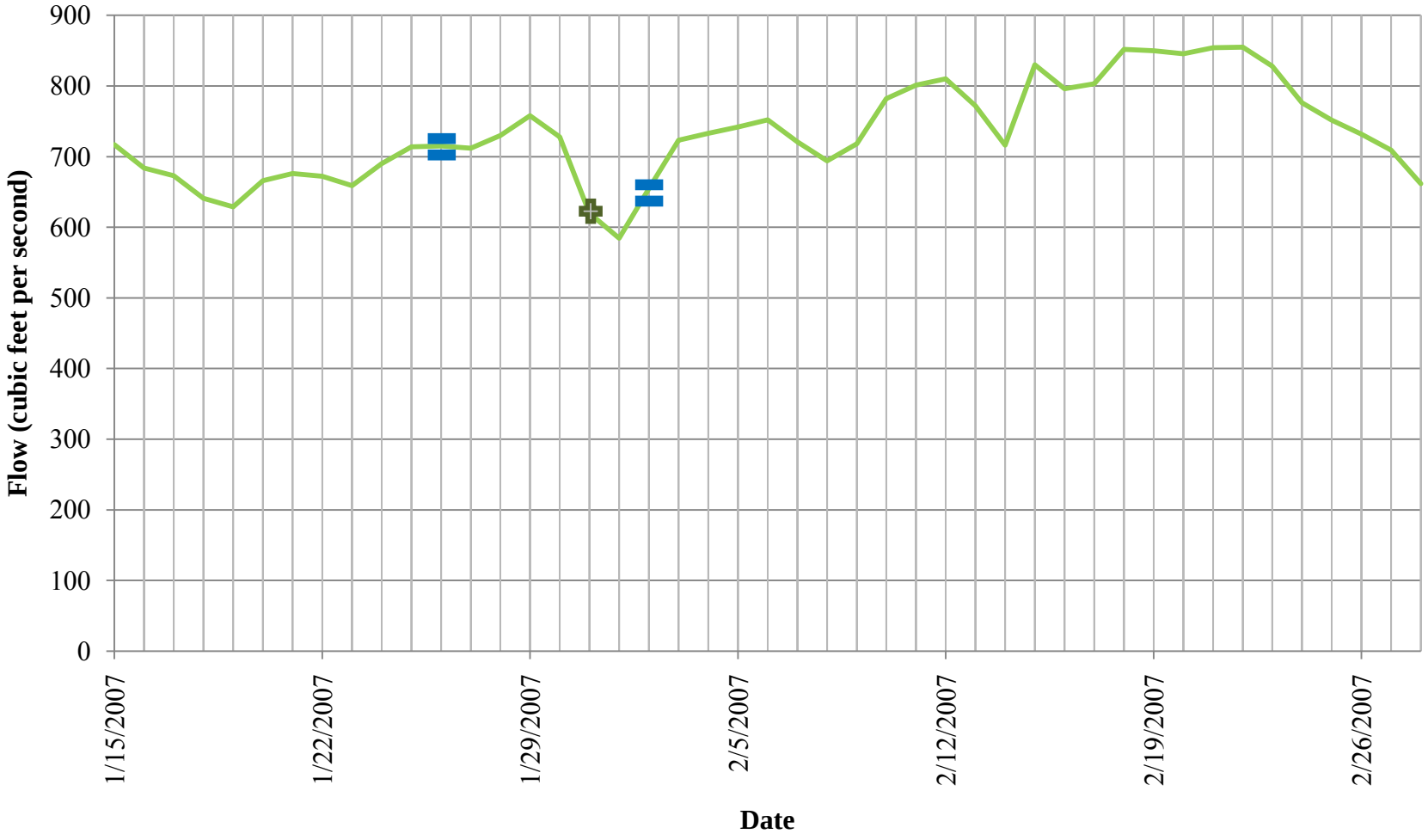


Figure 36. Sum of the Mean Daily Discharge at USGS Gage 08331510, Rio Grande at State Highway 346 near Bosque, NM, and USGS Gage 08353000 Rio Puerco near Bernardo, NM, during Spring 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 5, Rio Grande at La Joya, NM.]

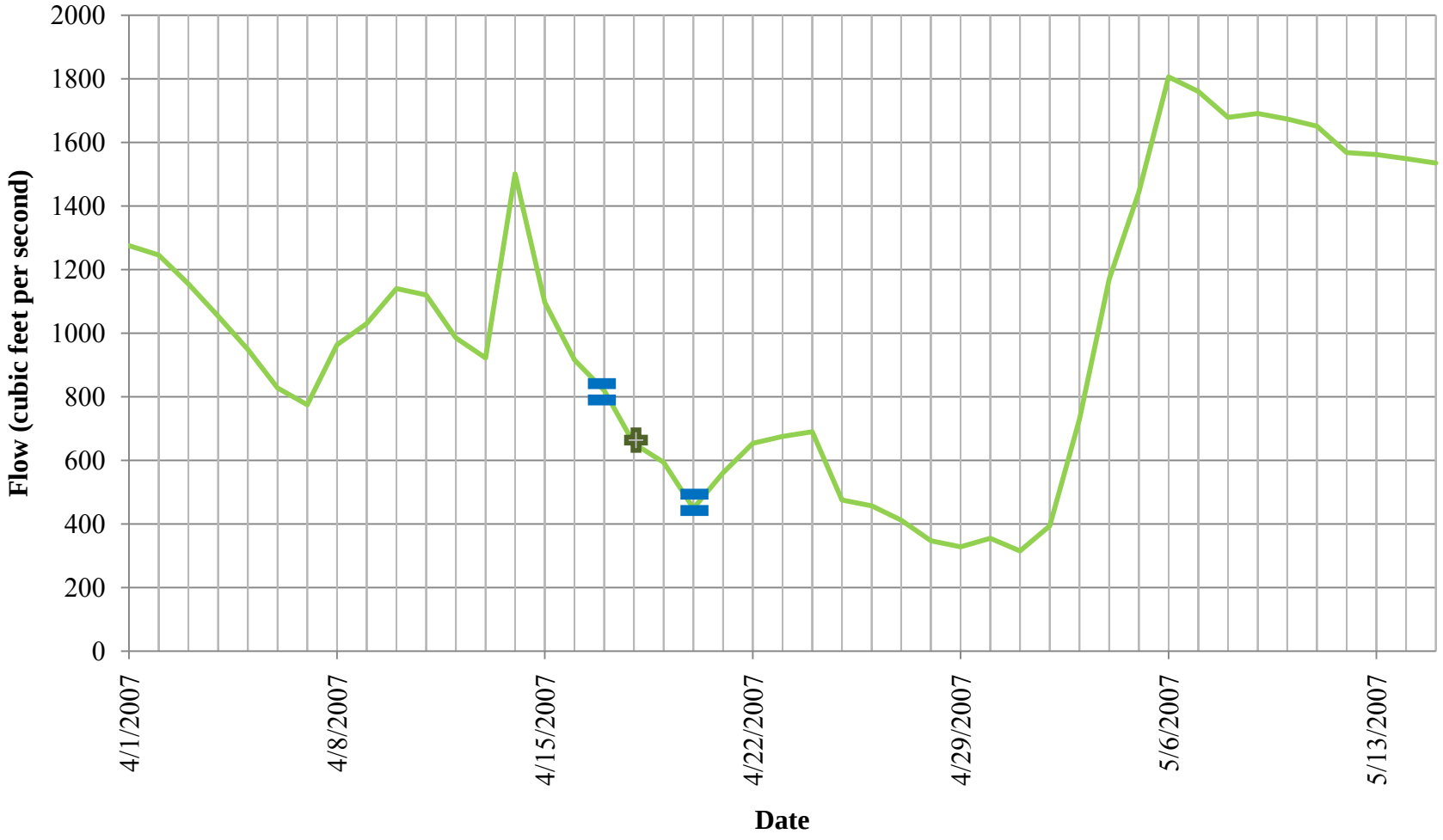


Figure 37. Sum of the Mean Daily Discharge at USGS Gage 08331510, Rio Grande at State Highway 346 near Bosque, NM, and USGS Gage 08353000 Rio Puerco near Bernardo, NM, during Fall 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 5, Rio Grande at La Joya, NM.]

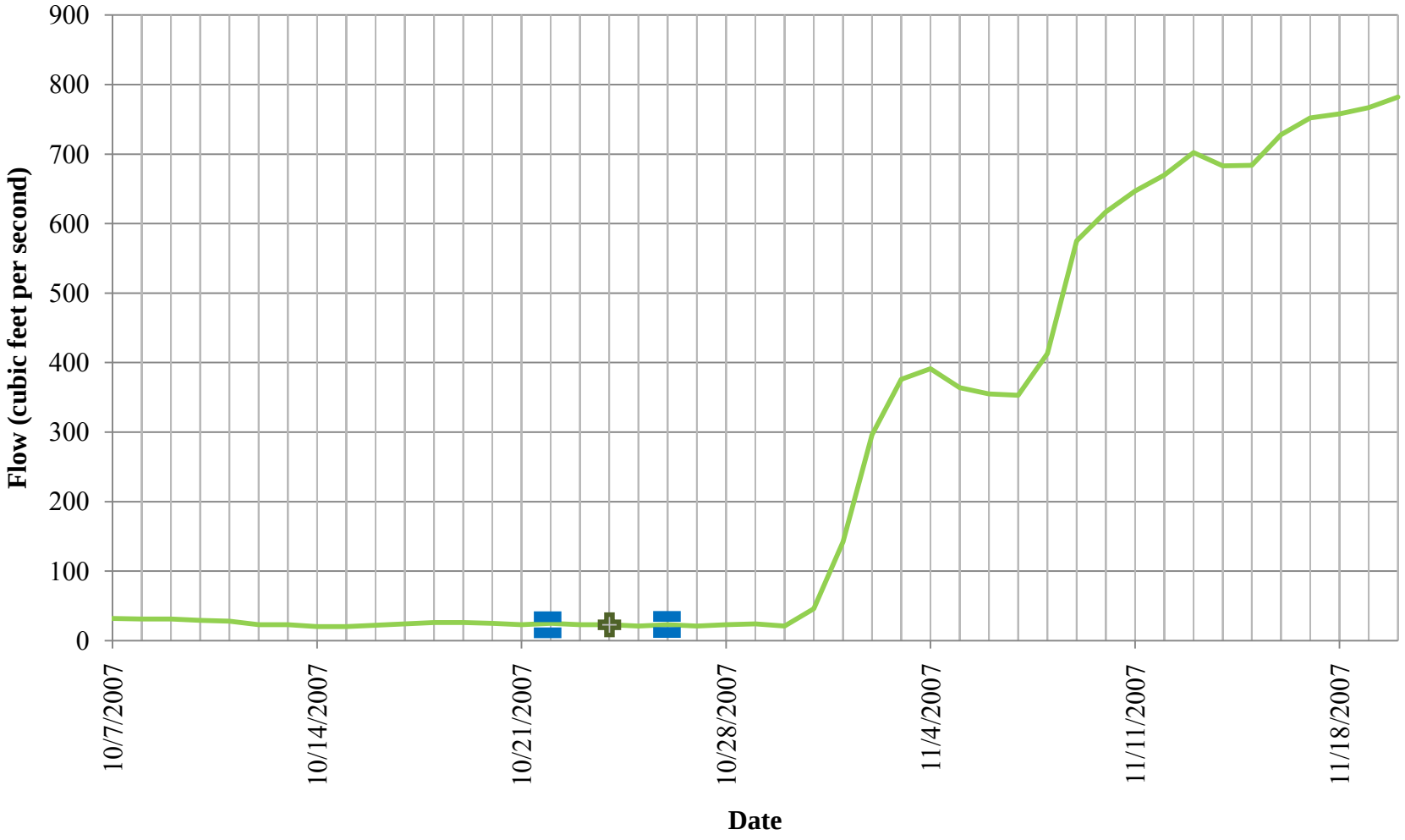


Figure 38. Sum of the Mean Daily Discharge at USGS Gage 08331510, Rio Grande at State Highway 346 near Bosque, NM, and USGS Gage 08353000 Rio Puerco near Bernardo, NM, during Winter 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 5, Rio Grande at La Joya, NM.]

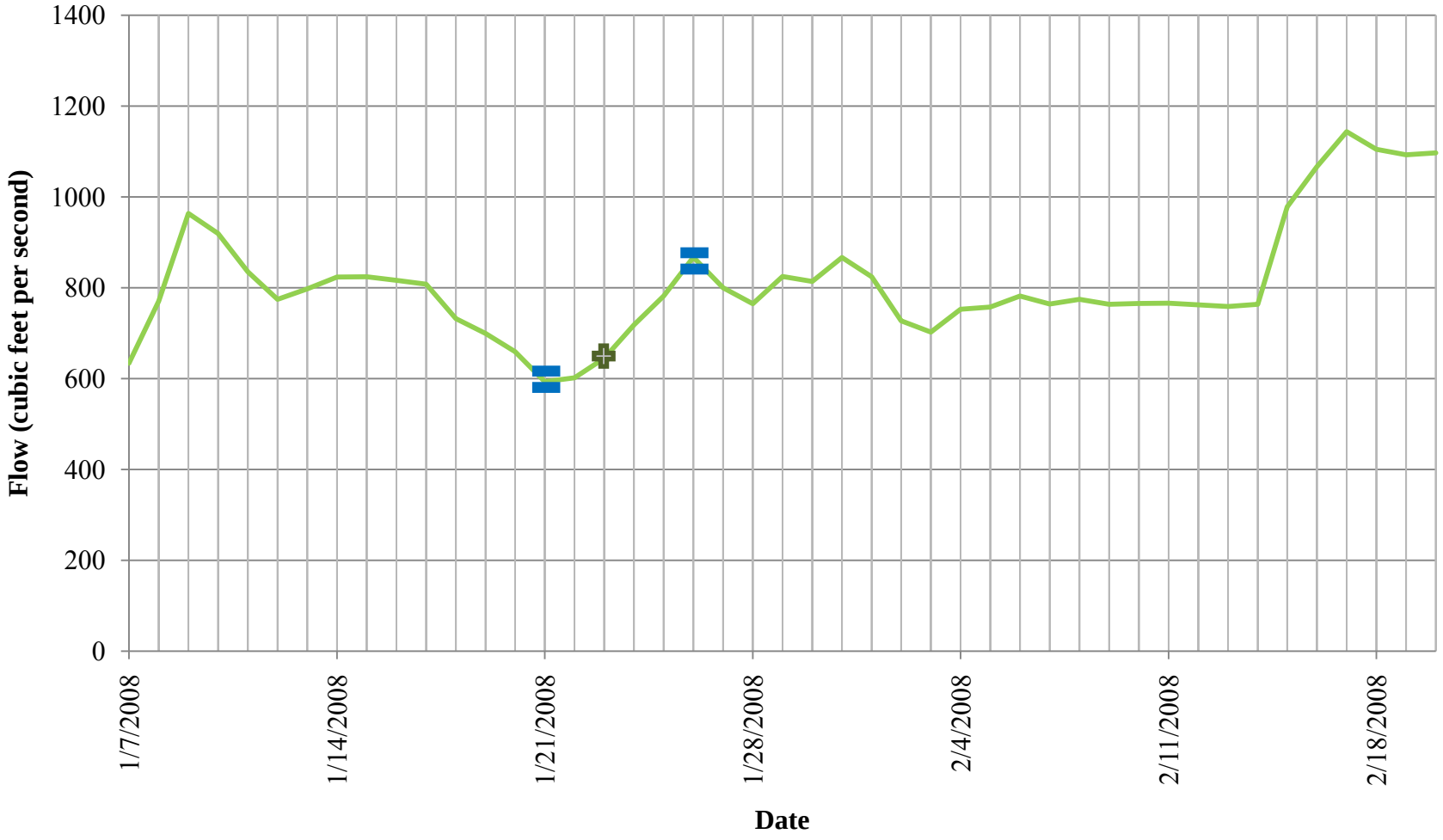


Figure 39. Sum of the Mean Daily Discharge at USGS Gage 08331510, Rio Grande at State Highway 346 near Bosque, NM, and USGS Gage 08353000 Rio Puerco near Bernardo, NM, during Spring 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 5, Rio Grande at La Joya, NM.]

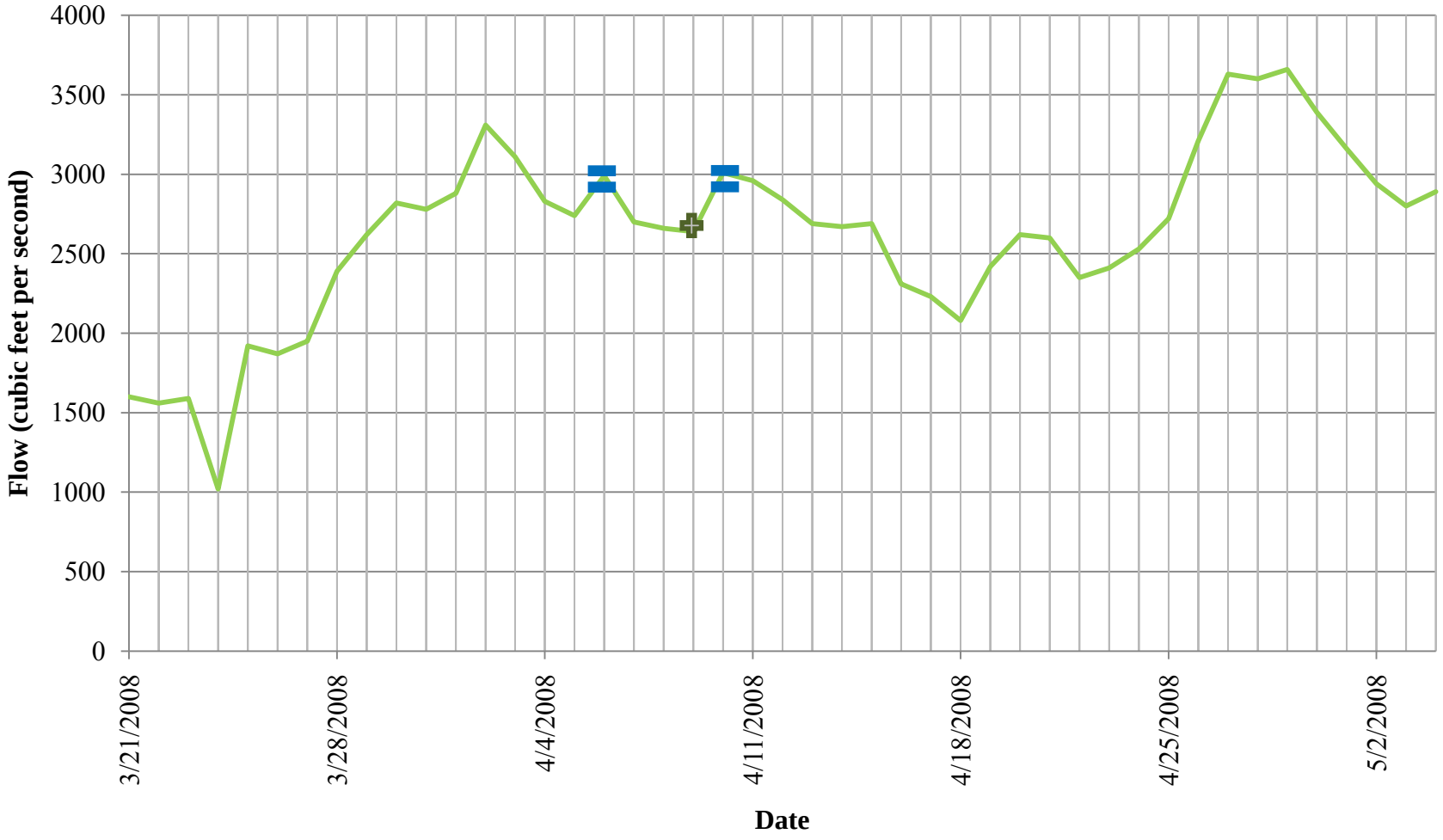


Figure 40. Sum of the Mean Daily Discharge at USGS Gage 08331510, Rio Grande at State Highway 346 near Bosque, NM, and USGS Gage 08353000 Rio Puerco near Bernardo, NM, during Summer 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 5, Rio Grande at La Joya, NM.]

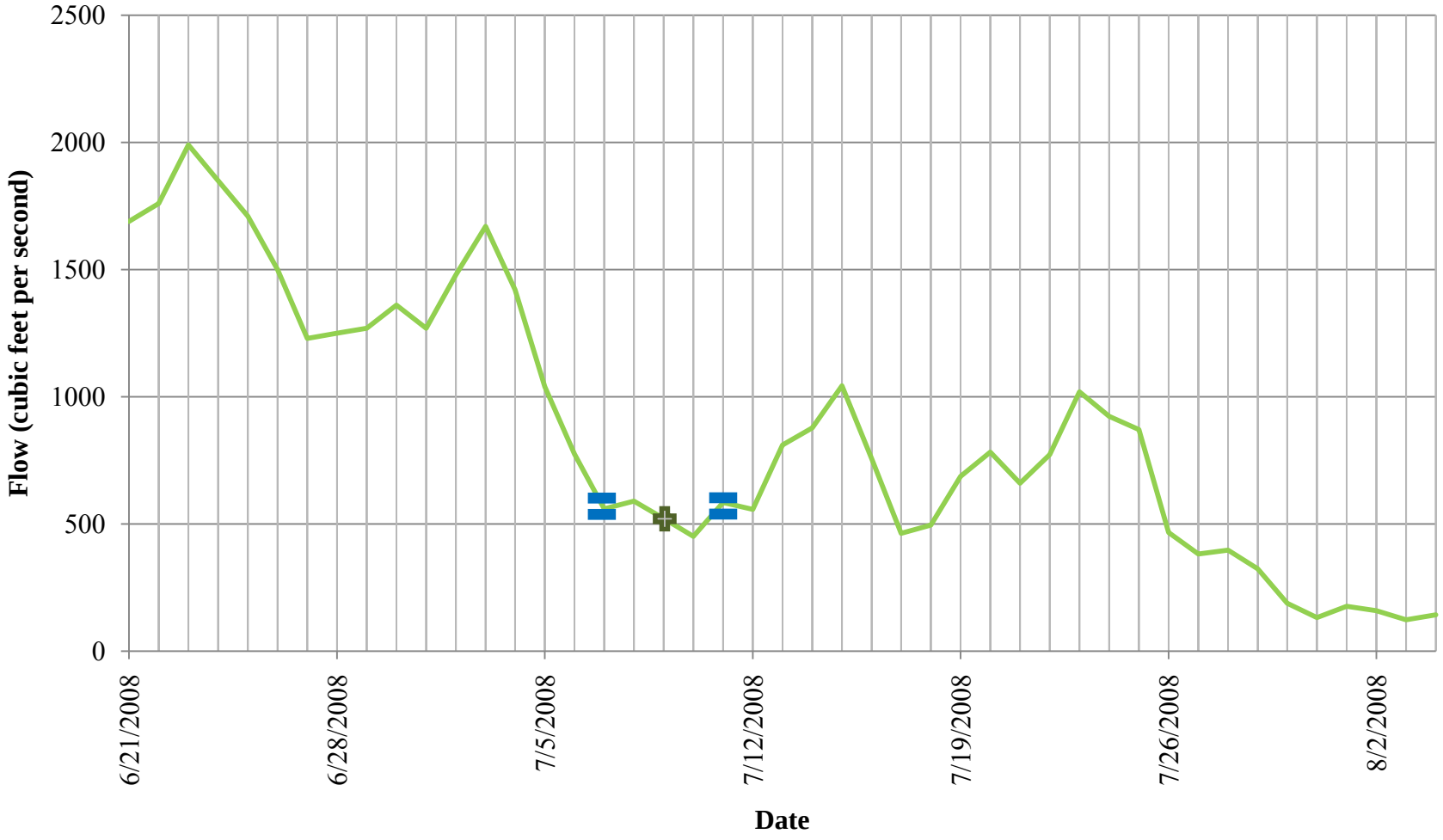


Figure 41. Mean Daily Discharge at USGS Gage 08355490, Rio Grande above US Highway 380 near San Antonio, NM, during Summer 2006.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 6, Rio Grande near San Antonio, NM.]

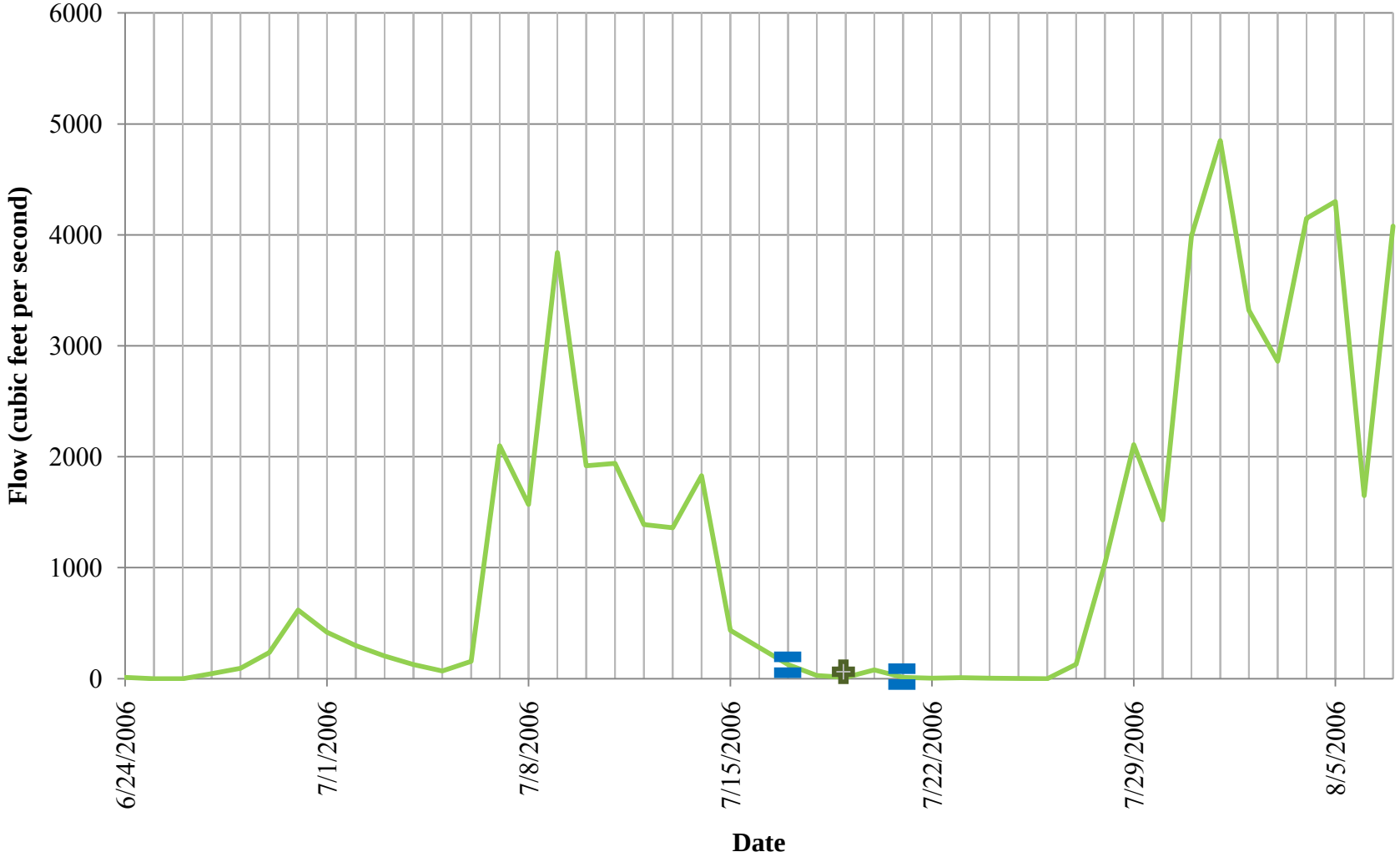


Figure 42. Mean Daily Discharge at USGS Gage 08355490, Rio Grande above US Highway 380 near San Antonio, NM, during Fall 2006.

["=", indicates start and end of continuous water quality monitoring at Rio Grande near Lemitar, NM.] ; and "+", indicates fish collection event at Site 6, Rio Grande near San Antonio, NM.]

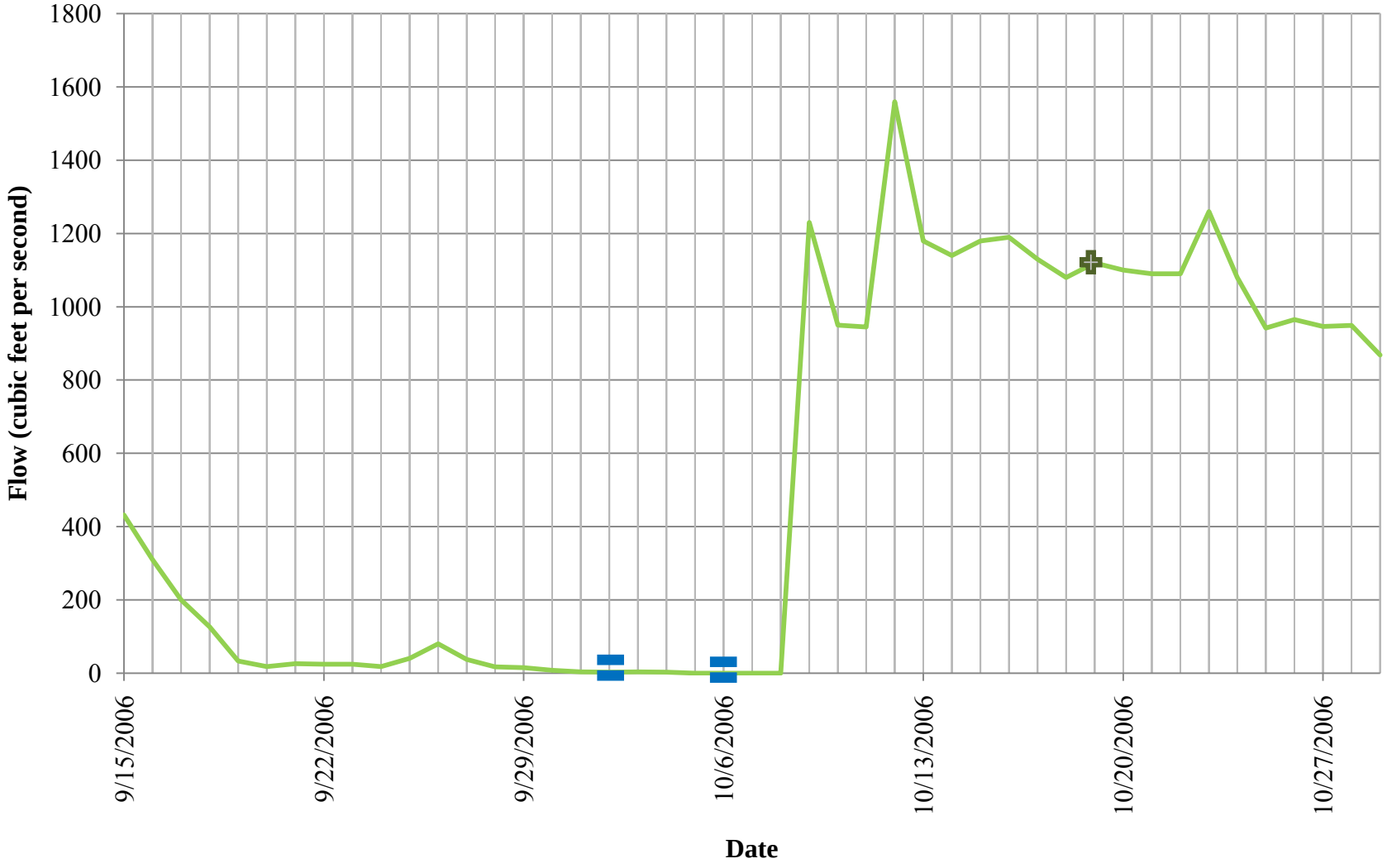


Figure 43. Mean Daily Discharge at USGS Gage 08355490, Rio Grande above US Highway 380 near San Antonio, NM, during Winter 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 6, Rio Grande near San Antonio, NM.]

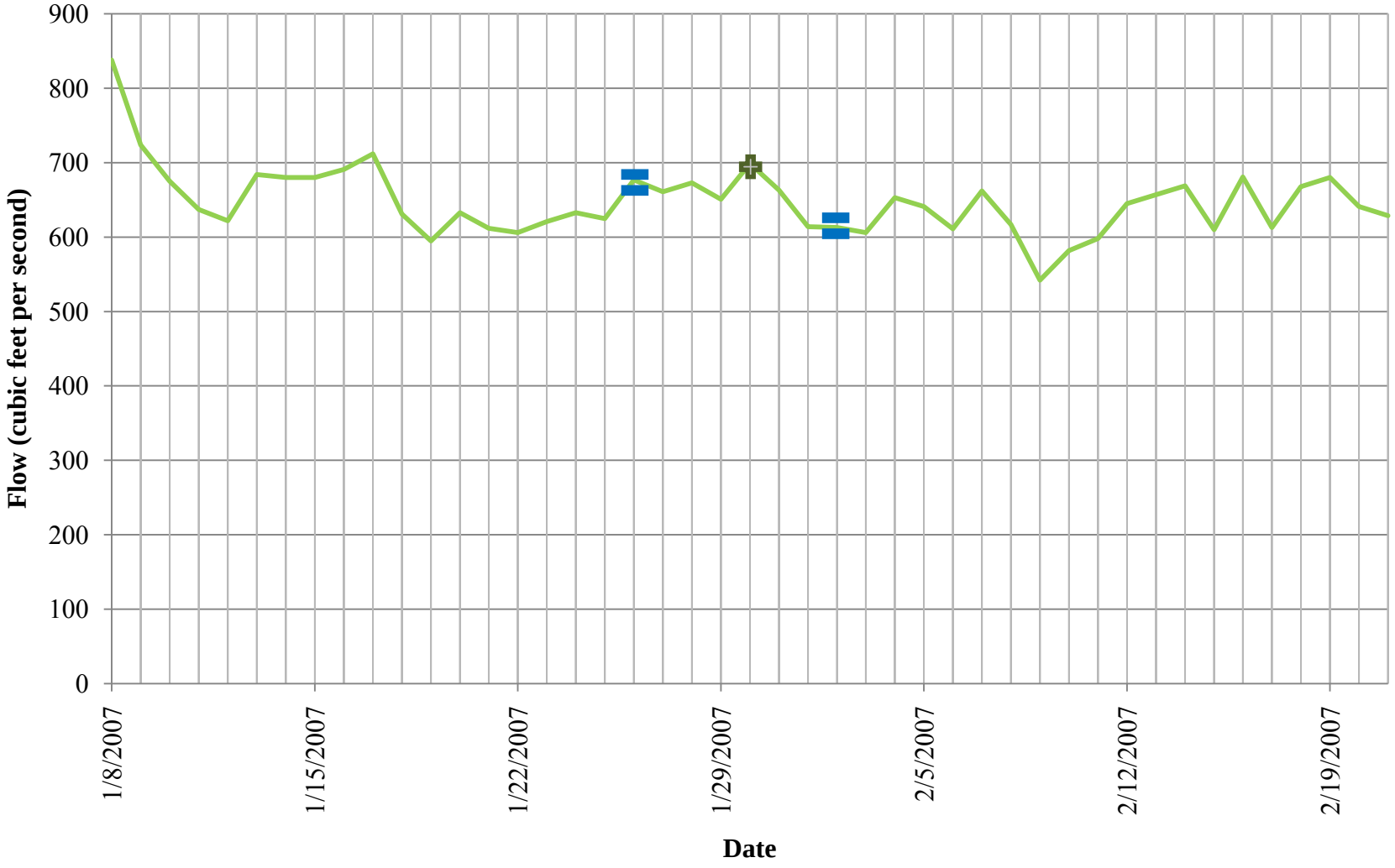


Figure 44. Mean Daily Discharge at USGS Gage 08355490, Rio Grande above US Highway 380 near San Antonio, NM, during Spring 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 6, Rio Grande near San Antonio, NM.]

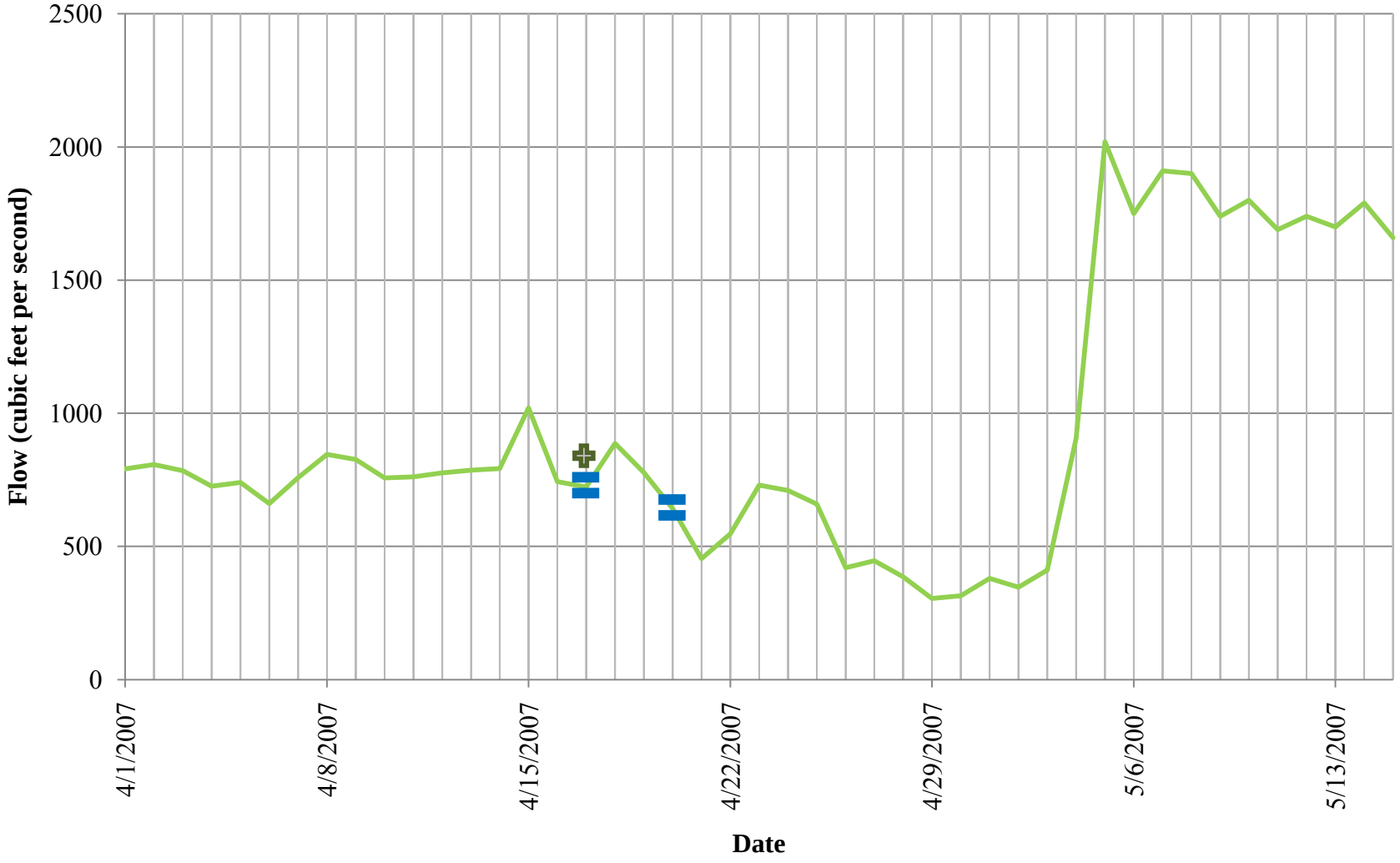


Figure 45. Mean Daily Discharge at USGS Gage 08355490, Rio Grande above US Highway 380 near San Antonio, NM, during Fall 2007.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 6, Rio Grande near San Antonio, NM.]

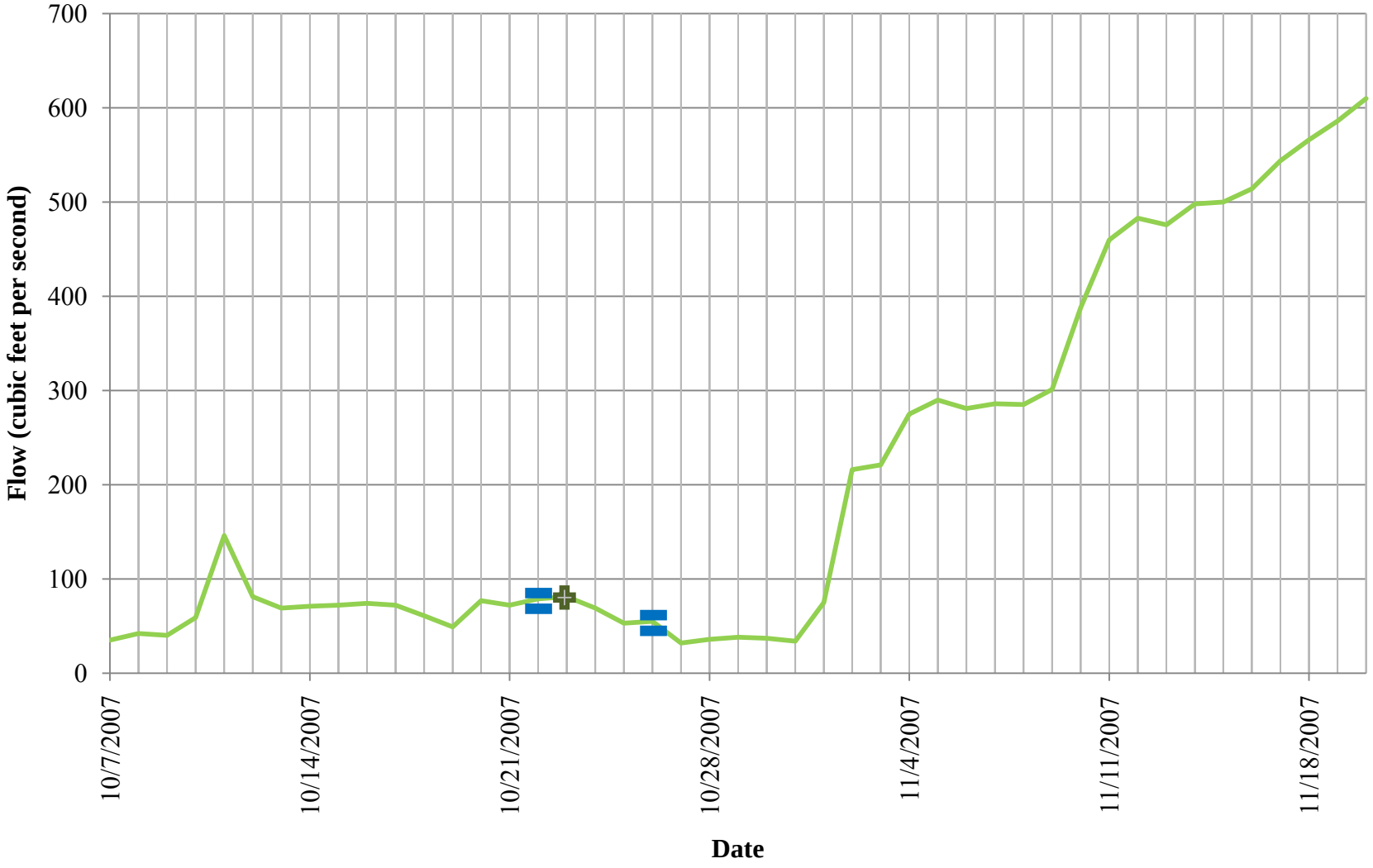


Figure 46. Mean Daily Discharge at USGS Gage 08355490, Rio Grande above US Highway 380 near San Antonio, NM, during Winter 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 6, Rio Grande near San Antonio, NM.]

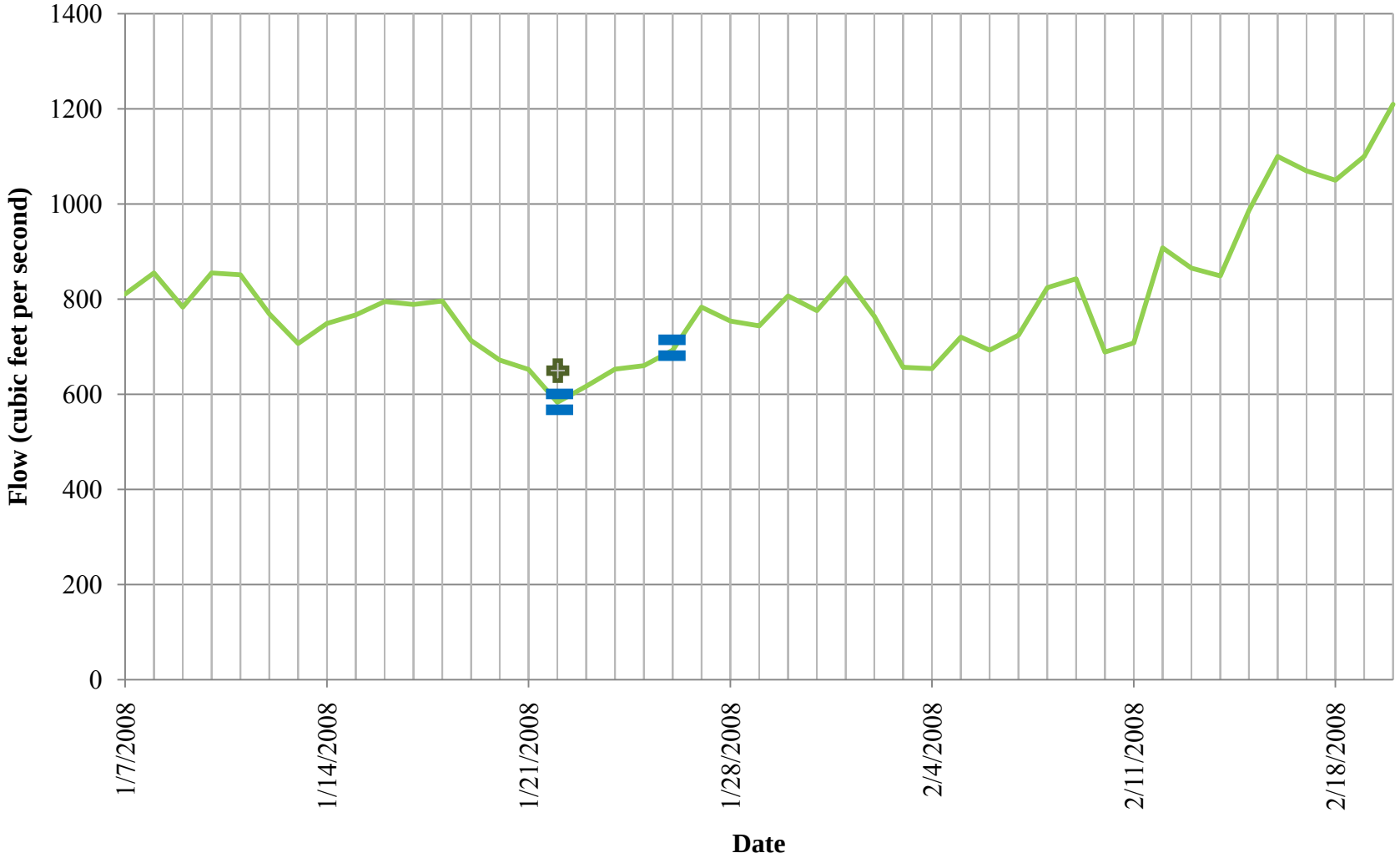


Figure 47. Mean Daily Discharge at USGS Gage 08355490, Rio Grande above US Highway 380 near San Antonio, NM, during Spring 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 6, Rio Grande near San Antonio, NM.]

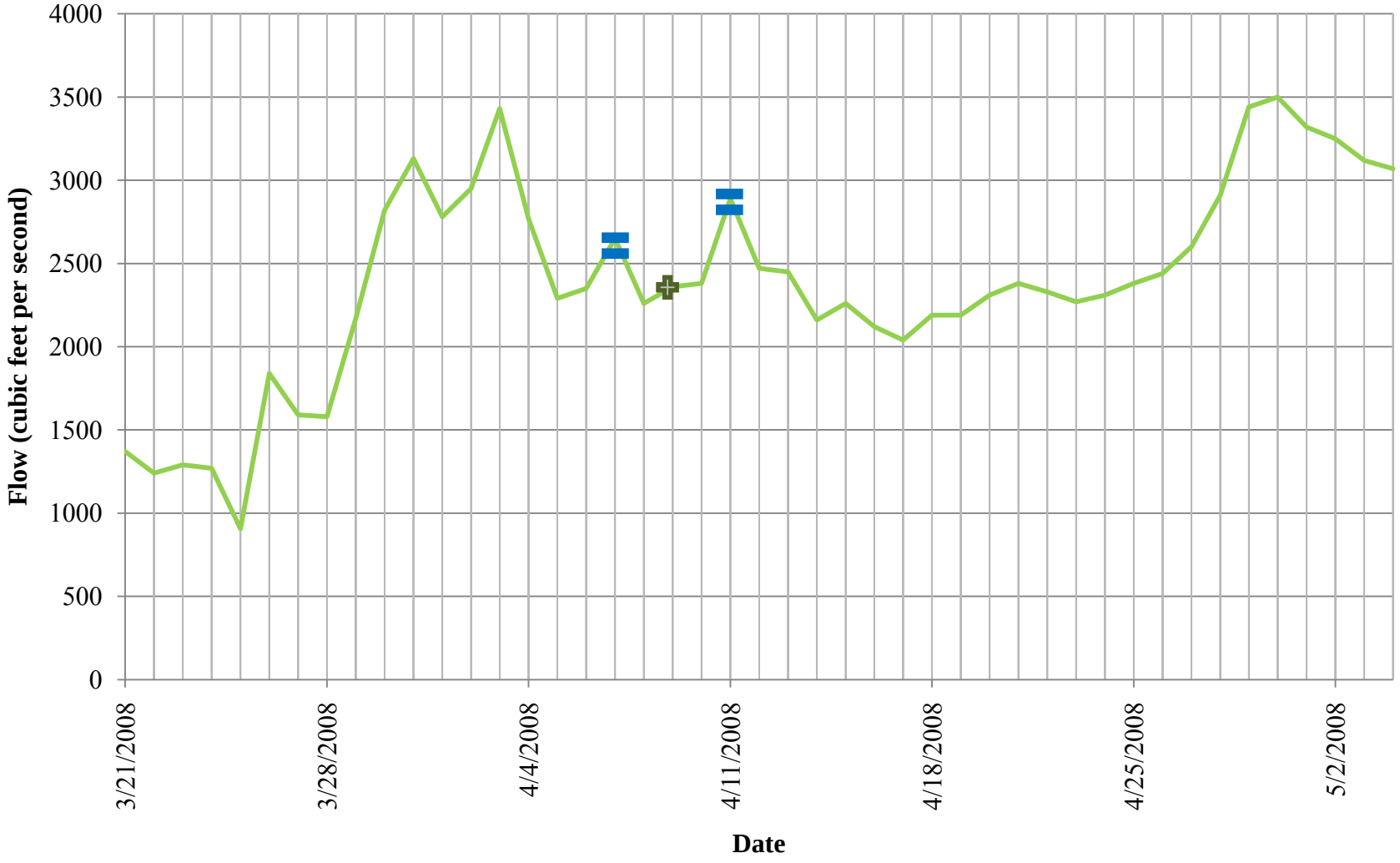
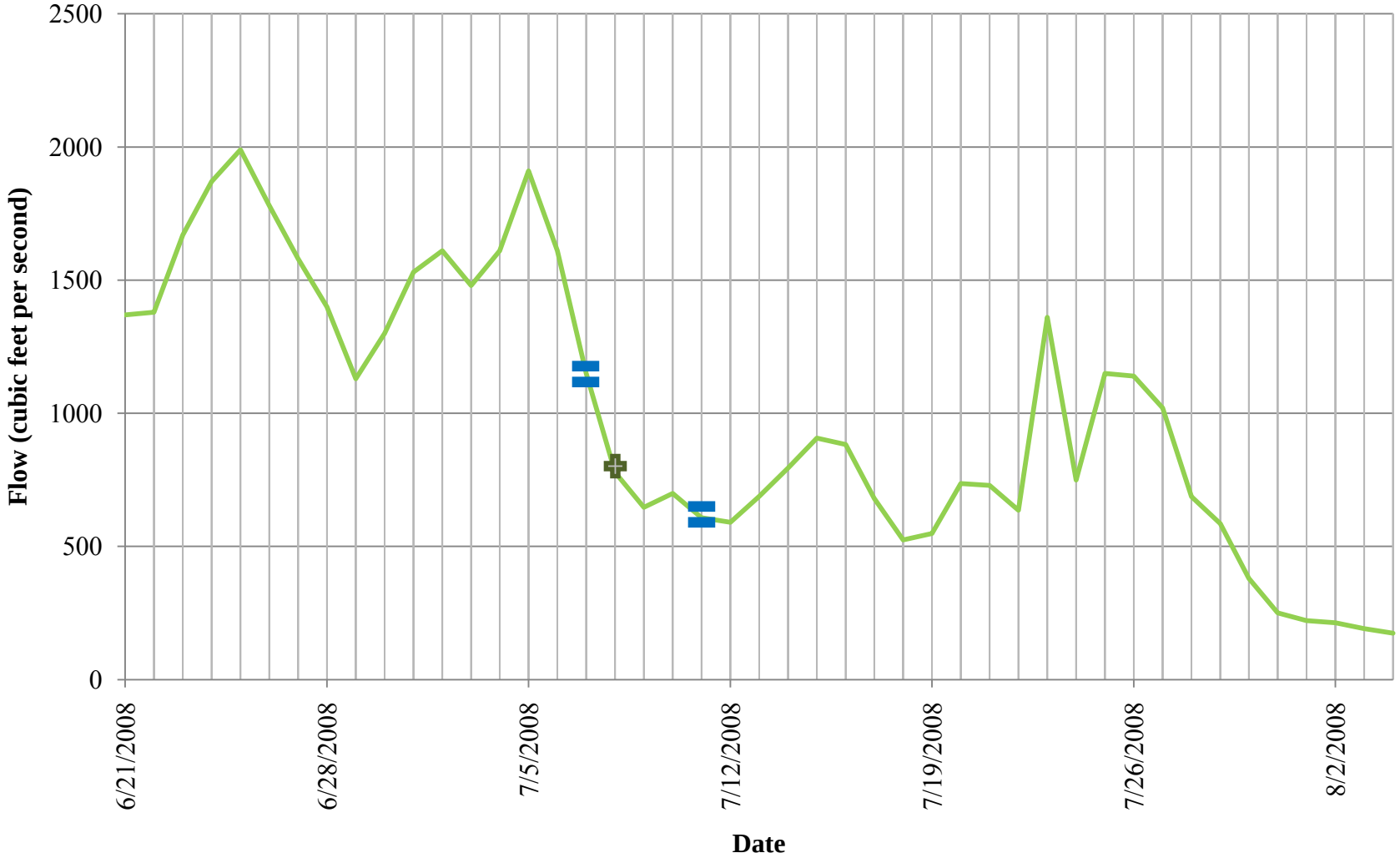


Figure 48. Mean Daily Discharge at USGS Gage 08355490, Rio Grande above US Highway 380 near San Antonio, NM, during Summer 2008.

["=", indicates start and end of continuous water quality monitoring; and "+", indicates fish collection event at Site 6, Rio Grande near San Antonio, NM.]



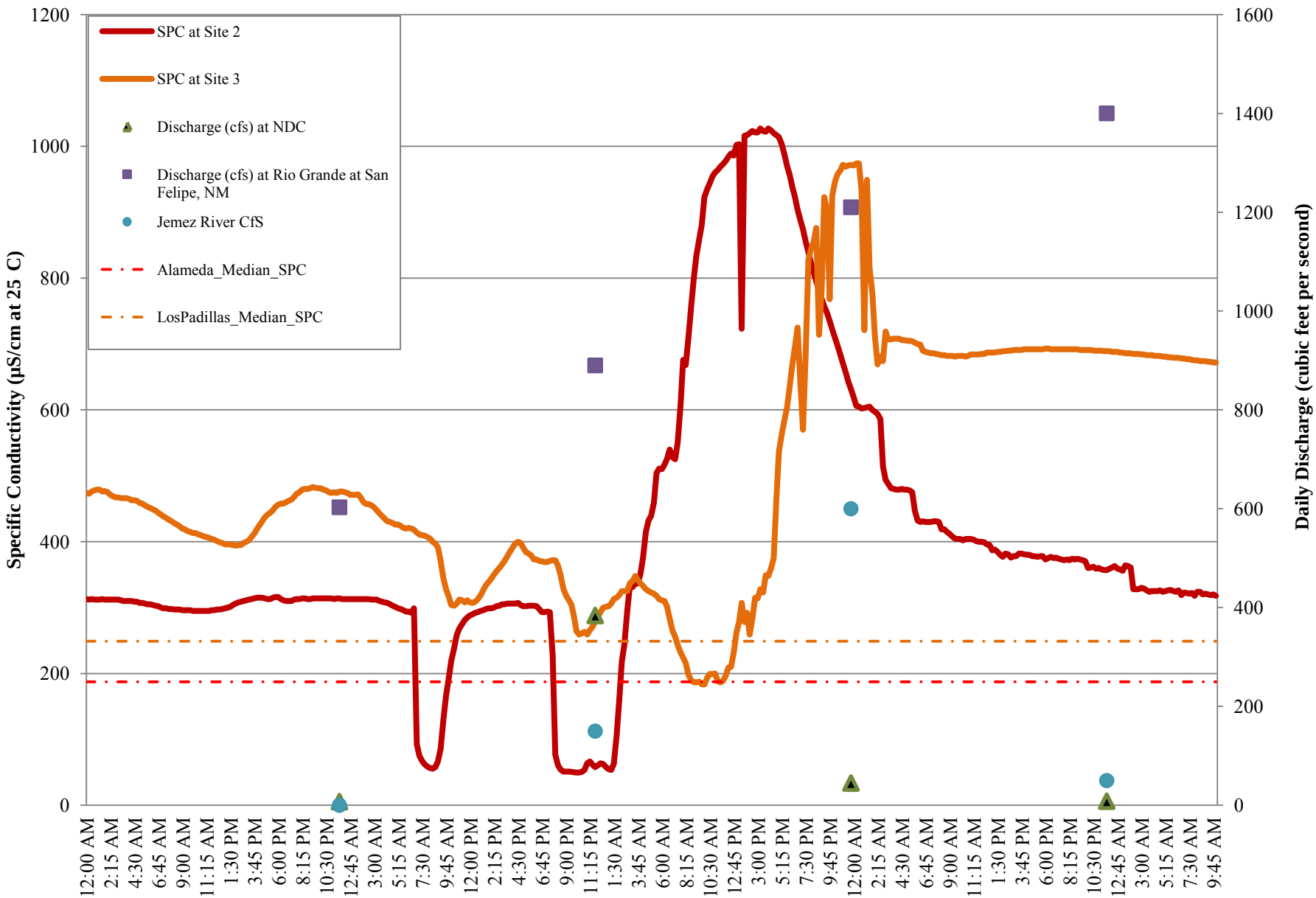


Figure 49. Specific conductivity (SPC; uS/cm at 25C) in the Rio Grande at Site 2 and at Site 3, beginning 12:00AM, October 9, 2006, and Daily Discharge (cubic feet per second (cfs)) at USGS Gage 08329900 (NDC), USGS Gage 08329000 (Jemez River), and USGS Gage 08319000 Rio Grande at San Felipe, New Mexico.

Table 1. Site number, site name name, latitude and longitude (in decimal degress) of a central point, and description of the RGSM Health Study sampling sites.

Site Number	Site Name	Latitude and Longitude (central point - decimal degrees)	Site Location Description
1	Rio Grande at Bernalillo, New Mexico	35.3181, -106.5589	approximately 0.1 mi upstream to 0.8 mi downstream of the Highway 550 Bridge crossing
2	Rio Grande at Alameda, New Mexico	35.2101, -106.6172	approximately 0.7 mi upstream and 1.1 mi downstream of AMAFCA North Diversion Channel mouth
3	Rio Grande at Los Padillas, New Mexico	34.9716, -106.6897	Just north of the Interstate 25 Bridge to approximately 5 mi upstream
4	Rio Grande at Los Lunas, New Mexico	34.8228, -106.7149	approximately 0.6 mi to 2.4 mi north of the Main Street (Highway 6) Bridge crossing
5	Rio Grande at La Joya, New Mexico	34.3073, -106.8493	approximately 2.4 mi to 3.8 mi north of the confluence with the Rio Salado
6	Rio Grande near San Antonio, New Mexico	33.8775, -106.8495	approximately 0.5 mi downstream and 1.2 mi upstream of Bosque del Apache National Wildlife Refuge (BdANWR) North Boundary

Table 2. Site number, sample date, wetted width, average depth, average velocity, site discharge, and daily discharge reported at the nearest USGS Gage of the sample sites during 2006 to 2008.

[See Table 1 for Site number, name and location; USGS Gage 08329918 used for Sites 1 and 2, USGS Gage 08330875 used for Site 3, USGS Gage 08331160 used for Site 4, the sum of USGS Gage 08331510 and USGS Gage 08353000 used for Site 5, and, USGS Gage 08355490 used for Site 6; m, meter; ft, foot; s, second; footnotes identify the equation used to derive value indicated; $\log_e$, natural logarithm]

Site Number	Sample Date	Wetted Width (m)	Wetted Width (ft)	Average Depth (m)	Average Depth (ft)	Average Velocity ($m^{-1}s^{-1}$)	Average Velocity ($ft^{-1}s^{-1}$)	Sample Site Discharge (ft^3s^{-1})	USGS Gage Daily Discharge (ft^3s^{-1})
1	July 27 2006	40.2	132	0.68	2.22	0.47	1.55	455	637
2	July 26 2006	78.3[a]	257[b]	0.32[a]	1.05[c]	0.47[a]	1.56[d]	452[e]	435
3	July 25 2006	84.3[a]	277[f]	0.36[a]	1.17[g]	0.49[a]	1.60[h]	472[i]	506
4	July 20 2006	27.4	90	0.38	1.25	0.05	0.18	22	53
5	July 19 2006	60.0	197	0.05	0.18	0.09	0.30	12	27
6	July 18 2006	6.8	22	0.13	0.43	0.05	0.18	35	29
1	October 11, 2006	88[a]	289[b]	0.55[a]	1.80[c]	0.70[a]	2.28[d]	1042[e]	1100
2	October 12, 2006	90.5[a]	297[b]	0.61[a]	1.99[c]	0.75[a]	2.47[d]	1308[e]	1400
3	October 17, 2006	125.6	412	0.31	1.01	0.43	1.43	647	780
4	October 16, 2006	83.0	272	0.58	1.90	0.60	1.97	1025	898
5	October 18, 2006	56.4	185	0.59	1.93	0.52	1.71	720	508
6	October 6, 2006	dry							0
1	January 25, 2007	44.0	143	0.43	1.40	1.02	3.35	686	710
2	January 24, 2007	107.3	352	0.37	1.20	0.41	1.35	642	760
3	January 23, 2007	128.3	421	0.30	0.98	0.35	1.16	557	560
4	February 1, 2007	107.6	352	0.37	1.20	0.41	1.35	642	691
5	January 31, 2007	96.3	316	0.43	1.42	0.51	1.66	726	620
6	January 30, 2007	51.0	167	0.51	1.68	0.73	2.40	729	699

Table 2. Site number, sample date, wetted width, average depth, average velocity, site discharge, and daily discharge reported at the nearest USGS Gage of the sample sites during 2006 to 2008.

[See Table 1 for Site number, name and location; USGS Gage 08329918 used for Sites 1 and 2, USGS Gage 08330875 used for Site 3, USGS Gage 08331160 used for Site 4, the sum of USGS Gage 08331510 and USGS Gage 08353000 used for Site 5, and, USGS Gage 08355490 used for Site 6; m, meter; ft, foot; s, second; footnotes identify the equation used to derive value indicated; $\log_e$, natural logarithm]

Site Number	Sample Date	Wetted Width (m)	Wetted Width (ft)	Average Depth (m)	Average Depth (ft)	Average Velocity ($m^{-1}s^{-1}$)	Average Velocity ($ft^{-1}s^{-1}$)	Sample Site Discharge (ft^3s^{-1})	USGS Gage Daily Discharge (ft^3s^{-1})
1	April 26, 2007	61.6	202	0.37	1.21	0.46	1.51	921	764
2	April 25, 2007	115.0	376	0.41	1.33	0.52	1.41	934	731
3	April 24, 2007	185.0	606	0.34	1.10	0.33	1.09	715	828
4	April 19, 2007	84.0	274	0.36	1.17	0.40	1.30	528	558
5	April 18, 2007	96.0	315	0.46	1.50	0.54	1.77	844	653
6	April 17, 2007	166.0	545	0.59	1.94	0.88	2.90	971	723
1	October 31, 2007	60.4	198	0.37	1.20	0.41	1.34	365	311
2	October 30, 2007	62.8	206	0.28	0.90	0.40	1.32	296	271
3	October 29, 2007	101.2	332	0.22	0.72	0.31	1.03	310	314
4	October 25, 2007	29.0	96	0.32	1.04	0.25	0.86	32	35
5	October 24, 2007	1.7[a]	6[j]	0.04[a]	0.12[k]	0.22[a]	0.72[l]	28[m]	23
6	October 23, 2007	17.0	56	0.25	0.81	0.45	1.47	67	81
1	January 30, 2008	52.4	172	0.48	1.58	0.94	3.09	895	915
2	January 29, 2008	100.6	330	0.40	1.32	0.51	1.68	730	829
3	January 28, 2008	61.3	201	0.23	0.77	0.60	1.95	534	593
4	January 24, 2008	85.3	280	0.51	1.67	0.50	1.64	789	776
5	January 23, 2008	40.8	134	0.71	2.32	0.59	1.92	610	645
6	January 22, 2008	51.0	168	0.38	1.24	0.76	2.49	564	583

Table 2. Site number, sample date, wetted width, average depth, average velocity, site discharge, and daily discharge reported at the nearest USGS Gage of the sample sites during 2006 to 2008.

[See Table 1 for Site number, name and location; USGS Gage 08329918 used for Sites 1 and 2, USGS Gage 08330875 used for Site 3, USGS Gage 08331160 used for Site 4, the sum of USGS Gage 08331510 and USGS Gage 08353000 used for Site 5, and, USGS Gage 08355490 used for Site 6; m, meter; ft, foot; s, second; footnotes identify the equation used to derive value indicated; $\log_e$, natural logarithm]

Site Number	Sample Date	Wetted Width (m)	Wetted Width (ft)	Average Depth (m)	Average Depth (ft)	Average Velocity ($m^{-1}s^{-1}$)	Average Velocity ($ft^{-1}s^{-1}$)	Sample Site Discharge (ft^3s^{-1})	USGS Gage Daily Discharge (ft^3s^{-1})
1	April 16, 2008	98.4[a]	323[b]	0.79[a]	2.60[c]	0.93[a]	3.07[d]	2711[e]	2980
2	April 15, 2008	99.0[a]	325[b]	0.81[a]	2.64[c]	0.95[a]	3.11[d]	2853[e]	3140
3	April 14, 2008	164.2[a]	539[f]	0.69[a]	2.27[g]	0.63[a]	2.07[h]	2722[i]	3500
4	April 10, 2008	105.7[a]	347[o]	0.59[a]	1.93[p]	0.61[a]	2.02[q]	2858[e]	2660
5	April 10, 2008	94.3[a]	309[n]	0.87[a]	2.84[o]	0.77[a]	2.53[p]	3534[q]	3010
6	April 9, 2008	56.9[a]	187[r]	0.82[a]	2.71[s]	1.01[a]	3.32[t]	2453[u]	2360
1	July 16 2008	52.4	172	0.48	1.57	0.70	2.31	822	858
2	July 15 2008	98.0	321	0.47	1.54	0.48	1.59	791	890
3	July 14 2008	117.0	383	0.44	1.44	0.42	1.39	840	989
4	July 10 2008	46.3	152	0.37	1.22	0.36	1.18	280	329
5	July 09 2008	37.2	122	0.70	2.31	0.59	1.93	584	522
6	July 08 2008	64.0	210	0.51	1.69	0.47	1.54	629	778

[a] – conversion from feet to meters; meters = feet * 0.3048

[b] = $48.4201+34.3195*\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))

[c] = $-3.8626+0.8079*\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))

[d] = $-3.2146+0.7852*\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))

[e] = 65.898+0.8875*(USGS Gage Daily Discharge (ft^3s^{-1}))

[f] = $-567.131+135.503*\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))

[g] = $-3.8626+0.8079*\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))

[h] = $0.0865+0.243*\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))

Table 2. Site number, sample date, wetted width, average depth, average velocity, site discharge, and daily discharge reported at the nearest USGS Gage of the sample sites during 2006 to 2008.

[See Table 1 for Site number, name and location; USGS Gage 08329918 used for Sites 1 and 2, USGS Gage 08330875 used for Site 3, USGS Gage 08331160 used for Site 4, the sum of USGS Gage 08331510 and USGS Gage 08353000 used for Site 5, and, USGS Gage 08355490 used for Site 6; m, meter; ft, foot; s, second; footnotes identify the equation used to derive value indicated; $\log_e$, natural logarithm]

Site Number	Sample Date	Wetted Width (m)	Wetted Width (ft)	Average Depth (m)	Average Depth (ft)	Average Velocity ($m^{-1}s^{-1}$)	Average Velocity ($ft^{-1}s^{-1}$)	Sample Site Discharge (ft^3s^{-1})	USGS Gage Daily Discharge (ft^3s^{-1})

[i] = 91.3534+0.7517*(USGS Gage Daily Discharge (ft^3s^{-1}))
[j] = -189.6456+62.2893*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[k] = -1.626+0.5577*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[l] = -0.4383+0.3707*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[m] = 0.512+1.174*(USGS Gage Daily Discharge (ft^3s^{-1}))
[n] = -189.6456+62.2893*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[o] = -1.626+0.5577*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[p] = -0.4383+0.3707*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[q] = 0.512+1.174*(USGS Gage Daily Discharge (ft^3s^{-1}))
[r] = -91.0047+35.7421*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[s] = -1.626+0.5577*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[t] = -1.3148+0.5971*$\log_e$(USGS Gage Daily Discharge (ft^3s^{-1}))
[u] = -2.6037+1.0407*(USGS Gage Daily Discharge (ft^3s^{-1}))

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
7/19/2006	2006	summer	5	Rio Grande at La Joya	06-27	7-06-S5	7	329615	3798059
7/19/2006	2006	summer	5	Rio Grande at La Joya	06-27	7-06-S5	14	329845	3797726
7/20/2006	2006	summer	4	Rio Grande at Los Lunas	06-28	7-06-S4	34	343305	3854254
7/25/2006	2006	summer	3	Rio Grande at Los Padillas	06-34	7-06-S3	3	345710	3871392
7/25/2006	2006	summer	3	Rio Grande at Los Padillas	06-34	7-06-S3	5	345836	3871215
7/25/2006	2006	summer	3	Rio Grande at Los Padillas	06-34	7-06-S3	9	345939	3872445
7/27/2006	2006	summer	1	Rio Grande at Bernalillo	06-36	7-06-S1	2	358305	3909605
7/27/2006	2006	summer	1	Rio Grande at Bernalillo	06-36	7-06-S1	3	358385	3909920
7/27/2006	2006	summer	1	Rio Grande at Bernalillo	06-36	7-06-S1	4	358335	3909865
7/27/2006	2006	summer	1	Rio Grande at Bernalillo	06-36	7-06-S1	4	358367	3909977
7/27/2006	2006	summer	1	Rio Grande at Bernalillo	06-36	7-06-S1	6	358308	3909838
7/27/2006	2006	summer	1	Rio Grande at Bernalillo	06-36	7-06-S1	11	358321	3909724
7/27/2006	2006	summer	1	Rio Grande at Bernalillo	06-36	7-06-S1	12	358303	3909705
7/27/2006	2006	summer	1	Rio Grande at Bernalillo	06-36	7-06-S1	12	358266	3909373
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	1	358305	3909605
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	2	358305	3909605
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	4	358305	3909605
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	5	358305	3909605
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	6	358305	3909605
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	7	358305	3909605
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	19	358305	3909605
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	21	358514	3910057
10/11/2006	2006	autumn	1	Rio Grande at Bernalillo	07-01	10-06-S1	26	358318	3909724
10/12/2006	2006	autumn	2	Rio Grande at Alameda	07-02	10-06-S2	7	352710	3897503
10/12/2006	2006	autumn	2	Rio Grande at Alameda	07-02	10-06-S2	15	352472	3897419
10/12/2006	2006	autumn	2	Rio Grande at Alameda	07-02	10-06-S2	16	352457	3897416
10/12/2006	2006	autumn	2	Rio Grande at Alameda	07-02	10-06-S2	17	352472	3897413
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	1	343366	3854169

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	2	343379	3854138
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	3	343404	3854123
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	4	343404	3854123
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	5	343480	3853999
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	6	343470	3854064
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	7	343453	3854086
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	8	343417	3854389
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	9	343428	3854354
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	10	343426	3854261
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	11	343454	3854250
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	12	343460	3854155
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	13	343461	3854126
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	14	343481	3854072
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	15	343462	3854073
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	16	343488	3854052
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	17	343479	3854011
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	18	343499	3853982
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	20	343422	3853744
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	21	343366	3853735
10/16/2006	2006	autumn	4	Rio Grande at Los Lunas	07-03	10-06-S4	24	343386	3853717
10/17/2006	2006	autumn	3	Rio Grande at Los Padillas	07-04	10-06-S3	2	346215	3869493
10/17/2006	2006	autumn	3	Rio Grande at Los Padillas	07-04	10-06-S3	10	346279	3869637
10/17/2006	2006	autumn	3	Rio Grande at Los Padillas	07-04	10-06-S3	11	346297	3869604
10/17/2006	2006	autumn	3	Rio Grande at Los Padillas	07-04	10-06-S3	15	346326	3869236
10/17/2006	2006	autumn	3	Rio Grande at Los Padillas	07-04	10-06-S3	19	346481	3869071
10/17/2006	2006	autumn	3	Rio Grande at Los Padillas	07-04	10-06-S3	23	346201	3869823
10/17/2006	2006	autumn	3	Rio Grande at Los Padillas	07-04	10-06-S3	24	346225	3869704
10/18/2006	2006	autumn	5	Rio Grande at La Joya	07-05	10-06-S5	1	329662	3798021

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
10/18/2006	2006	autumn	5	Rio Grande at La Joya	07-05	10-06-S5	2	329683	3798029
10/18/2006	2006	autumn	5	Rio Grande at La Joya	07-05	10-06-S5	3	329696	3798035
10/18/2006	2006	autumn	5	Rio Grande at La Joya	07-05	10-06-S5	4	329698	3798041
10/19/2006	2006	autumn	6	Rio Grande near San Antonio	NA	NA	6	328962	3749069
10/19/2006	2006	autumn	6	Rio Grande near San Antonio	NA	NA	4, 5	328991	3749927
1/23/2007	2007	winter	3	Rio Grande at Los Padillas	07-17	1-07-S3	8	346387	3869288
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	5	352342	3897473
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	8	352014	3897061
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	10	351996	3897031
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	13	352019	3897076
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	14	352585	3897661
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	15	352552	3897669
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	16	352507	3897573
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	17	352483	3897547
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	18	352445	3897540
1/24/2007	2007	winter	2	Rio Grande at Alameda	07-18	1-07-S2	19	352437	3897535
1/30/2007	2007	winter	6	Rio Grande near San Antonio	07-19	1-07-S6	16	329003	3750034
1/30/2007	2007	winter	6	Rio Grande near San Antonio	07-19	1-07-S6	17	329002	3750013
1/31/2007	2007	winter	5	Rio Grande at La Joya	07-20	1-07-S5	2	329698	3797981
1/31/2007	2007	winter	5	Rio Grande at La Joya	07-20	1-07-S5	3	329704	3797931
1/31/2007	2007	winter	5	Rio Grande at La Joya	07-20	1-07-S5	8	329729	3797882
1/31/2007	2007	winter	5	Rio Grande at La Joya	07-20	1-07-S5	12	329770	3797850
1/31/2007	2007	winter	5	Rio Grande at La Joya	07-20	1-07-S5	15	329790	3797779
1/31/2007	2007	winter	5	Rio Grande at La Joya	07-20	1-07-S5	16	329804	3797769
1/31/2007	2007	winter	5	Rio Grande at La Joya	07-20	1-07-S5	22	329784	3797569
2/1/2007	2007	winter	4	Rio Grande at Los Lunas	07-21	2-07-S4	1	343376	3854481
2/1/2007	2007	winter	4	Rio Grande at Los Lunas	07-21	2-07-S4	5	343367	3854024
2/1/2007	2007	winter	4	Rio Grande at Los Lunas	07-21	2-07-S4	7	343440	3853783

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
2/1/2007	2007	winter	4	Rio Grande at Los Lunas	07-21	2-07-S4	8	343396	3853695
4/17/2007	2007	spring	6	Rio Grande near San Antonio	NA	NA	2	328990	3750171
4/18/2007	2007	spring	5	Rio Grande at La Joya	07-32	4-07-S5	3	329694	3797996
4/18/2007	2007	spring	5	Rio Grande at La Joya	07-32	4-07-S5	4	329699	3797976
4/18/2007	2007	spring	5	Rio Grande at La Joya	07-32	4-07-S5	5	329909	3797003
4/18/2007	2007	spring	5	Rio Grande at La Joya	07-32	4-07-S5	9	329329	3798572
4/18/2007	2007	spring	5	Rio Grande at La Joya	07-32	4-07-S5	10	329317	3798592
4/18/2007	2007	spring	5	Rio Grande at La Joya	07-32	4-07-S5	11	329313	3798607
4/18/2007	2007	spring	5	Rio Grande at La Joya	07-32	4-07-S5	12	329313	3798610
4/18/2007	2007	spring	5	Rio Grande at La Joya	07-32	4-07-S5	13	329452	3798413
4/19/2007	2007	spring	4	Rio Grande at Los Lunas	07-33	4-07-S4	6	343413	3854357
4/19/2007	2007	spring	4	Rio Grande at Los Lunas	07-33	4-07-S4	7	343416	3854353
4/19/2007	2007	spring	4	Rio Grande at Los Lunas	07-33	4-07-S4	15	343431	3854192
4/19/2007	2007	spring	4	Rio Grande at Los Lunas	07-33	4-07-S4	17	343445	3854125
4/19/2007	2007	spring	4	Rio Grande at Los Lunas	07-33	4-07-S4	18	343474	3854043
4/25/2007	2007	spring	2	Rio Grande at Alameda	07-35	4-07-S2	1	352950	3897713
4/25/2007	2007	spring	2	Rio Grande at Alameda	07-35	4-07-S2	3	352918	3897727
4/25/2007	2007	spring	2	Rio Grande at Alameda	07-35	4-07-S2	4	352890	3897718
4/25/2007	2007	spring	2	Rio Grande at Alameda	07-35	4-07-S2	5	352823	3897710
4/25/2007	2007	spring	2	Rio Grande at Alameda	07-35	4-07-S2	6	352794	3897723
4/25/2007	2007	spring	2	Rio Grande at Alameda	07-35	4-07-S2	8	352674	3897669
4/25/2007	2007	spring	2	Rio Grande at Alameda	07-35	4-07-S2	9	352588	3897665
4/25/2007	2007	spring	2	Rio Grande at Alameda	07-35	4-07-S2	10	352531	3897618
4/26/2007	2007	spring	1	Rio Grande at Bernalillo	07-36	4-07-S1	2	358298	3909811
4/26/2007	2007	spring	1	Rio Grande at Bernalillo	07-36	4-07-S1	11	358257	3909077
4/26/2007	2007	spring	1	Rio Grande at Bernalillo	07-36	4-07-S1	21	358253	3909055
4/26/2007	2007	spring	1	Rio Grande at Bernalillo	07-36	4-07-S1	22	358243	3909042
10/23/2007	2007	autumn	6	Rio Grande near San Antonio	08-05	10-07-S6	2	329304	3750689

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
10/23/2007	2007	autumn	6	Rio Grande near San Antonio	08-05	10-07-S6	9	329083	3750324
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	2	329654	3798016
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	3	329659	3798029
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	4	329648	3798028
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	5	329630	3797905
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	8	329664	3797874
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	15	329895	3797100
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	24	330116	3796784
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	25	330141	3796760
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	26	330135	3796746
10/24/2007	2007	autumn	5	Rio Grande at La Joya	08-06	10-07-S5	27	330177	3796735
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	1	352959	3897730
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	2	352938	3897725
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	3	352931	3897731
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	4	352904	3897735
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	5	352890	3897730
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	6	352890	3897730
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	7	352879	3897715
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	8	352845	3897701
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	9	352839	3897688
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	10	352831	3897704
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	11	352812	3897711
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	12	352806	3897709
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	13	352813	3897710
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	14	352784	3897725
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	15	352762	3897724
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	16	352762	3897724
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	17	352756	3897711

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	18	352756	3897711
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	19	352724	3897695
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	20	352709	3897685
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	21	352702	3897693
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	22	352702	3897693
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	23	352681	3897680
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	24	352670	3897668
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	25	352656	3897661
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	26	352642	3897665
10/30/2007	2007	autumn	2	Rio Grande at Alameda	08-09	10-07-S2	27	352625	3897663
10/31/2007	2007	autumn	1	Rio Grande at Bernalillo	08-10	10-07-S1	1	358457	3910079
10/31/2007	2007	autumn	1	Rio Grande at Bernalillo	08-10	10-07-S1	2	358447	3910073
10/31/2007	2007	autumn	1	Rio Grande at Bernalillo	08-10	10-07-S1	3	358437	3910061
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	6	329031	3750117
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	7	329020	3750095
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	8	328998	3750071
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	9	328990	3750083
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	10	328997	3750075
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	11	328990	3750075
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	14	328994	3750076
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	15	328980	3750049
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	16	328984	3750023
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	17	328983	3749993
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	18	328984	3749957
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	19	328979	3749898
1/22/2008	2008	winter	6	Rio Grande near San Antonio	08-22	1-08-S6	12, 13	328977	3750091
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	1	329669	3798015
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	2	329701	3797976

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	3	329699	3797951
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	4	329711	3797949
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	5	329718	3797945
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	6	329725	3797931
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	7	329715	3797923
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	8	329739	3797908
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	9	329762	3797892
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	10	329766	3797857
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	11	329789	3797849
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	12	329794	3797846
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	13	329814	3797809
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	14	329820	3797796
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	15	329823	3797789
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	16	329824	3797762
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	17	329857	3797712
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	18	329852	3797700
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	19	329851	3797682
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	20	329850	3797657
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	21	329852	3797633
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	22	329846	3797614
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	23	329837	3797590
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	24	329853	3797602
1/23/2008	2008	winter	5	Rio Grande at La Joya	08-23	1-08-S5	25	329796	3797545
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	6	343230	3854688
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	11	343347	3854476
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	12	343355	3854474
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	13	343357	3854471
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	14	343377	3854471

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	15	343407	3854428
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	16	343415	3854430
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	19	343430	3854393
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	22	343429	3854371
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	25	343447	3854339
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	26	343458	3854326
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	17, 18	343427	3854406
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	20, 21	343425	3854384
1/24/2008	2008	winter	4	Rio Grande at Los Lunas	08-24	1-08-S4	23, 24	343425	3854379
1/28/2008	2008	winter	3	Rio Grande at Los Padillas	08-25	1-08-S3	25	345766	3870968
1/28/2008	2008	winter	3	Rio Grande at Los Padillas	08-25	1-08-S3	26	345775	3870923
1/29/2008	2008	winter	2	Rio Grande at Alameda	08-26	1-08-S2	1	352927	3897731
1/29/2008	2008	winter	2	Rio Grande at Alameda	08-26	1-08-S2	2	352914	3897733
1/29/2008	2008	winter	2	Rio Grande at Alameda	08-26	1-08-S2	3	352809	3897709
1/29/2008	2008	winter	2	Rio Grande at Alameda	08-26	1-08-S2	4	352798	3897714
1/29/2008	2008	winter	2	Rio Grande at Alameda	08-26	1-08-S2	5	352682	3897677
1/29/2008	2008	winter	2	Rio Grande at Alameda	08-26	1-08-S2	6	352626	3897660
1/29/2008	2008	winter	2	Rio Grande at Alameda	08-26	1-08-S2	7	352603	3897668
1/29/2008	2008	winter	2	Rio Grande at Alameda	08-26	1-08-S2	8	352577	3897664
1/30/2008	2008	winter	1	Rio Grande at Bernalillo	08-27	1-08-S1	3	358370	3909989
1/30/2008	2008	winter	1	Rio Grande at Bernalillo	08-27	1-08-S1	9	358344	3909886
1/30/2008	2008	winter	1	Rio Grande at Bernalillo	08-27	1-08-S1	10	358331	3909883
1/30/2008	2008	winter	1	Rio Grande at Bernalillo	08-27	1-08-S1	11	358330	3909875
1/30/2008	2008	winter	1	Rio Grande at Bernalillo	08-27	1-08-S1	12	358291	3909812
1/30/2008	2008	winter	1	Rio Grande at Bernalillo	08-27	1-08-S1	18	358298	3909723
4/8/2008	2008	spring	4	Rio Grande at Los Lunas	08-36	4-08-S4	8	343101	3856350
4/8/2008	2008	spring	4	Rio Grande at Los Lunas	08-36	4-08-S4	10	343093	3856289
4/8/2008	2008	spring	4	Rio Grande at Los Lunas	08-36	4-08-S4	11	343092	3856264

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Site Name	Fish Pathogen Identifier	Fish Necropsy Identifier*	Seine Haul Number	UTM 13N Easting	UTM 13N Northing
4/8/2008	2008	spring	4	Rio Grande at Los Lunas	08-36	4-08-S4	12	343081	3856251
4/9/2008	2008	spring	6	Rio Grande near San Antonio	08-37	4-08-S6	15	328938	3749560
4/9/2008	2008	spring	6	Rio Grande near San Antonio	08-37	4-08-S6	17	328868	3749595
4/15/2008	2008	spring	2	Rio Grande at Alameda	08-40	4-08-S2	1, 2	353930	3898605
4/16/2008	2008	spring	1	Rio Grande at Bernalillo	08-41	4-08-S1	31	358310	3909381
4/16/2008	2008	spring	1	Rio Grande at Bernalillo	08-41	4-08-S1	32	358320	3909438
7/9/2008	2008	summer	5	Rio Grande at La Joya	08-54	7-08-S5	13	329763	3797482
7/9/2008	2008	summer	5	Rio Grande at La Joya	08-54	7-08-S5	14	329770	3797463
7/15/2008	2008	summer	2	Rio Grande at Alameda	08-57	7-08-S2	2	352947	3897722
7/15/2008	2008	summer	2	Rio Grande at Alameda	08-57	7-08-S2	3	352681	3897675
7/15/2008	2008	summer	2	Rio Grande at Alameda	08-57	7-08-S2	6	352369	3897495
7/15/2008	2008	summer	2	Rio Grande at Alameda	08-57	7-08-S2	7	352338	3897470
7/15/2008	2008	summer	2	Rio Grande at Alameda	08-57	7-08-S2	11	351735	3897107

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
7/19/2006	2006	summer	5	side channel	2	9:45 AM	34.5	8.12	6.90	82.8	643
7/19/2006	2006	summer	5	side channel	2	10:22 AM	25.6	7.84	5.68	69.6	584
7/20/2006	2006	summer	4	side channel	6	10:20 AM	26.7	8.26	7.22	90.9	399
7/25/2006	2006	summer	3	side channel	1	10:00 AM	NA	NA	NA	NA	NA
7/25/2006	2006	summer	3	side channel	1	10:11 AM	NA	NA	NA	NA	NA
7/25/2006	2006	summer	3	side channel	2	3:31 PM	NA	NA	NA	NA	NA
7/27/2006	2006	summer	1	side channel	1	10:42 AM	23.0	7.54	6.47	75.6	312
7/27/2006	2006	summer	1	side channel	1	10:53 AM	23.3	7.30	6.11	71.6	312
7/27/2006	2006	summer	1	side channel	1	9:03 AM	22.6	8.48	6.04	69.9	312
7/27/2006	2006	summer	1	side channel	1	10:54 AM	23.3	7.46	6.30	73.7	312
7/27/2006	2006	summer	1	side channel	1	9:11 AM	22.6	8.42	6.44	74.5	312
7/27/2006	2006	summer	1	side channel	3	9:46 AM	22.9	8.35	6.38	74.3	312
7/27/2006	2006	summer	1	side channel	2	9:50 AM	22.9	8.28	6.29	73.4	312
7/27/2006	2006	summer	1	side channel	25	11:56 AM	24.5	8.23	5.85	70.4	313
10/11/2006	2006	autumn	1	side channel	6	7:48 AM	13.7	8.72	7.21	69.6	388
10/11/2006	2006	autumn	1	side channel	1	NA	NA	NA	NA	NA	NA
10/11/2006	2006	autumn	1	side channel	1	NA	NA	NA	4.54	NA	NA
10/11/2006	2006	autumn	1	side channel	2	8:04 AM	13.6	8.91	NA	43.8	386
10/11/2006	2006	autumn	1	side channel	4	NA	NA	NA	4.11	NA	NA
10/11/2006	2006	autumn	1	side channel	9	8:08 AM	13.6	8.70	NA	39.6	386
10/11/2006	2006	autumn	1	side channel	2	9:07 AM	13.9	7.79	5.97	57.9	380
10/11/2006	2006	autumn	1	side channel	1	9:18 AM	13.7	7.37	5.39	51.9	378
10/11/2006	2006	autumn	1	side channel	3	9:44 AM	13.0	7.87	5.22	50.9	377
10/12/2006	2006	autumn	2	side channel	10	7:57 AM	11.7	7.24	6.75	62.0	371
10/12/2006	2006	autumn	2	side channel	3	8:25 AM	14.0	7.53	6.96	67.6	337
10/12/2006	2006	autumn	2	side channel	2	8:27 AM	8.6	7.09	8.13	69.0	475
10/12/2006	2006	autumn	2	side channel	2	8:29 AM	14.0	6.32	6.86	66.1	335
10/16/2006	2006	autumn	4	channel in island	4	8:23 AM	13.8	7.00	7.93	76.6	358

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
10/16/2006	2006	autumn	4	channel in island	1	8:31 AM	13.7	7.14	8.12	78.4	353
10/16/2006	2006	autumn	4	channel in island	1	8:35 AM	13.9	7.32	7.37	76.3	351
10/16/2006	2006	autumn	4	channel in island	1	NA	NA	NA	7.71	NA	NA
10/16/2006	2006	autumn	4	side channel	4	8:59 AM	13.8	7.42	7.91	76.6	378
10/16/2006	2006	autumn	4	side channel	3	NA	NA	NA	NA	NA	NA
10/16/2006	2006	autumn	4	side channel	8	NA	NA	NA	NA	NA	NA
10/16/2006	2006	autumn	4	side channel	12	9:21 AM	13.9	6.85	7.96	77.1	NA
10/16/2006	2006	autumn	4	side channel	2	9:24 AM	13.9	7.24	7.95	77.2	369
10/16/2006	2006	autumn	4	side channel	2	9:30 AM	14.1	7.16	8.30	80.7	359
10/16/2006	2006	autumn	4	side channel	6	9:32 AM	14.1	7.18	7.95	77.4	375
10/16/2006	2006	autumn	4	side channel	6	9:38 AM	14.1	7.09	8.28	80.7	377
10/16/2006	2006	autumn	4	side channel	2	9:42 AM	14.2	7.15	7.73	75.5	380
10/16/2006	2006	autumn	4	side channel	3	NA	14.1	7.27	8.15	79.0	377
10/16/2006	2006	autumn	4	side channel	2	9:49 AM	14.4	7.17	7.66	75.1	384
10/16/2006	2006	autumn	4	side channel	2	NA	14.1	7.28	7.97	77.6	357
10/16/2006	2006	autumn	4	side channel	2	9:57 AM	14.2	7.34	7.42	77.3	376
10/16/2006	2006	autumn	4	side channel	2	10:00 AM	14.1	7.35	7.84	76.2	363
10/16/2006	2006	autumn	4	side channel	4	10:16 AM	14.4	7.40	7.71	75.4	381
10/16/2006	2006	autumn	4	side channel	2	10:19 AM	14.4	7.45	7.81	76.7	379
10/16/2006	2006	autumn	4	side channel	2	10:27 AM	14.5	7.44	7.98	78.1	378
10/17/2006	2006	autumn	3	side channel	1	7:56 AM	13.3	6.05	7.28	69.7	354
10/17/2006	2006	autumn	3	side channel	1	8:28 AM	13.6	6.48	7.14	68.6	411
10/17/2006	2006	autumn	3	side channel	2	8:31 AM	13.6	6.27	7.16	68.8	407
10/17/2006	2006	autumn	3	side channel	2	8:53 AM	13.3	6.26	7.13	68.2	353
10/17/2006	2006	autumn	3	side channel	1	9:20 AM	13.8	6.51	7.09	68.5	397
10/17/2006	2006	autumn	3	side channel	5	10:51 AM	15.0	6.76	7.56	74.9	391
10/17/2006	2006	autumn	3	side channel	1	11:02 AM	15.5	6.54	7.50	75.1	389
10/18/2006	2006	autumn	5	side channel	4	8:45 AM	13.9	6.59	8.87	85.8	471

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
10/18/2006	2006	autumn	5	side channel	22	8:50 AM	13.1	6.71	9.00	86.0	1083
10/18/2006	2006	autumn	5	side channel	2	8:58 AM	12.8	6.75	7.90	74.4	1079
10/18/2006	2006	autumn	5	side channel	2	9:00 AM	12.8	6.71	8.74	82.4	964
10/19/2006	2006	autumn	6	side channel	3	10:16 AM	11.8	5.62	10.10	93.3	503
10/19/2006	2006	autumn	6	side channel	3	10:13 AM	11.8	6.25	10.04	92.8	503
1/23/2007	2007	winter	3	side channel	1	9:01 AM	2.2	7.98	13.83	100.6	421
1/24/2007	2007	winter	2	side channel	1	9:29 AM	1.7	8.61	10.82	77.7	303
1/24/2007	2007	winter	2	side channel	2	10:11 AM	3.0	8.51	10.14	75.6	325
1/24/2007	2007	winter	2	side channel	2	10:15 AM	3.2	8.42	10.09	75.5	326
1/24/2007	2007	winter	2	side channel	1	10:36 AM	4.2	8.41	9.66	74.0	351
1/24/2007	2007	winter	2	side channel	1	1:45 PM	6.0	8.44	10.70	86.1	281
1/24/2007	2007	winter	2	side channel	1	1:48 PM	5.8	8.47	10.80	86.5	301
1/24/2007	2007	winter	2	side channel	3	1:57 PM	6.0	8.42	10.73	86.0	303
1/24/2007	2007	winter	2	side channel	1	2:00 PM	6.0	8.43	10.78	86.8	281
1/24/2007	2007	winter	2	side channel	1	2:03 PM	6.1	8.43	10.70	86.3	301
1/24/2007	2007	winter	2	side channel	4	2:05 PM	6.1	8.54	10.76	86.8	248
1/30/2007	2007	winter	6	side channel	1	10:37 AM	NA	NA	NA	NA	NA
1/30/2007	2007	winter	6	side channel	1	10:39 AM	NA	NA	NA	NA	NA
1/31/2007	2007	winter	5	side channel	3	8:49 AM	5.7	6.35	9.82	78.4	572
1/31/2007	2007	winter	5	side channel	1	8:51 AM	5.7	6.44	9.93	79.3	592
1/31/2007	2007	winter	5	side channel	1	9:04 AM	5.8	6.57	10.14	81.2	509
1/31/2007	2007	winter	5	side channel	1	9:09 AM	6.0	6.55	10.20	82.1	515
1/31/2007	2007	winter	5	side channel	1	9:16 AM	5.4	6.36	9.80	77.7	547
1/31/2007	2007	winter	5	side channel	1	9:17 AM	6.1	6.46	9.81	78.9	527
1/31/2007	2007	winter	5	side channel	10	9:38 AM	6.3	6.68	10.36	84.0	512
2/1/2007	2007	winter	4	side channel	2	8:30 AM	5.1	7.96	9.48	74.6	449
2/1/2007	2007	winter	4	side channel	3	9:07 AM	5.2	7.41	9.43	74.2	396
2/1/2007	2007	winter	4	side channel	12	9:39 AM	5.4	7.33	9.57	76.0	432

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
2/1/2007	2007	winter	4	side channel	1	9:46 AM	5.5	7.58	9.59	76.1	310
4/17/2007	2007	spring	6	channel in island	1	10:52 AM	14.1	8.38	6.70	64.4	510
4/18/2007	2007	spring	5	side channel	1	9:13 AM	13.4	8.28	8.57	82.3	427
4/18/2007	2007	spring	5	side channel	1	9:15 AM	13.5	8.26	7.10	68.2	433
4/18/2007	2007	spring	5	side channel	1	9:37 AM	13.7	8.25	8.56	82.6	420
4/18/2007	2007	spring	5	side channel	1	12:06 PM	19.2	8.12	5.67	61.1	488
4/18/2007	2007	spring	5	side channel	4	12:08 PM	19.6	8.11	5.94	63.6	488
4/18/2007	2007	spring	5	side channel	1	12:11 PM	19.1	8.05	5.45	58.8	491
4/18/2007	2007	spring	5	side channel	1	12:12 PM	18.8	8.00	5.56	59.2	492
4/18/2007	2007	spring	5	side channel	4	12:40 PM	23.2	8.29	5.15	60.2	461
4/19/2007	2007	spring	4	side channel	1	8:59 AM	12.1	7.85	8.77	81.6	351
4/19/2007	2007	spring	4	side channel	2	9:01 AM	12.1	7.87	8.86	82.5	351
4/19/2007	2007	spring	4	side channel	3	9:57 AM	13.9	7.94	7.24	70.0	352
4/19/2007	2007	spring	4	channel in island	6	12:02 PM	15.6	8.25	7.70	77.6	355
4/19/2007	2007	spring	4	channel in island	1	12:12 PM	15.8	8.22	7.71	77.7	355
4/25/2007	2007	spring	2	side channel	1	8:12 AM	10.9	8.52	9.69	87.8	293
4/25/2007	2007	spring	2	side channel	1	8:24 AM	11.0	8.67	9.76	88.6	293
4/25/2007	2007	spring	2	side channel	1	8:26 AM	11.1	8.63	9.70	88.3	293
4/25/2007	2007	spring	2	side channel	2	8:29 AM	11.1	8.66	9.71	88.4	265
4/25/2007	2007	spring	2	side channel	13	8:32 AM	11.1	8.64	9.69	88.2	291
4/25/2007	2007	spring	2	side channel	3	8:41 AM	11.3	8.65	9.92	90.5	294
4/25/2007	2007	spring	2	side channel	1	8:46 AM	11.3	8.65	9.81	89.7	294
4/25/2007	2007	spring	2	side channel	1	8:53 AM	11.5	8.60	9.66	88.6	291
4/26/2007	2007	spring	1	side channel	1	8:26 AM	11.1	8.60	9.15	83.2	311
4/26/2007	2007	spring	1	side channel	1	9:46 AM	11.4	8.52	9.05	82.8	306
4/26/2007	2007	spring	1	side channel	1	10:37 AM	11.8	8.38	8.52	78.6	309
4/26/2007	2007	spring	1	side channel	2	10:43 AM	11.9	8.39	8.72	80.1	304
10/23/2007	2007	autumn	6	side channel	1	9:02 AM	4.6	7.84	13.50	104.7	678

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
10/23/2007	2007	autumn	6	side channel	1	9:30 AM	5.2	8.23	13.54	106.9	668
10/24/2007	2007	autumn	5	side channel	5	8:41 AM	4.0	7.35	10.98	83.7	593
10/24/2007	2007	autumn	5	side channel	1	8:43 AM	4.2	7.33	10.83	83.1	591
10/24/2007	2007	autumn	5	side channel	1	8:45 AM	6.1	7.85	10.18	82.0	622
10/24/2007	2007	autumn	5	side channel	1	8:52 AM	8.2	8.38	9.93	84.3	659
10/24/2007	2007	autumn	5	side channel	1	9:02 AM	8.2	8.22	9.77	83.0	657
10/24/2007	2007	autumn	5	side channel	1	9:52 AM	8.4	8.37	10.63	90.3	658
10/24/2007	2007	autumn	5	side channel	2	10:27 AM	9.3	8.45	9.89	86.3	647
10/24/2007	2007	autumn	5	side channel	1	10:29 AM	9.3	8.49	9.73	84.9	657
10/24/2007	2007	autumn	5	side channel	3	10:31 AM	9.4	8.52	9.54	83.4	665
10/24/2007	2007	autumn	5	side channel	2	10:32 AM	9.5	8.50	9.47	83.1	671
10/30/2007	2007	autumn	2	side channel	3	8:20 AM	9.3	8.34	9.71	84.6	341
10/30/2007	2007	autumn	2	side channel	12	8:23 AM	9.3	8.30	9.62	83.8	341
10/30/2007	2007	autumn	2	side channel	1	8:24 AM	9.3	8.29	9.76	85.1	341
10/30/2007	2007	autumn	2	side channel	7	8:26 AM	9.3	8.30	9.71	84.6	341
10/30/2007	2007	autumn	2	side channel	1	8:28 AM	9.3	8.30	9.74	84.9	341
10/30/2007	2007	autumn	2	side channel	1	8:28 AM	9.3	8.30	9.74	84.9	341
10/30/2007	2007	autumn	2	side channel	3	8:29 AM	9.3	8.35	9.73	84.7	340
10/30/2007	2007	autumn	2	side channel	1	8:31 AM	9.3	8.37	10.64	92.8	341
10/30/2007	2007	autumn	2	side channel	1	8:32 AM	9.2	8.36	9.76	85.0	341
10/30/2007	2007	autumn	2	side channel	2	8:33 AM	9.2	8.37	9.73	84.8	340
10/30/2007	2007	autumn	2	side channel	1	8:34 AM	9.3	8.34	9.85	85.9	341
10/30/2007	2007	autumn	2	side channel	8	8:37 AM	9.3	8.39	9.99	87.3	340
10/30/2007	2007	autumn	2	side channel	1	8:38 AM	9.3	8.39	9.87	85.8	340
10/30/2007	2007	autumn	2	side channel	2	8:39 AM	9.3	8.35	9.78	85.2	340
10/30/2007	2007	autumn	2	side channel	5	8:41 AM	9.3	8.32	9.91	86.2	341
10/30/2007	2007	autumn	2	side channel	5	8:41 AM	9.3	8.32	9.91	86.2	341
10/30/2007	2007	autumn	2	side channel	6	8:42 AM	9.2	8.35	9.83	85.6	341

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
10/30/2007	2007	autumn	2	side channel	6	8:42 AM	9.2	8.35	9.83	85.6	341
10/30/2007	2007	autumn	2	side channel	3	8:44 AM	9.3	8.37	9.82	85.6	341
10/30/2007	2007	autumn	2	side channel	4	8:45 AM	9.2	8.40	10.08	88.3	340
10/30/2007	2007	autumn	2	side channel	2	8:49 AM	9.3	8.39	9.87	86.1	340
10/30/2007	2007	autumn	2	side channel	2	8:49 AM	9.3	8.39	9.87	86.1	340
10/30/2007	2007	autumn	2	side channel	3	8:50 AM	9.3	8.39	9.85	86.0	339
10/30/2007	2007	autumn	2	side channel	12	8:51 AM	9.2	8.37	9.79	85.0	340
10/30/2007	2007	autumn	2	side channel	1	8:52 AM	9.3	8.40	9.81	85.5	340
10/30/2007	2007	autumn	2	side channel	8	8:54 AM	9.2	8.36	9.79	85.3	340
10/30/2007	2007	autumn	2	side channel	3	8:55 AM	9.2	8.35	9.84	85.7	340
10/31/2007	2007	autumn	1	side channel	10	8:19 AM	11.1	8.18	8.87	80.7	341
10/31/2007	2007	autumn	1	side channel	27	8:21 AM	11.1	8.17	8.76	80.1	341
10/31/2007	2007	autumn	1	side channel	56	8:23 AM	11.0	8.18	8.93	81.2	342
1/22/2008	2008	winter	6	side channel	1	11:18 AM	2.6	8.11	15.54	114.8	583
1/22/2008	2008	winter	6	side channel	1	11:23 AM	2.9	8.35	14.38	106.6	585
1/22/2008	2008	winter	6	side channel	3	11:25 AM	3.0	8.46	14.10	104.6	579
1/22/2008	2008	winter	6	side channel	7	11:26 AM	3.1	8.28	14.12	105.3	586
1/22/2008	2008	winter	6	side channel	2	11:24 AM	2.9	8.23	14.35	106.6	585
1/22/2008	2008	winter	6	side channel	3	11:30 AM	2.8	8.38	15.21	112.9	586
1/22/2008	2008	winter	6	side channel	1	11:34 AM	2.5	8.27	14.57	107.0	584
1/22/2008	2008	winter	6	side channel	9	11:36 AM	2.5	8.42	14.99	109.9	558
1/22/2008	2008	winter	6	side channel	6	11:38 AM	3.0	8.15	14.47	107.8	578
1/22/2008	2008	winter	6	side channel	2	11:40 AM	3.0	8.14	14.59	108.6	586
1/22/2008	2008	winter	6	side channel	1	11:42 AM	3.0	8.33	14.36	106.8	580
1/22/2008	2008	winter	6	side channel	1	11:46 AM	3.1	8.19	14.09	105.0	580
1/22/2008	2008	winter	6	side channel	11	11:32 AM	2.6	8.35	14.81	109.9	581
1/23/2008	2008	winter	5	side channel	1	9:42 AM	2.6	8.28	10.62	78.2	531
1/23/2008	2008	winter	5	side channel	4	9:50 AM	2.7	8.27	10.38	76.5	561

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
1/23/2008	2008	winter	5	side channel	1	9:54 AM	2.7	7.89	10.53	77.6	456
1/23/2008	2008	winter	5	side channel	1	9:55 AM	2.8	8.04	10.41	77.0	525
1/23/2008	2008	winter	5	side channel	6	9:56 AM	2.8	7.99	10.46	77.5	569
1/23/2008	2008	winter	5	side channel	2	9:57 AM	2.8	7.99	10.57	78.1	550
1/23/2008	2008	winter	5	side channel	1	9:59 AM	2.8	7.98	10.48	77.6	540
1/23/2008	2008	winter	5	side channel	1	10:01 AM	2.8	7.95	10.43	77.2	560
1/23/2008	2008	winter	5	side channel	1	10:03 AM	2.8	8.15	10.42	77.1	565
1/23/2008	2008	winter	5	side channel	3	10:05 AM	2.9	8.17	10.25	76.1	529
1/23/2008	2008	winter	5	side channel	1	10:06 AM	2.9	8.07	10.54	78.2	550
1/23/2008	2008	winter	5	side channel	1	10:07 AM	2.9	8.03	10.51	78.0	565
1/23/2008	2008	winter	5	side channel	3	10:10 AM	2.9	7.96	10.42	77.4	555
1/23/2008	2008	winter	5	side channel	1	10:12 AM	3.0	7.99	10.37	77.0	548
1/23/2008	2008	winter	5	side channel	1	10:13 AM	3.0	8.08	10.43	77.6	560
1/23/2008	2008	winter	5	side channel	2	10:16 AM	3.1	8.19	10.60	79.1	533
1/23/2008	2008	winter	5	side channel	1	10:23 AM	3.0	8.20	10.26	76.5	580
1/23/2008	2008	winter	5	side channel	1	10:24 AM	3.1	8.08	10.10	75.4	578
1/23/2008	2008	winter	5	side channel	1	10:25 AM	3.1	8.09	10.41	77.7	558
1/23/2008	2008	winter	5	side channel	1	10:28 AM	3.1	8.14	10.52	78.2	568
1/23/2008	2008	winter	5	side channel	1	10:30 AM	3.1	8.17	10.53	78.7	567
1/23/2008	2008	winter	5	side channel	1	10:33 AM	3.2	8.07	10.98	82.0	574
1/23/2008	2008	winter	5	side channel	1	10:34 AM	3.2	8.15	10.60	79.3	565
1/23/2008	2008	winter	5	side channel	1	10:35 AM	3.2	8.14	10.09	80.2	565
1/23/2008	2008	winter	5	side channel	1	10:40 AM	3.3	8.02	10.29	77.3	561
1/24/2008	2008	winter	4	side channel	11	8:29 AM	4.4	8.23	10.07	77.8	449
1/24/2008	2008	winter	4	side channel	1	8:47 AM	4.5	8.13	10.02	77.5	447
1/24/2008	2008	winter	4	side channel	2	8:48 AM	4.5	8.09	10.16	78.6	445
1/24/2008	2008	winter	4	side channel	2	8:49 AM	4.5	8.15	10.04	77.7	447
1/24/2008	2008	winter	4	side channel	3	8:51 AM	4.5	8.04	10.08	78.0	444

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
1/24/2008	2008	winter	4	side channel	2	8:55 AM	4.3	8.14	10.25	78.8	449
1/24/2008	2008	winter	4	side channel	1	9:00 AM	4.3	8.15	10.32	79.5	449
1/24/2008	2008	winter	4	side channel	3	9:04 AM	4.3	8.17	10.27	79.1	448
1/24/2008	2008	winter	4	side channel	2	9:09 AM	4.5	8.12	10.12	78.3	447
1/24/2008	2008	winter	4	side channel	2	9:11 AM	4.5	8.15	10.09	78.0	447
1/24/2008	2008	winter	4	side channel	4	9:14 AM	4.5	8.14	10.03	77.5	444
1/24/2008	2008	winter	4	side channel	1	9:02 AM	4.4	8.14	10.30	79.6	448
1/24/2008	2008	winter	4	side channel	3	9:05 AM	4.5	8.19	9.90	76.5	438
1/24/2008	2008	winter	4	side channel	10	9:10 AM	4.4	8.09	10.04	77.7	448
1/28/2008	2008	winter	3	channel in island	2	9:41 AM	5.7	7.99	11.82	94.3	382
1/28/2008	2008	winter	3	channel in island	2	9:43 AM	5.8	8.08	11.54	92.1	381
1/29/2008	2008	winter	2	side channel	1	9:11 AM	1.4	8.77	12.69	90.6	350
1/29/2008	2008	winter	2	side channel	1	9:12 AM	1.4	8.79	12.58	89.9	376
1/29/2008	2008	winter	2	side channel	1	9:18 AM	1.5	8.92	12.32	88.0	376
1/29/2008	2008	winter	2	side channel	1	9:19 AM	1.5	8.64	12.44	88.9	373
1/29/2008	2008	winter	2	side channel	1	9:28 AM	1.6	8.65	12.66	90.7	377
1/29/2008	2008	winter	2	side channel	2	9:32 AM	1.6	8.68	12.50	89.6	376
1/29/2008	2008	winter	2	side channel	1	9:34 AM	1.6	8.70	12.35	89.3	376
1/29/2008	2008	winter	2	side channel	42	9:37 AM	1.8	8.30	12.85	92.5	376
1/30/2008	2008	winter	1	side channel	1	8:45 AM	0.6	8.09	10.97	76.7	335
1/30/2008	2008	winter	1	side channel	1	9:03 AM	0.7	8.30	11.35	79.2	346
1/30/2008	2008	winter	1	side channel	1	9:05 AM	0.7	8.17	11.00	76.9	346
1/30/2008	2008	winter	1	side channel	2	9:06 AM	0.7	8.20	11.12	77.5	345
1/30/2008	2008	winter	1	side channel	1	9:14 AM	0.7	8.13	11.37	80.0	343
1/30/2008	2008	winter	1	side channel	1	10:11 AM	0.9	8.13	11.35	79.6	337
4/8/2008	2008	spring	4	side channel	2	9:22 AM	11.2	7.58	9.14	83.3	308
4/8/2008	2008	spring	4	side channel	4	9:33 AM	11.5	7.76	9.13	83.8	311
4/8/2008	2008	spring	4	side channel	1	9:35 AM	11.4	7.81	9.05	82.9	309

* Original number did not contain an "S".

Table 3. Results of fish collection, Site Number, Date, Habitat Type, Number RGSM, Temperature, pH, dissolved oxygen, and specific conductivity. [Easting and Northing meter coordinates of UTM 13, NAD83; NA, not available]

RGSM Collection Date	Year	Season	Site Number	Habitat Type	Number of RGSM	Collection Time	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Oxygen saturation (%)	Specific Conductivity (µS/cm)
4/8/2008	2008	spring	4	side channel	1	9:37 AM	11.4	7.69	9.11	83.4	310
4/9/2008	2008	spring	6	channel confluence	1	11:05 AM	13.7	8.12	8.59	83.0	344
4/9/2008	2008	spring	6	side channel	2	11:18 AM	14.0	8.46	10.01	96.8	361
4/15/2008	2008	spring	2	side channel	7	8:12 AM	9.3	7.68	9.35	81.3	275
4/16/2008	2008	spring	1	side channel	2	10:03 AM	9.7	8.01	10.00	88.0	276
4/16/2008	2008	spring	1	side channel	1	10:07 AM	9.8	8.02	10.04	88.4	274
7/9/2008	2008	summer	5	channel mouth	15	9:44 AM	22.7	8.17	7.00	81.9	361
7/9/2008	2008	summer	5	channel mouth	1	9:45 AM	22.7	8.17	7.01	81.6	399
7/15/2008	2008	summer	2	side channel	1	8:24 AM	21.3	8.24	6.28	82.3	267
7/15/2008	2008	summer	2	side channel	1	8:46 AM	21.7	8.31	7.34	84.0	232
7/15/2008	2008	summer	2	side channel	1	9:33 AM	22.6	8.35	7.16	82.8	265
7/15/2008	2008	summer	2	side channel	2	9:41 AM	22.7	8.33	7.29	84.4	277
7/15/2008	2008	summer	2	side channel	1	10:38 AM	23.1	8.27	7.16	83.5	282

* Original number did not contain an "S".

Table 4. Water Quality Results and RGSM Catch Results during Seine Hauls. [RGSM, Rio Grande silvery minnow; n, number; mean, average; min, minimum; max, maximum; SD, standard deviation]

Site Number and Collection Date	Number of RGSM per Successful Seine Haul					Temperature (°C)				
	n	mean	min	max	SD	n	mean	min	max	SD
Site 1, July 27 2006	25	4.2	1	25	5.2	25	23.45	22.05	25.62	1.03
Site 2, July 26 2006	6	9.2	1	21	7.7	6	23.48	23.40	23.60	0.08
Site 3, July 25 2006	11	1.7	1	3	0.8	0				
Site 4, July 20 2006	29	3.6	1	24	4.4	23	24.68	23.05	26.96	1.31
Site 5, July 19 2006	15	2.3	1	8	1.9	15	26.46	24.42	34.58	3.37
Site 6, July 18 2006	17	2.4	1	6	1.3	17	24.52	23.60	25.52	0.62
Site 1, October 11 2006	33	2.5	1	9	1.8	25	13.69	13.03	14.10	0.21
Site 2, October 12 2006	19	4.9	1	34	7.6	18	13.56	8.61	14.12	1.36
Site 3, October 17 2006	26	1.8	1	5	1.2	26	13.65	12.21	15.48	0.80
Site 4, October 16 2006	29	3.2	1	12	2.4	26	14.25	13.67	15.14	0.35
Site 5, October 18 2006	22	3.7	1	22	4.5	22	14.28	12.76	16.70	0.86
Site 6, October 19 2006	4	4.8	2	11	4.2	4	11.53	11.06	11.82	0.35
Site 1, January 25 2007	1	1.0	1	1		0				
Site 2, January 24 2007	19	1.7	1	4	1.0	19	3.52	0.82	6.13	1.95
Site 3, January 23 2007	21	2.0	1	9	2.0	19	2.56	1.51	4.20	0.89
Site 4, February 01 2007	15	2.5	1	12	2.8	15	5.48	4.51	6.03	0.42
Site 5, January 31 2007	30	3.2	1	24	4.7	30	5.92	5.35	6.32	0.20
Site 6, January 30 2007	24	2.5	1	7	1.8	2	3.97	3.96	3.98	0.01
Site 1, April 26 2007	22	1.4	1	3	0.6	22	11.48	11.05	12.13	0.32
Site 2, April 25 2007	23	2.6	1	13	3.0	23	12.42	9.69	15.55	1.53
Site 3, April 24 2007	13	2.8	1	11	2.7	13	11.60	11.21	12.06	0.31
Site 4, April 19 2007	18	1.8	1	6	1.4	18	12.75	10.54	15.84	1.51
Site 5, April 18 2007	13	2.4	1	8	2.1	12	16.77	11.86	23.23	3.75
Site 6, April 17 2007	3	1.0	1	1	0.0	3	13.12	12.50	14.08	0.84

Table 4. Water Quality Results and RGSM Catch Results during Seine Hauls. [RGSM, Rio Grande silvery minnow; n, number; mean, average; min, minimum; max, maximum; SD, standard deviation]

Site Number and Collection Date	Number of RGSM per Successful Seine Haul					Temperature (°C)				
	n	mean	min	max	SD	n	mean	min	max	SD
Site 1, October 31 2007	3	31.0	10	56	23.3	3	11.07	10.99	11.12	0.07
Site 2, October 30 2007	27	3.9	1	12	3.2	27	9.27	9.16	9.32	0.03
Site 3, October 29 2007	32	1.7	1	5	1.1	32	12.65	11.20	14.74	1.05
Site 4, October 25 2007	6	16.2	2	43	14.0	6	7.42	7.26	7.59	0.14
Site 5, October 24 2007	24	1.8	1	5	1.2	24	8.23	3.65	10.04	1.83
Site 6, October 23 2007	22	1.3	1	4	0.7	22	6.07	4.57	8.12	1.13
Site 1, January 30 2008	20	5.1	1	37	10.8	20	0.75	0.64	1.11	0.13
Site 2, January 29 2008	9	10.6	1	45	18.7	9	1.58	1.42	1.80	0.13
Site 3, January 28 2008	24	3.8	1	13	3.7	23	5.85	5.30	6.39	0.38
Site 4, January 24 2008	21	4.0	1	14	3.7	21	4.45	4.32	4.52	0.07
Site 5, January 23 2008	30	1.6	1	6	1.2	30	3.02	2.62	3.56	0.25
Site 6, January 22 2008	20	3.2	1	11	2.9	20	2.47	1.15	3.08	0.62
Site 1, April 16 2008	31	2.4	1	8	2.0	31	9.44	8.98	10.30	0.32
Site 2, April 15 2008	12	8.8	1	14	4.5	12	9.24	9.15	9.34	0.06
Site 3, April 14 2008	33	2.8	1	8	1.8	33	11.28	10.31	12.47	0.60
Site 4, April 10 2008	15	6.2	1	23	6.8	15	11.08	10.35	11.68	0.42
Site 5, April 10 2008	1	1.0	1	1		1	10.44	10.44	10.44	
Site 6, April 09 2008	17	1.7	1	4	0.9	15	13.52	13.22	14.01	0.24
Site 1, July 16 2008	20	5.4	1	40	9.1	11	19.76	2.41	21.70	5.75
Site 2, July 15 2008	30	2.7	1	21	3.8	30	22.22	21.10	23.74	0.67
Site 3, July 14 2008	32	3.5	1	16	3.7	32	22.68	22.22	23.70	0.43
Site 4, July 10 2008	31	4.0	1	24	5.1	15	21.35	20.74	21.80	0.29
Site 5, July 09 2008	28	3.5	1	15	3.7	20	22.08	10.37	22.87	2.76
Site 6, July 08 2008	32	3.5	1	15	3.0	32	22.91	22.80	23.57	0.17

Table 4. Water Quality Results and RGSM Catch Results during Seine Hauls. [RGSM, Rio Grande silvery minnow; n, number; mean, average; min, minimum; max, maximum; SD, standard deviation]

Site Number and Collection Date	pH (standard units)					Dissolved Oxygen (mg/L)				
	n	mean	min	max	std	n	mean	min	max	SD
Site 1, July 27 2006	25	8.13	7.30	8.50	0.38	23	6.19	5.57	6.60	0.29
Site 2, July 26 2006	5	7.38	7.16	7.61	0.22	5	7.25	6.67	7.50	0.34
Site 3, July 25 2006	0					0				
Site 4, July 20 2006	23	8.20	7.90	8.51	0.12	22	7.29	6.80	7.63	0.19
Site 5, July 19 2006	15	7.95	7.81	8.12	0.09	14	6.08	5.02	6.90	0.45
Site 6, July 18 2006	17	9.36	9.07	9.48	0.12	17	7.02	6.76	7.35	0.16
Site 1, October 11 2006	25	7.97	6.99	8.91	0.49	25	5.25	3.92	7.43	0.83
Site 2, October 12 2006	17	7.35	6.32	7.69	0.32	18	6.93	6.62	8.13	0.36
Site 3, October 17 2006	26	6.37	6.01	6.79	0.23	26	7.24	6.94	7.73	0.21
Site 4, October 16 2006	25	7.27	6.85	7.51	0.16	26	7.87	7.37	8.30	0.23
Site 5, October 18 2006	22	6.77	6.03	7.08	0.27	22	8.48	7.47	9.16	0.44
Site 6, October 19 2006	4	6.01	5.62	6.34	0.35	4	10.13	10.02	10.34	0.15
Site 1, January 25 2007	0					0				
Site 2, January 24 2007	19	8.48	8.35	8.61	0.07	19	10.76	9.66	13.01	0.87
Site 3, January 23 2007	19	7.89	7.54	8.09	0.16	19	13.79	13.07	14.40	0.39
Site 4, February 01 2007	15	7.61	6.79	8.08	0.41	15	9.55	9.40	10.00	0.14
Site 5, January 31 2007	30	6.54	6.20	6.95	0.13	30	10.19	9.80	10.61	0.18
Site 6, January 30 2007	2	7.75	7.62	7.87	0.18	2	11.71	11.71	11.71	0.00
Site 1, April 26 2007	22	8.51	8.38	8.67	0.07	22	8.79	8.21	9.28	0.29
Site 2, April 25 2007	23	8.62	8.36	8.73	0.08	23	9.41	8.28	10.01	0.48
Site 3, April 24 2007	12	8.18	7.91	8.40	0.14	13	6.76	5.56	7.45	0.62
Site 4, April 19 2007	18	7.92	7.71	8.25	0.17	18	8.15	7.24	8.90	0.57
Site 5, April 18 2007	12	8.17	7.87	8.39	0.15	12	6.46	5.11	8.57	1.26
Site 6, April 17 2007	3	8.35	8.27	8.41	0.07	3	7.51	6.70	8.02	0.71

Table 4. Water Quality Results and RGSM Catch Results during Seine Hauls. [RGSM, Rio Grande silvery minnow; n, number; mean, average; min, minimum; max, maximum; SD, standard deviation]

Site Number and Collection Date	pH (standard units)					Dissolved Oxygen (mg/L)				
	n	mean	min	max	std	n	mean	min	max	SD
Site 1, October 31 2007	3	8.18	8.17	8.18	0.01	3	8.85	8.76	8.93	0.09
Site 2, October 30 2007	27	8.35	8.29	8.40	0.03	27	9.85	9.62	10.64	0.18
Site 3, October 29 2007	32	8.08	7.41	8.50	0.25	32	11.87	10.54	12.90	0.58
Site 4, October 25 2007	6	7.94	7.62	8.32	0.27	6	9.73	9.62	9.84	0.09
Site 5, October 24 2007	24	8.32	7.33	8.56	0.33	24	10.11	8.66	11.94	0.61
Site 6, October 23 2007	22	8.27	7.76	8.61	0.22	22	12.96	3.66	14.50	2.13
Site 1, January 30 2008	20	8.14	8.03	8.30	0.06	20	11.28	10.97	11.58	0.19
Site 2, January 29 2008	9	8.67	8.30	8.92	0.17	9	12.49	12.02	12.85	0.24
Site 3, January 28 2008	23	7.97	7.61	8.19	0.19	23	11.81	10.87	13.33	0.56
Site 4, January 24 2008	21	8.11	7.98	8.23	0.07	19	10.21	9.90	11.12	0.26
Site 5, January 23 2008	30	8.10	7.89	8.28	0.10	30	10.45	10.09	10.98	0.19
Site 6, January 22 2008	20	8.28	7.93	8.77	0.17	20	14.74	14.09	15.80	0.52
Site 1, April 16 2008	31	7.92	7.68	8.13	0.12	31	10.11	9.86	10.90	0.18
Site 2, April 15 2008	12	7.82	7.62	8.02	0.11	12	9.40	9.00	9.57	0.15
Site 3, April 14 2008	33	8.07	7.52	8.48	0.23	33	11.24	10.37	12.69	0.62
Site 4, April 10 2008	15	7.46	6.59	7.86	0.38	15	8.73	7.98	9.19	0.39
Site 5, April 10 2008	1	7.84	7.84	7.84		1	8.57	8.57	8.57	
Site 6, April 09 2008	15	8.23	7.98	8.53	0.19	15	8.71	8.18	10.01	0.43
Site 1, July 16 2008	11	8.23	8.11	8.35	0.08	11	7.37	7.15	7.83	0.20
Site 2, July 15 2008	30	8.32	8.05	8.49	0.11	30	7.01	5.92	7.43	0.38
Site 3, July 14 2008	32	7.95	7.82	8.26	0.11	32	7.21	6.90	7.83	0.28
Site 4, July 10 2008	15	8.09	7.72	8.22	0.11	15	6.76	6.17	7.10	0.27
Site 5, July 09 2008	20	8.28	8.12	8.69	0.18	20	6.95	6.58	7.26	0.16
Site 6, July 08 2008	32	8.31	8.02	8.49	0.14	32	6.98	6.03	7.78	0.50

Table 4. Water Quality Results and RGSM Catch Results during Seine Hauls. [RGSM, Rio Grande silvery minnow; n, number; mean, average; min, minimum; max, maximum; SD, standard deviation]

Site Number and Collection Date	Specific Conductivity (uS/cm)				
	n	mean	min	max	SD
Site 1, July 27 2006	25	312.2	310	314	1.0
Site 2, July 26 2006	5	307.0	303	312	3.7
Site 3, July 25 2006	0				
Site 4, July 20 2006	23	396.3	391	401	2.1
Site 5, July 19 2006	15	623.6	563	678	36.7
Site 6, July 18 2006	17	671.8	669	674	1.3
Site 1, October 11 2006	25	380.5	374	388	4.2
Site 2, October 12 2006	18	344.9	320	475	33.9
Site 3, October 17 2006	26	381.7	353	430	19.7
Site 4, October 16 2006	25	380.9	343	492	34.8
Site 5, October 18 2006	22	608.6	424	1083	245.7
Site 6, October 19 2006	4	501.0	498	503	2.4
Site 1, January 25 2007	0				
Site 2, January 24 2007	19	309.1	248	351	23.1
Site 3, January 23 2007	19	403.6	330	427	27.6
Site 4, February 01 2007	15	433.1	310	499	41.1
Site 5, January 31 2007	30	519.5	417	592	33.1
Site 6, January 30 2007	2	485.0	484	486	1.4
Site 1, April 26 2007	22	306.5	298	311	2.9
Site 2, April 25 2007	23	293.7	263	304	10.1
Site 3, April 24 2007	13	350.6	331	394	15.9
Site 4, April 19 2007	18	352.2	350	355	1.8
Site 5, April 18 2007	12	495.4	420	691	94.5
Site 6, April 17 2007	3	518.3	510	523	7.2

Table 4. Water Quality Results and RGSM Catch Results during Seine Hauls. [RGSM, Rio Grande silvery minnow; n, number; mean, average; min, minimum; max, maximum; SD, standard deviation]

Site Number and Collection Date	Specific Conductivity (uS/cm)				
	n	mean	min	max	SD
Site 1, October 31 2007	3	341.3	341	342	0.6
Site 2, October 30 2007	27	340.5	339	341	0.6
Site 3, October 29 2007	32	424.5	395	487	25.6
Site 4, October 25 2007	6	474.2	472	475	1.3
Site 5, October 24 2007	24	651.3	591	689	26.4
Site 6, October 23 2007	22	676.7	660	727	12.0
Site 1, January 30 2008	19	344.4	335	352	5.8
Site 2, January 29 2008	9	373.0	350	377	8.7
Site 3, January 28 2008	23	392.7	370	419	17.5
Site 4, January 24 2008	21	447.2	438	454	3.0
Site 5, January 23 2008	30	549.0	456	580	24.7
Site 6, January 22 2008	20	577.7	507	587	17.8
Site 1, April 16 2008	31	273.2	251	277	5.9
Site 2, April 15 2008	12	276.8	273	281	2.6
Site 3, April 14 2008	33	278.2	268	294	4.0
Site 4, April 10 2008	15	313.5	308	328	5.0
Site 5, April 10 2008	1	340.0	340	340	
Site 6, April 09 2008	15	362.4	344	396	11.2
Site 1, July 16 2008	11	270.1	267	272	1.6
Site 2, July 15 2008	30	274.0	232	304	13.1
Site 3, July 14 2008	32	290.9	252	320	16.1
Site 4, July 10 2008	15	341.7	317	350	9.9
Site 5, July 09 2008	20	384.7	361	400	10.6
Site 6, July 08 2008	32	382.0	293	536	37.3

Table 6. Summary statistics for water temperature measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Water temperature in Celsius; N, number of observations; Std. Dev., standard deviation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc.; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Water temperature values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Minimum	Average	Maximum	Std. Dev.	Variance
Water Quality Summary by Site and Date in Sampling Year 1								
Rio Grande at Bernalillo, NM	Nike	7/21/2006	663	18.8	23.3	26.6	1.5	2.3
Rio Grande at Alameda, NM	Athena	7/21/2006	509	19.7	25.0	29.4	2.4	5.8
Rio Grande at Los Lunas, NM	Nike	7/17/2006	365	21.2	28.2	38.4	4.8	23.1
Rio Grande at La Joya, NM	Athena	7/17/2006	374	22.6	26.7	32.2	2.8	7.9
Rio Grande near San Antonio, NM	Apollo	7/17/2006	301	21.6	27.4	37.0	4.3	18.5
Rio Grande at Bernalillo, NM	Athena	10/6/2006	654	11.2	16.2	20.2	1.9	3.7
Rio Grande at Bernalillo, NM	Hermes	10/6/2006	182	16.9	17.9	20.0	0.9	0.8
Rio Grande at Alameda, NM	Nike	10/6/2006	279	12.9	17.5	21.9	2.0	4.1
Rio Grande at Alameda, NM	Phoebe	10/6/2006	403	12.3	16.5	21.8	2.2	4.7
Rio Grande at Los Padillas, NM	Apollo	10/6/2006	389	13.7	18.5	24.2	2.6	6.6
Rio Grande at Los Padillas, NM	Homer	10/6/2006	451	12.7	18.0	24.1	2.7	7.1
Rio Grande at Los Padillas, NM	Apollo	10/13/2006	379	12.4	15.4	18.3	1.4	1.9
Rio Grande at Los Padillas, NM	Homer	10/13/2006	583	10.3	15.1	18.7	1.8	3.1
Rio Grande at Los Lunas, NM	Nike	10/13/2006	481	8.6	14.7	18.1	2.2	4.9
Rio Grande at Los Lunas, NM	Phoebe	10/13/2006	474	10.1	14.6	17.5	1.9	3.5
Rio Grande at La Joya, NM	Athena	10/13/2006	335	11.2	15.5	17.0	0.7	0.5
Rio Grande at La Joya, NM	Hermes	10/13/2006	210	14.3	15.5	16.8	0.6	0.3
Rio Grande at Bernalillo, NM	Homer	1/22/2007	365	0.4	2.5	4.0	0.9	0.7
Rio Grande at Bernalillo, NM	Athena	2/2/2007	378	0.8	3.2	5.5	1.1	1.2
Rio Grande at Alameda, NM	Hermes	1/22/2007	239	0.7	2.6	5.1	1.2	1.4
Rio Grande at Los Padillas, NM	Athena	1/22/2007	385	1.5	4.3	7.0	1.4	2.0
Rio Grande at Los Padillas, NM	Phoebe	1/22/2007	370	1.1	3.8	6.6	1.4	2.0
Rio Grande at Los Lunas, NM	Homer	1/26/2007	540	3.9	6.0	8.0	1.0	1.1

Table 6. Summary statistics for water temperature measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Water temperature in Celsius; N, number of observations; Std. Dev., standard deviation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc.; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Water temperature values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Minimum	Average	Maximum	Std. Dev.	Variance
Rio Grande at La Joya, NM	Hermes	1/26/2007	594	4.0	5.8	8.0	1.0	1.0
Rio Grande near San Antonio, NM	Athena	1/26/2007	643	1.8	5.4	9.2	1.6	2.5
Rio Grande near San Antonio, NM	Phoebe	1/26/2007	399	2.1	5.0	8.1	1.4	1.9
Rio Grande at Bernalillo, NM	Phoebe	4/20/2007	28	13.2	14.2	14.6	0.4	0.1
Rio Grande at Alameda, NM	Nike	4/20/2007	654	9.7	13.0	16.6	1.7	3.0
Rio Grande at Alameda, NM	Hermes	4/20/2007	321	9.6	12.6	14.6	1.4	1.9
Rio Grande at Los Padillas, NM	Apollo	4/20/2007	280	9.7	13.9	18.3	2.2	4.6
Rio Grande at Los Padillas, NM	Homer	4/20/2007	655	9.5	14.4	21.0	2.5	6.5
Rio Grande at Los Lunas, NM	Athena	4/13/2007	90	9.2	9.9	11.2	0.7	0.5
Rio Grande at Los Lunas, NM	Phoebe	4/13/2007	66	8.3	9.7	10.8	0.9	0.7
Rio Grande at La Joya, NM	Apollo	4/17/2007	275	13.2	15.8	18.3	1.5	2.4
Rio Grande at La Joya, NM	Hermes	4/17/2007	272	13.2	15.6	18.1	1.5	2.4
Rio Grande near San Antonio, NM	Nike	4/17/2007	289	10.7	15.5	19.5	2.2	4.8
Rio Grande near San Antonio, NM	Homer	4/17/2007	276	11.3	15.3	19.4	2.3	5.2
Water Quality Summary by Site and Date in Sampling Year 2								
Rio Grande at Bernalillo, NM	Apollo	10/26/2007	548	9.8	12.9	15.8	1.4	2.0
Rio Grande at Bernalillo, NM	Phoebe	10/26/2007	548	9.5	12.6	15.5	1.4	2.1
Rio Grande at Alameda, NM	Athena	10/26/2007	548	9.4	13.0	16.8	2.1	4.3
Rio Grande at Alameda, NM	Hermes	10/26/2007	378	9.4	13.3	16.8	2.1	4.3
Rio Grande at Los Padillas, NM	Nike	10/26/2007	563	10.9	15.6	20.8	2.5	6.4
Rio Grande at Los Padillas, NM	Marge	10/26/2007	563	10.0	15.5	20.8	2.8	7.7
Rio Grande at Los Lunas, NM	Nike	10/22/2007	371	3.6	12.0	21.1	4.6	20.9
Rio Grande at Los Lunas, NM	Hermes	10/22/2007	136	3.6	11.4	21.0	5.6	31.2
Rio Grande at La Joya, NM	Athena	10/22/2007	374	7.1	11.7	16.1	2.3	5.3

Table 6. Summary statistics for water temperature measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Water temperature in Celsius; N, number of observations; Std. Dev., standard deviation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc.; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Water temperature values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Minimum	Average	Maximum	Std. Dev.	Variance
Rio Grande at La Joya, NM	Marge	10/22/2007	374	6.9	11.5	16.0	2.3	5.4
Rio Grande near San Antonio, NM	Apollo	10/22/2007	377	4.9	10.8	16.6	3.0	8.9
Rio Grande near San Antonio, NM	Phoebe	10/22/2007	377	4.5	10.4	17.2	3.3	10.6
Rio Grande at Bernalillo, NM	Nike	1/26/2008	459	-0.1	2.4	6.1	1.3	1.7
Rio Grande at Bernalillo, NM	Marge	1/26/2008	459	-0.2	2.3	6.0	1.3	1.7
Rio Grande at Alameda, NM	Apollo	1/26/2008	460	1.2	3.9	8.0	1.6	2.6
Rio Grande at Alameda, NM	Phoebe	1/26/2008	446	0.8	3.7	7.7	1.6	2.5
Rio Grande at Los Padillas, NM	Athena	1/26/2008	459	0.1	4.2	9.2	2.2	4.6
Rio Grande at Los Padillas, NM	Hermes	1/26/2008	388	1.0	4.6	9.0	1.8	3.3
Rio Grande at Los Lunas, NM	Athena	1/24/2008	199	3.9	5.4	7.4	1.1	1.1
Rio Grande at Los Lunas, NM	Phoebe	1/24/2008	199	3.3	5.0	7.0	1.1	1.2
Rio Grande at La Joya, NM	Nike	1/22/2008	357	2.3	4.6	6.6	1.0	1.1
Rio Grande at La Joya, NM	Marge	1/22/2008	357	2.2	4.6	6.5	1.0	1.1
Rio Grande near San Antonio, NM	Apollo	1/22/2008	371	0.7	4.0	8.0	1.4	2.1
Rio Grande near San Antonio, NM	Hermes	1/22/2008	296	0.9	4.0	7.9	1.4	2.1
Rio Grande at Bernalillo, NM	Apollo	4/11/2008	484	7.9	10.6	13.8	1.7	3.0
Rio Grande at Bernalillo, NM	Hermes	4/11/2008	100	8.4	10.5	13.5	1.5	2.3
Rio Grande at Alameda, NM	Athena	4/11/2008	480	8.2	11.3	13.9	1.5	2.2
Rio Grande at Alameda, NM	Marge	4/11/2008	462	8.0	11.1	13.8	1.5	2.2
Rio Grande at Los Padillas, NM	Nike	4/11/2008	491	8.2	12.0	17.2	2.0	4.0
Rio Grande at Los Padillas, NM	Phoebe	4/11/2008	500	7.9	11.8	16.9	2.1	4.4
Rio Grande at Los Lunas, NM	Athena	4/7/2008	164	9.1	12.3	15.4	2.1	4.6
Rio Grande at Los Lunas, NM	Hermes	4/7/2008	59	8.7	12.6	15.1	2.4	5.8
Rio Grande at La Joya, NM	Apollo	4/7/2008	273	10.2	13.5	15.5	1.4	1.9

Table 6. Summary statistics for water temperature measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Water temperature in Celsius; N, number of observations; Std. Dev., standard deviation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc.; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Water temperature values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Minimum	Average	Maximum	Std. Dev.	Variance
Rio Grande at La Joya, NM	Hermes	4/7/2008	252	9.9	13.4	15.2	1.2	1.3
Rio Grande near San Antonio, NM	Nike	4/7/2008	287	10.5	13.7	16.8	1.7	3.0
Rio Grande at Bernalillo, NM	Phoebe	7/11/2008	561	19.5	22.1	24.7	1.2	1.5
Rio Grande at Alameda, NM	Athena	7/11/2008	523	20.9	23.1	27.3	1.5	2.1
Rio Grande at Alameda, NM	Hermes	7/11/2008	549	20.7	22.9	27.0	1.4	2.0
Rio Grande at Los Padillas, NM	Marge	7/11/2008	146	21.3	23.8	27.2	1.4	1.9
Rio Grande at Los Lunas, NM	Marge	7/7/2008	270	19.1	23.1	27.4	1.9	3.7
Rio Grande at La Joya, NM	Athena	7/7/2008	222	21.2	23.8	26.4	1.4	1.9
Rio Grande at La Joya, NM	Phoebe	7/7/2008	104	22.6	24.3	26.1	1.1	1.2
Rio Grande near San Antonio, NM	Apollo	7/7/2008	381	21.7	23.6	27.0	1.3	1.8
Rio Grande near San Antonio, NM	Hermes	7/7/2008	26	24.3	25.6	26.8	0.8	0.7
Water Quality Summary by Season								
Site Name	Season of Deployment		N	Minimum	Average	Maximum	Std. Dev.	Variance
Rio Grande at Bernalillo, NM	Spring		612	7.9	10.8	14.6	1.8	3.3
Rio Grande at Alameda, NM	Spring		1,917	8.0	12.1	16.6	1.8	3.2
Rio Grande at Los Padillas, NM	Spring		1,926	7.9	13.0	21.0	2.5	6.5
Rio Grande at Los Lunas, NM	Spring		379	8.3	11.3	15.4	2.2	4.7
Rio Grande at La Joya, NM	Spring		1,072	9.9	14.6	18.3	1.8	3.3
Rio Grande near San Antonio, NM	Spring		852	10.5	14.8	19.5	2.2	5.0
Rio Grande at Bernalillo, NM	Summer		1,224	18.8	22.8	26.6	1.5	2.3
Rio Grande at Alameda, NM	Summer		1,581	19.7	23.6	29.4	2.0	4.1
Rio Grande at Los Padillas, NM	Summer		146	21.3	23.8	27.2	1.4	1.9
Rio Grande at Los Lunas, NM	Summer		635	19.1	26.0	38.4	4.6	21.2
Rio Grande at La Joya, NM	Summer		700	21.2	25.4	32.2	2.6	6.8

Table 6. Summary statistics for water temperature measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Water temperature in Celsius; N, number of observations; Std. Dev., standard deviation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc.; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Water temperature values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Minimum	Average	Maximum	Std. Dev.	Variance
Rio Grande near San Antonio, NM	Summer		708	21.6	25.3	37.0	3.5	12.3
Rio Grande at Bernalillo, NM	Fall		1,932	9.5	14.4	20.2	2.5	6.3
Rio Grande at Alameda, NM	Fall		1,620	9.4	14.7	21.9	2.8	8.0
Rio Grande at Los Padillas, NM	Fall		2,928	10.0	16.2	24.2	2.7	7.2
Rio Grande at Los Lunas, NM	Fall		1,462	3.6	13.7	21.1	3.6	12.8
Rio Grande at La Joya, NM	Fall		1,293	6.9	13.2	17.0	2.6	7.0
Rio Grande near San Antonio, NM	Fall		754	4.5	10.6	17.2	3.1	9.8
Rio Grande at Bernalillo, NM	Winter		1,661	-0.2	2.6	6.1	1.2	1.5
Rio Grande at Alameda, NM	Winter		1,145	0.7	3.6	8.0	1.6	2.6
Rio Grande at Los Padillas, NM	Winter		1,602	0.1	4.2	9.2	1.8	3.1
Rio Grande at Los Lunas, NM	Winter		938	3.3	5.6	8.0	1.1	1.3
Rio Grande at La Joya, NM	Winter		1,308	2.2	5.1	8.0	1.2	1.4
Rio Grande near San Antonio, NM	Winter		1,709	0.7	4.7	9.2	1.6	2.6
Water Quality Summary by Site and Sample Year								
Site Name	Site Number and Sample Year		N	Minimum	Average	Maximum	Std. Dev.	Variance
Rio Grande at Bernalillo, NM	Site 1, Year 1		2,270	0.4	14.0	26.6	8.4	70.6
Rio Grande at Alameda, NM	Site 2, Year 1		2,417	0.7	15.6	29.4	6.5	42.4
Rio Grande at Los Padillas, NM	Site 3, Year 1		3,492	1.1	13.3	24.2	5.5	30.1
Rio Grande at Los Lunas, NM	Site 4, Year 1		2,016	3.9	14.4	38.4	7.9	61.7
Rio Grande at La Joya, NM	Site 5, Year 1		2,060	4.0	14.8	32.2	7.2	51.8
Rio Grande near San Antonio, NM	Site 6, Year 1		1,908	1.8	11.7	37.0	8.5	71.5
Rio Grande at Bernalillo, NM	Site 1, Year 2		3,159	-0.2	11.0	24.7	6.8	46.5
Rio Grande at Alameda, NM	Site 2, Year 2		3,846	0.8	13.2	27.3	7.1	51.1
Rio Grande at Los Padillas, NM	Site 3, Year 2		3,110	0.1	11.7	27.2	5.6	31.9

Table 6. Summary statistics for water temperature measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Water temperature in Celsius; N, number of observations; Std. Dev., standard deviation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc.; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Water temperature values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Minimum	Average	Maximum	Std. Dev.	Variance
Rio Grande at Los Lunas, NM	Site 4, Year 2		1,398	3.3	12.2	27.4	6.9	47.2
Rio Grande at La Joya, NM	Site 5, Year 2		2,313	2.2	11.6	26.4	6.3	40.1
Rio Grande near San Antonio, NM	Site 6, Year 2		2,115	0.7	11.5	27.0	7.2	52.3
Rio Grande at Bernalillo, NM	Site 1, all data		5,429	-0.2	12.3	26.6	7.7	58.8
Rio Grande at Alameda, NM	Site 2, all data		6,263	0.7	14.1	29.4	7.0	49.1
Rio Grande at Los Padillas, NM	Site 3, all data		6,602	0.1	12.5	27.2	5.6	31.5
Rio Grande at Los Lunas, NM	Site 4, all data		3,414	3.3	13.5	38.4	7.5	56.9
Rio Grande at La Joya, NM	Site 5, all data		4,373	2.2	13.1	32.2	6.9	48.1
Rio Grande near San Antonio, NM	Site 6, all data		4,023	0.7	11.6	37.0	7.8	61.4
All Rio Grande Site Data	all site data		30,104	-0.2	12.9	38.4	7.1	50.0

Table 7. Summary statistics for specific conductivity measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Specific conductance in microsiemens per centimeter at 25°C; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variatiance. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. did not measure conductance; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Specific conductivity values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Water Quality Summary by Site and Date in Sampling Year 1								
Rio Grande at Bernalillo, NM	Nike	7/21/2006	0					
Rio Grande at Alameda, NM	Athena	7/21/2006	0					
Rio Grande at Los Lunas, NM	Nike	7/17/2006	0					
Rio Grande at La Joya, NM	Athena	7/17/2006	0					
Rio Grande near San Antonio, NM	Apollo	7/17/2006	0					
Rio Grande at Bernalillo, NM	Athena	10/6/2006	0					
Rio Grande at Bernalillo, NM	Hermes	10/6/2006	182	292	296.7	303	2.7	7
Rio Grande at Alameda, NM	Nike	10/6/2006	0					
Rio Grande at Alameda, NM	Phoebe	10/6/2006	403	50	347.2	1027	196.1	38454
Rio Grande at Los Padillas, NM	Apollo	10/6/2006	0					
Rio Grande at Los Padillas, NM	Homer	10/6/2006	451	183	447.1	974	148.7	22106
Rio Grande at Los Padillas, NM	Apollo	10/13/2006	0					
Rio Grande at Los Padillas, NM	Homer	10/13/2006	583	114	337.8	376	34.4	1183
Rio Grande at Los Lunas, NM	Nike	10/13/2006	0					
Rio Grande at Los Lunas, NM	Phoebe	10/13/2006	474	151	229.1	361	52.4	2741
Rio Grande at La Joya, NM	Athena	10/13/2006	0					
Rio Grande at La Joya, NM	Hermes	10/13/2006	210	119	243.6	429	54.8	3007
Rio Grande at Bernalillo, NM	Homer	1/22/2007	365	189	274.1	354	27.6	760
Rio Grande at Bernalillo, NM	Athena	2/2/2007	0					

Table 7. Summary statistics for specific conductivity measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Specific conductance in microsiemens per centimeter at 25°C; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variatiance. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. did not measure conductance; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Specific conductivity values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Alameda, NM	Hermes	1/22/2007	239	119	215.0	303	54.6	2985
Rio Grande at Los Padillas, NM	Athena	1/22/2007	0					
Rio Grande at Los Padillas, NM	Phoebe	1/22/2007	370	83	200.7	353	88.8	7878
Rio Grande at Los Lunas, NM	Homer	1/26/2007	540	106	337.8	377	26.9	722
Rio Grande at La Joya, NM	Hermes	1/26/2007	594	118	212.7	437	113.3	12838
Rio Grande near San Antonio, NM	Athena	1/26/2007	0					
Rio Grande near San Antonio, NM	Phoebe	1/26/2007	338	51	331.1	460	117.5	13805
Rio Grande at Bernalillo, NM	Phoebe	4/20/2007	28	204	213.6	232	7.0	49
Rio Grande at Alameda, NM	Nike	4/20/2007	0					
Rio Grande at Alameda, NM	Hermes	4/20/2007	321	109	171.1	246	22.5	507
Rio Grande at Los Padillas, NM	Apollo	4/20/2007	0					
Rio Grande at Los Padillas, NM	Homer	4/20/2007	655	272	295.2	319	12.2	150
Rio Grande at Los Lunas, NM	Athena	4/13/2007	0					
Rio Grande at Los Lunas, NM	Phoebe	4/13/2007	66	195	221.6	251	15.6	242
Rio Grande at La Joya, NM	Apollo	4/17/2007	0					
Rio Grande at La Joya, NM	Hermes	4/17/2007	272	204	330.0	378	69.8	4868
Rio Grande near San Antonio, NM	Nike	4/17/2007	0					
Rio Grande near San Antonio, NM	Homer	4/17/2007	276	197	272.0	475	69.7	4853
Water Quality Summary by Site and Date in Sampling Year 2								
Rio Grande at Bernalillo, NM	Apollo	10/26/2007	0					

Table 7. Summary statistics for specific conductivity measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Specific conductance in microsiemens per centimeter at 25°C; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variatiance. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. did not measure conductance; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Specific conductivity values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Phoebe	10/26/2007	548	307	319.4	336	7.4	55
Rio Grande at Alameda, NM	Athena	10/26/2007	0					
Rio Grande at Alameda, NM	Hermes	10/26/2007	378	162	244.5	352	76.7	5885
Rio Grande at Los Padillas, NM	Nike	10/26/2007	0					
Rio Grande at Los Padillas, NM	Marge	10/26/2007	563	355	464.2	511	27.3	747
Rio Grande at Los Lunas, NM	Nike	10/22/2007	0					
Rio Grande at Los Lunas, NM	Hermes	10/22/2007	136	129	447.1	477	53.3	2845
Rio Grande at La Joya, NM	Athena	10/22/2007	0					
Rio Grande at La Joya, NM	Marge	10/22/2007	374	573	605.4	653	17.1	292
Rio Grande near San Antonio, NM	Apollo	10/22/2007	0					
Rio Grande near San Antonio, NM	Phoebe	10/22/2007	377	299	333.7	637	66.5	4426
Rio Grande at Bernalillo, NM	Nike	1/26/2008	0					
Rio Grande at Bernalillo, NM	Marge	1/26/2008	459	250	275.4	349	15.8	250
Rio Grande at Alameda, NM	Apollo	1/26/2008	0					
Rio Grande at Alameda, NM	Phoebe	1/26/2008	446	125	275.2	328	34.4	1185
Rio Grande at Los Padillas, NM	Athena	1/26/2008	0					
Rio Grande at Los Padillas, NM	Hermes	1/26/2008	388	251	322.9	352	12.9	167
Rio Grande at Los Lunas, NM	Athena	1/24/2008	0					
Rio Grande at Los Lunas, NM	Phoebe	1/24/2008	199	156	246.1	328	29.6	877
Rio Grande at La Joya, NM	Nike	1/22/2008	0					

Table 7. Summary statistics for specific conductivity measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Specific conductance in microsiemens per centimeter at 25°C; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variatiance. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. did not measure conductance; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Specific conductivity values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at La Joya, NM	Marge	1/22/2008	357	379	406.6	427	11.6	135
Rio Grande near San Antonio, NM	Apollo	1/22/2008	0					
Rio Grande near San Antonio, NM	Hermes	1/22/2008	296	127	462.9	502	82.8	6860
Rio Grande at Bernalillo, NM	Apollo	4/11/2008	0					
Rio Grande at Bernalillo, NM	Hermes	4/11/2008	100	173	180.3	248	13.3	177
Rio Grande at Alameda, NM	Athena	4/11/2008	0					
Rio Grande at Alameda, NM	Marge	4/11/2008	462	78	248.5	257	28.3	802
Rio Grande at Los Padillas, NM	Nike	4/11/2008	0					
Rio Grande at Los Padillas, NM	Phoebe	4/11/2008	500	232	240.6	247	4.4	20
Rio Grande at Los Lunas, NM	Athena	4/7/2008	0					
Rio Grande at Los Lunas, NM	Hermes	4/7/2008	59	267	277.1	287	5.8	34
Rio Grande at La Joya, NM	Apollo	4/7/2008	0					
Rio Grande at La Joya, NM	Hermes	4/7/2008	252	110	157.1	299	77.1	5944
Rio Grande near San Antonio, NM	Nike	4/7/2008	0					
Rio Grande at Bernalillo, NM	Phoebe	7/11/2008	100	266	272.8	276	2.1	4
Rio Grande at Alameda, NM	Athena	7/11/2008	0					
Rio Grande at Alameda, NM	Hermes	7/11/2008	549	178	226.3	278	23.4	549
Rio Grande at Los Padillas, NM	Marge	7/11/2008	146	91	275.6	393	83.3	6943
Rio Grande at Los Lunas, NM	Marge	7/7/2008	270	321	344.7	381	13.5	184
Rio Grande at La Joya, NM	Athena	7/7/2008	0					

Table 7. Summary statistics for specific conductivity measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Specific conductance in microsiemens per centimeter at 25°C; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variatiance. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. did not measure conductance; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Specific conductivity values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at La Joya, NM	Phoebe	7/7/2008	104	160	179.6	358	42.6	1818
Rio Grande near San Antonio, NM	Apollo	7/7/2008	0					
Rio Grande near San Antonio, NM	Hermes	7/7/2008	26	369	379.7	389	5.4	29
Water Quality Summary by Season								
Site Name	Season of Deployment		N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Spring		128	173	187.6	248	18.5	341
Rio Grande at Alameda, NM	Spring		783	78	216.8	257	46.2	2133
Rio Grande at Los Padillas, NM	Spring		1155	232	271.6	319	28.7	825
Rio Grande at Los Lunas, NM	Spring		125	195	247.8	287	30.3	917
Rio Grande at La Joya, NM	Spring		524	110	246.8	378	113.4	12849
Rio Grande near San Antonio, NM	Spring		276	197	272.0	475	69.7	4853
Rio Grande at Bernalillo, NM	Summer		100	266	272.8	276	2.1	4
Rio Grande at Alameda, NM	Summer		549	178	226.3	278	23.4	549
Rio Grande at Los Padillas, NM	Summer		146	91	275.6	393	83.3	6943
Rio Grande at Los Lunas, NM	Summer		270	321	344.7	381	13.5	184
Rio Grande at La Joya, NM	Summer		104	160	179.6	358	42.6	1818
Rio Grande near San Antonio, NM	Summer		26	369	379.7	389	5.4	29
Rio Grande at Bernalillo, NM	Fall		730	292	313.8	336	11.8	140
Rio Grande at Alameda, NM	Fall		781	50	297.5	1027	159.1	25303
Rio Grande at Los Padillas, NM	Fall		1597	114	413.3	974	101.2	10248

Table 7. Summary statistics for specific conductivity measurements by sample year, date of deployment, season, and site listed from upstream to downstream. [Specific conductance in microsiemens per centimeter at 25°C; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variatiance. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. did not measure conductance; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. Specific conductivity values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Los Lunas, NM	Fall		610	129	277.7	477	104.9	11007
Rio Grande at La Joya, NM	Fall		584	119	475.3	653	177.4	31458
Rio Grande near San Antonio, NM	Fall		377	299	333.7	637	66.5	4426
Rio Grande at Bernalillo, NM	Winter		824	189	274.8	354	21.8	476
Rio Grande at Alameda, NM	Winter		685	119	254.2	328	51.3	2632
Rio Grande at Los Padillas, NM	Winter		758	83	263.3	353	87.5	7662
Rio Grande at Los Lunas, NM	Winter		739	106	313.1	377	49.2	2417
Rio Grande at La Joya, NM	Winter		951	118	285.5	437	130.0	16892
Rio Grande near San Antonio, NM	Winter		634	51	392.6	502	122.0	14880
Water Quality Summary by Site								
Site Name	(upstream to downstream)		N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	1		1782	173	284.4	354	37.1	1379
Rio Grande at Alameda, NM	2		2798	50	250.3	1027	97.2	9457
Rio Grande at Los Padillas, NM	3		3656	83	331.9	974	108.4	11742
Rio Grande at Los Lunas, NM	4		1744	106	300.9	477	75.6	5713
Rio Grande at La Joya, NM	5		2163	110	322.3	653	168.5	28378
Rio Grande near San Antonio, NM	6		1313	51	350.1	637	108.3	11719
All Rio Grande Sites	All		13456	50	304.9	1027	113.6	12904

Table 8. Summary statistics for pH measurements by sample year, date of deployment, season, and site listed from upstream to downstream. ["pH" is the negative base 10 logarithm of the molar activity of dissolved hydrogen ions (H+) and a measure of acidity or basicity; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and did not measure pH; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. pH values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Water Quality Summary by Sampling Year 1								
Rio Grande at Bernalillo, NM	Nike	7/21/2006	0					
Rio Grande at Alameda, NM	Athena	7/21/2006	0					
Rio Grande at Los Lunas, NM	Nike	7/17/2006	0					
Rio Grande at La Joya, NM	Athena	7/17/2006	0					
Rio Grande near San Antonio, NM	Apollo	7/17/2006	0					
Rio Grande at Bernalillo, NM	Athena	10/6/2006	0					
Rio Grande at Bernalillo, NM	Hermes	10/6/2006	182	8.3	8.5	8.7	0.1	0.01
Rio Grande at Alameda, NM	Nike	10/6/2006	0					
Rio Grande at Alameda, NM	Phoebe	10/6/2006	403	7.8	8.4	9.0	0.2	0.06
Rio Grande at Los Padillas, NM	Apollo	10/6/2006	0					
Rio Grande at Los Padillas, NM	Homer	10/6/2006	451	7.9	8.1	8.4	0.1	0.02
Rio Grande at Los Padillas, NM	Apollo	10/13/2006	0					
Rio Grande at Los Padillas, NM	Homer	10/13/2006	583	7.8	8.2	8.3	0.1	0.00
Rio Grande at Los Lunas, NM	Nike	10/13/2006	0					
Rio Grande at Los Lunas, NM	Phoebe	10/13/2006	474	7.9	8.3	8.8	0.2	0.03
Rio Grande at La Joya, NM	Athena	10/13/2006	0					
Rio Grande at La Joya, NM	Hermes	10/13/2006	210	8.1	8.2	8.3	0.0	0.00

Table 8. Summary statistics for pH measurements by sample year, date of deployment, season, and site listed from upstream to downstream. ["pH" is the negative base 10 logarithm of the molar activity of dissolved hydrogen ions (H+) and a measure of acidity or basicity; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and did not measure pH; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. pH values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Homer	1/22/2007	365	8.1	8.5	9.0	0.3	0.07
Rio Grande at Bernalillo, NM	Athena	2/2/2007	0					
Rio Grande at Alameda, NM	Hermes	1/22/2007	239	8.2	8.4	8.7	0.2	0.03
Rio Grande at Los Padillas, NM	Athena	1/22/2007	0					
Rio Grande at Los Padillas, NM	Phoebe	1/22/2007	370	7.9	8.0	8.1	0.0	0.00
Rio Grande at Los Lunas, NM	Homer	1/26/2007	540	8.1	8.1	8.2	0.0	0.00
Rio Grande at La Joya, NM	Hermes	1/26/2007	594	8.0	8.2	8.3	0.0	0.00
Rio Grande near San Antonio, NM	Athena	1/26/2007	0					
Rio Grande near San Antonio, NM	Phoebe	1/26/2007	399	8.2	8.3	8.3	0.0	0.00
Rio Grande at Bernalillo, NM	Phoebe	4/20/2007	28	8.0	8.2	8.5	0.2	0.03
Rio Grande at Alameda, NM	Nike	4/20/2007	0					
Rio Grande at Alameda, NM	Hermes	4/20/2007	321	8.2	8.4	8.8	0.2	0.03
Rio Grande at Los Padillas, NM	Apollo	4/20/2007	0					
Rio Grande at Los Padillas, NM	Homer	4/20/2007	655	7.9	8.0	8.1	0.1	0.00
Rio Grande at Los Lunas, NM	Athena	4/13/2007	0					
Rio Grande at Los Lunas, NM	Phoebe	4/13/2007	66	7.8	7.8	7.9	0.0	0.00
Rio Grande at La Joya, NM	Apollo	4/17/2007	0					
Rio Grande at La Joya, NM	Hermes	4/17/2007	272	8.1	8.2	8.2	0.0	0.00

Table 8. Summary statistics for pH measurements by sample year, date of deployment, season, and site listed from upstream to downstream. ["pH" is the negative base 10 logarithm of the molar activity of dissolved hydrogen ions (H+) and a measure of acidity or basicity; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and did not measure pH; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. pH values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande near San Antonio, NM	Nike	4/17/2007	0					
Rio Grande near San Antonio, NM	Homer	4/17/2007	276	8.1	8.2	8.2	0.0	0.00
Water Quality Summary by Sampling Year 2								
Rio Grande at Bernalillo, NM	Apollo	10/26/2007	-					
Rio Grande at Bernalillo, NM	Phoebe	10/26/2007	548	8.5	8.7	9.0	0.1	0.02
Rio Grande at Alameda, NM	Athena	10/26/2007	-					
Rio Grande at Alameda, NM	Hermes	10/26/2007	378	7.9	8.5	8.8	0.2	0.02
Rio Grande at Los Padillas, NM	Nike	10/26/2007	-					
Rio Grande at Los Padillas, NM	Marge	10/26/2007	563	7.8	8.1	8.5	0.1	0.02
Rio Grande at Los Lunas, NM	Nike	10/22/2007	-					
Rio Grande at Los Lunas, NM	Hermes	10/22/2007	136	8.5	8.6	8.8	0.1	0.01
Rio Grande at La Joya, NM	Athena	10/22/2007	-					
Rio Grande at La Joya, NM	Marge	10/22/2007	374	8.4	8.5	8.6	0.0	0.00
Rio Grande near San Antonio, NM	Apollo	10/22/2007	-					
Rio Grande near San Antonio, NM	Phoebe	10/22/2007	377	8.4	8.5	8.6	0.0	0.00
Rio Grande at Bernalillo, NM	Nike	1/26/2008	-					
Rio Grande at Bernalillo, NM	Marge	1/26/2008	459	8.3	8.8	9.2	0.3	0.07
Rio Grande at Alameda, NM	Apollo	1/26/2008	-					

Table 8. Summary statistics for pH measurements by sample year, date of deployment, season, and site listed from upstream to downstream. ["pH" is the negative base 10 logarithm of the molar activity of dissolved hydrogen ions (H+) and a measure of acidity or basicity; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and did not measure pH; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. pH values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Alameda, NM	Phoebe	1/26/2008	446	8.4	8.6	8.8	0.1	0.01
Rio Grande at Los Padillas, NM	Athena	1/26/2008	-					
Rio Grande at Los Padillas, NM	Hermes	1/26/2008	388	8.2	8.2	8.3	0.0	0.00
Rio Grande at Los Lunas, NM	Athena	1/24/2008	-					
Rio Grande at Los Lunas, NM	Phoebe	1/24/2008	199	8.2	8.2	8.3	0.0	0.00
Rio Grande at La Joya, NM	Nike	1/22/2008	-					
Rio Grande at La Joya, NM	Marge	1/22/2008	357	8.3	8.4	8.5	0.0	0.00
Rio Grande near San Antonio, NM	Apollo	1/22/2008	-					
Rio Grande near San Antonio, NM	Hermes	1/22/2008	296	8.2	8.5	8.6	0.0	0.00
Rio Grande at Bernalillo, NM	Apollo	4/11/2008	-					
Rio Grande at Bernalillo, NM	Hermes	4/11/2008	100	8.0	8.6	8.9	0.2	0.04
Rio Grande at Alameda, NM	Athena	4/11/2008	-					
Rio Grande at Alameda, NM	Marge	4/11/2008	462	8.2	8.3	8.5	0.1	0.00
Rio Grande at Los Padillas, NM	Nike	4/11/2008	-					
Rio Grande at Los Padillas, NM	Phoebe	4/11/2008	500	7.7	7.8	7.9	0.1	0.00
Rio Grande at Los Lunas, NM	Athena	4/7/2008	-					
Rio Grande at Los Lunas, NM	Hermes	4/7/2008	59	7.8	7.9	8.1	0.1	0.01
Rio Grande at La Joya, NM	Apollo	4/7/2008	-					

Table 8. Summary statistics for pH measurements by sample year, date of deployment, season, and site listed from upstream to downstream. ["pH" is the negative base 10 logarithm of the molar activity of dissolved hydrogen ions (H+) and a measure of acidity or basicity; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and did not measure pH; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. pH values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at La Joya, NM	Hermes	4/7/2008	252	7.6	7.7	7.7	0.0	0.00
Rio Grande near San Antonio, NM	Nike	4/7/2008	-					
Rio Grande at Bernalillo, NM	Phoebe	7/11/2008	561	7.7	7.9	8.2	0.1	0.02
Rio Grande at Alameda, NM	Athena	7/11/2008	-					
Rio Grande at Alameda, NM	Hermes	7/11/2008	549	7.3	7.9	8.1	0.1	0.01
Rio Grande at Los Padillas, NM	Marge	7/11/2008	146	7.6	7.9	8.0	0.1	0.01
Rio Grande at Los Lunas, NM	Marge	7/7/2008	270	8.0	8.1	8.3	0.0	0.00
Rio Grande at La Joya, NM	Athena	7/7/2008	-					
Rio Grande at La Joya, NM	Phoebe	7/7/2008	104	7.8	7.8	7.9	0.0	0.00
Rio Grande near San Antonio, NM	Apollo	7/7/2008	-					
Rio Grande near San Antonio, NM	Hermes	7/7/2008	26	8.0	8.1	8.2	0.0	0.00
Water Quality Summary by Season								
Site Name	Season of Deployment		N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Spring		128	8.0	8.5	8.9	0.3	0.07
Rio Grande at Alameda, NM	Spring		783	8.2	8.3	8.8	0.1	0.02
Rio Grande at Los Padillas, NM	Spring		1,155	7.7	7.9	8.1	0.1	0.02
Rio Grande at Los Lunas, NM	Spring		125	7.8	7.9	8.1	0.1	0.01
Rio Grande at La Joya, NM	Spring		524	7.6	7.9	8.2	0.3	0.06

Table 8. Summary statistics for pH measurements by sample year, date of deployment, season, and site listed from upstream to downstream. ["pH" is the negative base 10 logarithm of the molar activity of dissolved hydrogen ions (H+) and a measure of acidity or basicity; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and did not measure pH; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. pH values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande near San Antonio, NM	Spring		276	8.1	8.2	8.2	0.0	0.00
Rio Grande at Bernalillo, NM	Summer		561	7.7	7.9	8.2	0.1	0.02
Rio Grande at Alameda, NM	Summer		549	7.3	7.9	8.1	0.1	0.01
Rio Grande at Los Padillas, NM	Summer		146	7.6	7.9	8.0	0.1	0.01
Rio Grande at Los Lunas, NM	Summer		270	8.0	8.1	8.3	0.0	0.00
Rio Grande at La Joya, NM	Summer		104	7.8	7.8	7.9	0.0	0.00
Rio Grande near San Antonio, NM	Summer		26	8.0	8.1	8.2	0.0	0.00
Rio Grande at Bernalillo, NM	Fall		730	8.3	8.6	9.0	0.1	0.02
Rio Grande at Alameda, NM	Fall		781	7.8	8.5	9.0	0.2	0.04
Rio Grande at Los Padillas, NM	Fall		1,597	7.8	8.1	8.5	0.1	0.01
Rio Grande at Los Lunas, NM	Fall		610	7.9	8.4	8.8	0.2	0.04
Rio Grande at La Joya, NM	Fall		584	8.1	8.4	8.6	0.2	0.02
Rio Grande near San Antonio, NM	Fall		377	8.4	8.5	8.6	0.0	0.00
Rio Grande at Bernalillo, NM	Winter		824	8.1	8.6	9.2	0.3	0.10
Rio Grande at Alameda, NM	Winter		685	8.2	8.5	8.8	0.2	0.03
Rio Grande at Los Padillas, NM	Winter		758	7.9	8.1	8.3	0.1	0.02
Rio Grande at Los Lunas, NM	Winter		739	8.1	8.2	8.3	0.0	0.00
Rio Grande at La Joya, NM	Winter		951	8.0	8.3	8.5	0.1	0.02

Table 8. Summary statistics for pH measurements by sample year, date of deployment, season, and site listed from upstream to downstream. ["pH" is the negative base 10 logarithm of the molar activity of dissolved hydrogen ions (H+) and a measure of acidity or basicity; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and did not measure pH; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. pH values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande near San Antonio, NM	Winter		695	8.2	8.4	8.6	0.1	0.01
Water Quality Summary by Site								
Site Name	(upstream to downstream)		N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	1		2,243	7.7	8.5	9.2	0.4	0.14
Rio Grande at Alameda, NM	2		2,798	7.3	8.3	9.0	0.3	0.07
Rio Grande at Los Padillas, NM	3		3,656	7.6	8.0	8.5	0.2	0.02
Rio Grande at Los Lunas, NM	4		1,744	7.8	8.2	8.8	0.2	0.03
Rio Grande at La Joya, NM	5		2,163	7.6	8.2	8.6	0.3	0.07
Rio Grande near San Antonio, NM	6		1,374	8.0	8.4	8.6	0.1	0.02
All Rio Grande Sites	All		13,978	7.3	8.2	9.2	0.29	0.08

Table 9. Summary statistics for oxygen dissolved in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Dissolved oxygen in mg/L; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Dissolved oxygen values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)]

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Water Quality Summary by Sampling Year 1								
Rio Grande at Bernalillo, NM	Nike	7/21/2006	663	3.4	5.7	7.8	1.3	1.8
Rio Grande at Alameda, NM	Athena	7/21/2006	509	3.4	5.8	6.9	0.9	0.8
Rio Grande at Los Lunas, NM	Nike	7/17/2006	365	5.8	7.0	7.9	0.5	0.3
Rio Grande at La Joya, NM	Athena	7/17/2006	374	6.0	6.5	7.3	0.4	0.2
Rio Grande near San Antonio, NM	Apollo	7/17/2006	301	2.9	5.0	6.9	1.0	0.9
Rio Grande at Bernalillo, NM	Athena	10/6/2006	654	7.3	7.9	8.7	0.2	0.1
Rio Grande at Bernalillo, NM	Hermes	10/6/2006	182	7.3	7.5	7.8	0.1	0.0
Rio Grande at Alameda, NM	Nike	10/6/2006	279	4.4	7.7	8.4	0.7	0.5
Rio Grande at Alameda, NM	Phoebe	10/6/2006	403	3.7	5.8	6.5	0.4	0.2
Rio Grande at Los Padillas, NM	Apollo	10/6/2006	389	4.2	6.5	7.8	1.3	1.7
Rio Grande at Los Padillas, NM	Homer	10/6/2006	451	4.8	6.6	7.1	0.3	0.1
Rio Grande at Los Padillas, NM	Apollo	10/13/2006	379	4.3	7.7	8.6	0.9	0.7
Rio Grande at Los Padillas, NM	Homer	10/13/2006	583	4.6	6.8	8.3	0.6	0.3
Rio Grande at Los Lunas, NM	Nike	10/13/2006	481	4.1	6.2	8.2	0.6	0.4
Rio Grande at Los Lunas, NM	Phoebe	10/13/2006	474	4.0	6.5	8.6	0.6	0.4
Rio Grande at La Joya, NM	Athena	10/13/2006	335	4.2	7.3	8.9	1.1	1.1
Rio Grande at La Joya, NM	Hermes	10/13/2006	210	4.2	7.2	8.0	0.7	0.5
Rio Grande at Bernalillo, NM	Homer	1/22/2007	365	10.6	11.0	11.4	0.2	0.0
Rio Grande at Bernalillo, NM	Athena	2/2/2007	378	10.7	11.2	11.5	0.2	0.0
Rio Grande at Alameda, NM	Hermes	1/22/2007	239	7.2	10.1	11.2	0.9	0.9

Table 9. Summary statistics for oxygen dissolved in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Dissolved oxygen in mg/L; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Dissolved oxygen values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)]

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Los Padillas, NM	Athena	1/22/2007	385	10.0	10.5	11.2	0.3	0.1
Rio Grande at Los Padillas, NM	Phoebe	1/22/2007	370	10.6	11.3	12.3	0.4	0.2
Rio Grande at Los Lunas, NM	Homer	1/26/2007	540	6.1	9.3	10.3	0.6	0.3
Rio Grande at La Joya, NM	Hermes	1/26/2007	594	5.2	8.8	10.1	1.3	1.7
Rio Grande near San Antonio, NM	Athena	1/26/2007	643	9.6	10.4	11.1	0.3	0.1
Rio Grande near San Antonio, NM	Phoebe	1/26/2007	399	5.5	10.2	11.2	1.0	0.9
Rio Grande at Bernalillo, NM	Phoebe	4/20/2007	28	4.3	6.4	8.4	1.5	2.4
Rio Grande at Alameda, NM	Nike	4/20/2007	654	4.4	7.7	9.3	1.5	2.1
Rio Grande at Alameda, NM	Hermes	4/20/2007	321	4.4	7.9	8.8	0.9	0.8
Rio Grande at Los Padillas, NM	Apollo	4/20/2007	280	3.9	6.3	8.7	1.5	2.2
Rio Grande at Los Padillas, NM	Homer	4/20/2007	655	4.9	6.4	7.4	0.5	0.3
Rio Grande at Los Lunas, NM	Athena	4/13/2007	90	4.9	7.5	8.8	1.1	1.2
Rio Grande at Los Lunas, NM	Phoebe	4/13/2007	66	4.9	8.1	8.7	0.5	0.3
Rio Grande at La Joya, NM	Apollo	4/17/2007	275	7.4	8.0	8.4	0.3	0.1
Rio Grande at La Joya, NM	Hermes	4/17/2007	272	6.4	7.2	8.0	0.4	0.1
Rio Grande near San Antonio, NM	Nike	4/17/2007	289	7.0	7.8	9.1	0.5	0.2
Rio Grande near San Antonio, NM	Homer	4/17/2007	276	4.7	7.5	8.2	0.5	0.3
Water Quality Summary by Sampling Year 2								
Rio Grande at Bernalillo, NM	Apollo	10/26/2007	548	8.8	9.2	9.8	0.3	0.1
Rio Grande at Bernalillo, NM	Phoebe	10/26/2007	548	7.5	8.0	8.6	0.2	0.1
Rio Grande at Alameda, NM	Athena	10/26/2007	548	4.6	6.4	9.6	1.3	1.7

Table 9. Summary statistics for oxygen dissolved in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Dissolved oxygen in mg/L; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Dissolved oxygen values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)]

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Alameda, NM	Hermes	10/26/2007	378	4.2	6.9	7.9	0.8	0.6
Rio Grande at Los Padillas, NM	Nike	10/26/2007	563	4.2	7.7	9.3	1.0	0.9
Rio Grande at Los Padillas, NM	Marge	10/26/2007	563	6.1	7.2	8.2	0.4	0.2
Rio Grande at Los Lunas, NM	Nike	10/22/2007	371	6.7	9.1	10.8	1.1	1.1
Rio Grande at Los Lunas, NM	Hermes	10/22/2007	136	4.9	7.5	9.5	1.0	1.1
Rio Grande at La Joya, NM	Athena	10/22/2007	374	7.7	8.7	9.7	0.5	0.2
Rio Grande at La Joya, NM	Marge	10/22/2007	374	7.1	8.2	9.3	0.5	0.3
Rio Grande near San Antonio, NM	Apollo	10/22/2007	377	4.9	8.4	10.7	1.6	2.6
Rio Grande near San Antonio, NM	Phoebe	10/22/2007	377	6.9	8.7	10.6	0.9	0.7
Rio Grande at Bernalillo, NM	Nike	1/26/2008	459	10.3	11.6	13.3	0.7	0.5
Rio Grande at Bernalillo, NM	Marge	1/26/2008	459	9.4	10.5	11.8	0.6	0.4
Rio Grande at Alameda, NM	Apollo	1/26/2008	460	9.8	11.1	11.6	0.4	0.1
Rio Grande at Alameda, NM	Phoebe	1/26/2008	446	6.0	10.1	11.3	1.3	1.7
Rio Grande at Los Padillas, NM	Athena	1/26/2008	459	9.7	10.8	12.0	0.5	0.3
Rio Grande at Los Padillas, NM	Hermes	1/26/2008	388	5.4	8.0	9.6	1.0	1.0
Rio Grande at Los Lunas, NM	Athena	1/24/2008	199	9.2	10.1	10.5	0.3	0.1
Rio Grande at Los Lunas, NM	Phoebe	1/24/2008	199	9.9	10.3	10.9	0.2	0.1
Rio Grande at La Joya, NM	Nike	1/22/2008	357	9.6	10.2	10.5	0.2	0.0
Rio Grande at La Joya, NM	Marge	1/22/2008	357	9.0	9.5	10.0	0.2	0.0
Rio Grande near San Antonio, NM	Apollo	1/22/2008	371	10.5	11.1	11.9	0.3	0.1
Rio Grande near San Antonio, NM	Hermes	1/22/2008	296	5.8	10.3	11.4	0.8	0.6

Table 9. Summary statistics for oxygen dissolved in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Dissolved oxygen in mg/L; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Dissolved oxygen values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)]

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Apollo	4/11/2008	484	8.7	9.2	9.9	0.2	0.1
Rio Grande at Bernalillo, NM	Hermes	4/11/2008	100	4.6	6.1	8.3	1.1	1.3
Rio Grande at Alameda, NM	Athena	4/11/2008	480	8.2	9.5	10.8	0.6	0.4
Rio Grande at Alameda, NM	Marge	4/11/2008	462	4.8	7.6	8.6	0.6	0.3
Rio Grande at Los Padillas, NM	Nike	4/11/2008	491	8.1	8.8	9.4	0.3	0.1
Rio Grande at Los Padillas, NM	Phoebe	4/11/2008	500	6.3	8.3	9.6	1.0	0.9
Rio Grande at Los Lunas, NM	Athena	4/7/2008	164	4.4	6.8	9.2	1.3	1.7
Rio Grande at Los Lunas, NM	Hermes	4/7/2008	59	4.3	5.5	6.8	0.8	0.6
Rio Grande at La Joya, NM	Apollo	4/7/2008	273	4.7	8.2	8.9	0.4	0.2
Rio Grande at La Joya, NM	Hermes	4/7/2008	252	4.8	6.4	6.8	0.3	0.1
Rio Grande near San Antonio, NM	Nike	4/7/2008	287	8.0	8.4	8.9	0.2	0.0
Rio Grande at Bernalillo, NM	Phoebe	7/11/2008	561	5.6	6.4	7.2	0.4	0.1
Rio Grande at Alameda, NM	Athena	7/11/2008	523	3.4	5.1	7.4	1.2	1.6
Rio Grande at Alameda, NM	Hermes	7/11/2008	549	4.2	5.9	6.5	0.5	0.2
Rio Grande at Los Padillas, NM	Marge	7/11/2008	146	3.4	5.8	6.7	0.9	0.9
Rio Grande at Los Lunas, NM	Marge	7/7/2008	270	5.6	6.0	6.8	0.3	0.1
Rio Grande at La Joya, NM	Athena	7/7/2008	222	3.5	4.1	6.5	0.6	0.4
Rio Grande at La Joya, NM	Phoebe	7/7/2008	104	3.6	4.9	6.5	1.0	1.0
Rio Grande near San Antonio, NM	Apollo	7/7/2008	381	6.6	7.4	8.3	0.4	0.2
Rio Grande near San Antonio, NM	Hermes	7/7/2008	26	3.5	5.3	6.8	1.2	1.5
Water Quality Summary by Season								

Table 9. Summary statistics for oxygen dissolved in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Dissolved oxygen in mg/L; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Dissolved oxygen values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)]

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Site Name	Season of Deployment		N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Spring		612	4.3	8.6	9.9	1.4	1.9
Rio Grande at Alameda, NM	Spring		1,917	4.4	8.2	10.8	1.3	1.7
Rio Grande at Los Padillas, NM	Spring		1,926	3.9	7.5	9.6	1.4	1.9
Rio Grande at Los Lunas, NM	Spring		379	4.3	7.0	9.2	1.3	1.8
Rio Grande at La Joya, NM	Spring		1,072	4.7	7.5	8.9	0.8	0.6
Rio Grande near San Antonio, NM	Spring		852	4.7	7.9	9.1	0.5	0.3
Rio Grande at Bernalillo, NM	Summer		1,224	3.4	6.0	7.8	1.1	1.2
Rio Grande at Alameda, NM	Summer		1,581	3.4	5.6	7.4	1.0	1.0
Rio Grande at Los Padillas, NM	Summer		146	3.4	5.8	6.7	0.9	0.9
Rio Grande at Los Lunas, NM	Summer		635	5.6	6.6	7.9	0.6	0.4
Rio Grande at La Joya, NM	Summer		700	3.5	5.5	7.3	1.3	1.6
Rio Grande near San Antonio, NM	Summer		708	2.9	6.3	8.3	1.4	1.9
Rio Grande at Bernalillo, NM	Fall		1,932	7.3	8.3	9.8	0.6	0.4
Rio Grande at Alameda, NM	Fall		1,608	3.7	6.6	9.6	1.1	1.2
Rio Grande at Los Padillas, NM	Fall		2,928	4.2	7.1	9.3	0.9	0.8
Rio Grande at Los Lunas, NM	Fall		1,462	4.0	7.2	10.8	1.4	2.0
Rio Grande at La Joya, NM	Fall		1,293	4.2	7.9	9.7	1.0	0.9
Rio Grande near San Antonio, NM	Fall		754	4.9	8.6	10.7	1.3	1.7
Rio Grande at Bernalillo, NM	Winter		1,661	9.4	11.1	13.3	0.7	0.4
Rio Grande at Alameda, NM	Winter		1,145	6.0	10.5	11.6	1.1	1.2

Table 9. Summary statistics for oxygen dissolved in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Dissolved oxygen in mg/L; N, number of observations; Min, minimum; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Dissolved oxygen values were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)]

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Los Padillas, NM	Winter		1,602	5.4	10.2	12.3	1.4	2.0
Rio Grande at Los Lunas, NM	Winter		938	6.1	9.7	10.9	0.6	0.4
Rio Grande at La Joya, NM	Winter		1,308	5.2	9.4	10.5	1.1	1.1
Rio Grande near San Antonio, NM	Winter		1,709	5.5	10.5	11.9	0.7	0.5
Water Quality Summary by Site								
Site Name	(upstream to downstream)		N	Min	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	1		5,429	3.4	8.7	13.3	2.0	4.1
Rio Grande at Alameda, NM	2		6,251	3.4	7.5	11.6	2.0	4.2
Rio Grande at Los Padillas, NM	3		6,602	3.4	7.9	12.3	1.8	3.1
Rio Grande at Los Lunas, NM	4		3,414	4.0	7.7	10.9	1.7	2.8
Rio Grande at La Joya, NM	5		4,373	3.5	7.9	10.5	1.6	2.6
Rio Grande near San Antonio, NM	6		4,023	2.9	8.8	11.9	1.8	3.4
All Rio Grande Sites	All		30,092	2.9	8.1	13.3	1.91	3.7

Table 10. Summary statistics for oxygen saturation in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Oxygen saturation in percent; N, number of observations; Min*, minimum of the censored data; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Note: Oxygen saturations were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Water Quality Summary by Sampling Year 1								
Rio Grande at Bernalillo, NM	Nike	7/21/2006	663	50	81	115	19.4	374.6
Rio Grande at Alameda, NM	Athena	7/21/2006	509	50	85	103	13.1	171.9
Rio Grande at Los Lunas, NM	Nike	7/17/2006	365	90	108	143	13.4	178.4
Rio Grande at La Joya, NM	Athena	7/17/2006	374	88	98	116	9.0	80.2
Rio Grande near San Antonio, NM	Apollo	7/17/2006	301	50	77	120	16.8	282.6
Rio Grande at Bernalillo, NM	Athena	10/6/2006	654	85	97	104	2.9	8.5
Rio Grande at Bernalillo, NM	Hermes	10/6/2006	182	91	93	98	1.8	3.4
Rio Grande at Alameda, NM	Nike	10/6/2006	279	51	96	108	10.5	109.3
Rio Grande at Alameda, NM	Phoebe	10/6/2006	403	51	85	95	6.8	45.6
Rio Grande at Los Padillas, NM	Apollo	10/6/2006	389	50	84	104	19.0	361.4
Rio Grande at Los Padillas, NM	Homer	10/6/2006	451	54	83	94	6.2	38.8
Rio Grande at Los Padillas, NM	Apollo	10/13/2006	379	50	93	102	11.0	119.9
Rio Grande at Los Padillas, NM	Homer	10/13/2006	583	51	81	91	6.4	41.3
Rio Grande at Los Lunas, NM	Nike	10/13/2006	481	51	74	98	8.7	76.1
Rio Grande at Los Lunas, NM	Phoebe	10/13/2006	474	50	79	96	8.1	66.1
Rio Grande at La Joya, NM	Athena	10/13/2006	335	50	88	105	12.9	167.7
Rio Grande at La Joya, NM	Hermes	10/13/2006	210	50	85	94	8.5	73.0
Rio Grande at Bernalillo, NM	Homer	1/22/2007	365	91	96	101	2.0	4.0
Rio Grande at Bernalillo, NM	Athena	2/2/2007	378	95	101	107	2.9	8.3

Table 10. Summary statistics for oxygen saturation in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Oxygen saturation in percent; N, number of observations; Min*, minimum of the censored data; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Note: Oxygen saturations were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Alameda, NM	Hermes	1/22/2007	239	64	89	101	9.1	82.7
Rio Grande at Los Padillas, NM	Athena	1/22/2007	385	94	98	105	3.1	9.7
Rio Grande at Los Padillas, NM	Phoebe	1/22/2007	370	99	103	111	3.0	8.8
Rio Grande at Los Lunas, NM	Homer	1/26/2007	540	58	89	101	5.5	30.7
Rio Grande at La Joya, NM	Hermes	1/26/2007	594	50	84	97	12.9	166.7
Rio Grande near San Antonio, NM	Athena	1/26/2007	643	96	99	106	2.2	5.0
Rio Grande near San Antonio, NM	Phoebe	1/26/2007	399	57	99	111	9.4	89.3
Rio Grande at Bernalillo, NM	Phoebe	4/20/2007	28	50	75	97	17.8	317.0
Rio Grande at Alameda, NM	Nike	4/20/2007	654	52	89	107	15.4	235.9
Rio Grande at Alameda, NM	Hermes	4/20/2007	321	50	90	100	10.1	101.1
Rio Grande at Los Padillas, NM	Apollo	4/20/2007	280	50	74	105	18.4	339.7
Rio Grande at Los Padillas, NM	Homer	4/20/2007	655	62	74	89	4.5	20.7
Rio Grande at Los Lunas, NM	Athena	4/13/2007	90	52	81	98	12.9	167.7
Rio Grande at Los Lunas, NM	Phoebe	4/13/2007	66	51	87	95	6.6	42.9
Rio Grande at La Joya, NM	Apollo	4/17/2007	275	95	98	102	2.0	4.1
Rio Grande at La Joya, NM	Hermes	4/17/2007	272	80	87	94	3.4	11.4
Rio Grande near San Antonio, NM	Nike	4/17/2007	289	88	95	106	4.5	20.2
Rio Grande near San Antonio, NM	Homer	4/17/2007	276	53	91	97	6.2	38.4

Table 10. Summary statistics for oxygen saturation in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Oxygen saturation in percent; N, number of observations; Min*, minimum of the censored data; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Note: Oxygen saturations were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Water Quality Summary by Sampling Year 2								
Rio Grande at Bernalillo, NM	Apollo	10/26/2007	548	98	104	115	5.7	32.7
Rio Grande at Bernalillo, NM	Phoebe	10/26/2007	548	82	90	101	4.5	20.5
Rio Grande at Alameda, NM	Athena	10/26/2007	548	52	73	111	16.2	263.6
Rio Grande at Alameda, NM	Hermes	10/26/2007	378	51	78	93	8.7	75.6
Rio Grande at Los Padillas, NM	Nike	10/26/2007	563	52	91	115	12.3	150.9
Rio Grande at Los Padillas, NM	Marge	10/26/2007	563	75	86	101	6.4	41.4
Rio Grande at Los Lunas, NM	Nike	10/22/2007	371	75	98	130	12.8	164.1
Rio Grande at Los Lunas, NM	Hermes	10/22/2007	136	62	79	101	9.8	95.2
Rio Grande at La Joya, NM	Athena	10/22/2007	374	86	93	106	5.5	29.9
Rio Grande at La Joya, NM	Marge	10/22/2007	374	79	87	98	4.3	18.6
Rio Grande near San Antonio, NM	Apollo	10/22/2007	377	55	87	106	14.2	200.5
Rio Grande near San Antonio, NM	Phoebe	10/22/2007	377	77	89	102	5.9	35.0
Rio Grande at Bernalillo, NM	Nike	1/26/2008	459	89	100	115	7.0	49.0
Rio Grande at Bernalillo, NM	Marge	1/26/2008	459	81	90	103	5.8	33.4
Rio Grande at Alameda, NM	Apollo	1/26/2008	460	90	100	107	3.5	12.6
Rio Grande at Alameda, NM	Phoebe	1/26/2008	446	50	91	106	12.0	143.5
Rio Grande at Los Padillas, NM	Athena	1/26/2008	459	92	97	105	3.4	11.5
Rio Grande at Los Padillas, NM	Hermes	1/26/2008	388	51	73	91	10.7	114.5
Rio Grande at Los Lunas, NM	Athena	1/24/2008	199	83	96	103	3.7	13.3

Table 10. Summary statistics for oxygen saturation in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Oxygen saturation in percent; N, number of observations; Min*, minimum of the censored data; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Note: Oxygen saturations were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Los Lunas, NM	Phoebe	1/24/2008	199	91	96	100	1.9	3.6
Rio Grande at La Joya, NM	Nike	1/22/2008	357	89	93	99	2.4	5.8
Rio Grande at La Joya, NM	Marge	1/22/2008	357	79	87	93	2.4	5.9
Rio Grande near San Antonio, NM	Apollo	1/22/2008	371	93	98	105	2.5	6.5
Rio Grande near San Antonio, NM	Hermes	1/22/2008	296	50	91	98	7.3	53.6
Rio Grande at Bernalillo, NM	Apollo	4/11/2008	484	93	99	106	3.2	10.4
Rio Grande at Bernalillo, NM	Hermes	4/11/2008	100	50	65	90	11.8	139.2
Rio Grande at Alameda, NM	Athena	4/11/2008	480	88	103	121	8.0	64.6
Rio Grande at Alameda, NM	Marge	4/11/2008	462	52	82	96	6.8	46.5
Rio Grande at Los Padillas, NM	Nike	4/11/2008	491	89	97	109	5.3	28.5
Rio Grande at Los Padillas, NM	Phoebe	4/11/2008	500	70	91	104	9.3	86.9
Rio Grande at Los Lunas, NM	Athena	4/7/2008	164	50	76	102	15.0	224.0
Rio Grande at Los Lunas, NM	Hermes	4/7/2008	59	50	62	80	10.5	110.7
Rio Grande at La Joya, NM	Apollo	4/7/2008	273	50	94	100	5.4	29.2
Rio Grande at La Joya, NM	Hermes	4/7/2008	252	51	73	78	4.3	18.8
Rio Grande near San Antonio, NM	Nike	4/7/2008	287	93	95	100	2.1	4.5
Rio Grande at Bernalillo, NM	Phoebe	7/11/2008	561	78	87	98	4.9	23.8
Rio Grande at Alameda, NM	Athena	7/11/2008	523	50	70	105	16.9	286.6
Rio Grande at Alameda, NM	Hermes	7/11/2008	549	57	82	92	6.6	44.1
Rio Grande at Los Padillas, NM	Marge	7/11/2008	146	50	81	95	12.8	163.2

Table 10. Summary statistics for oxygen saturation in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Oxygen saturation in percent; N, number of observations; Min*, minimum of the censored data; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Note: Oxygen saturations were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Los Lunas, NM	Marge	7/7/2008	270	77	84	91	3.4	11.8
Rio Grande at La Joya, NM	Athena	7/7/2008	222	50	58	92	9.3	86.1
Rio Grande at La Joya, NM	Phoebe	7/7/2008	104	50	70	94	15.5	241.4
Rio Grande near San Antonio, NM	Apollo	7/7/2008	381	88	103	118	6.3	39.2
Rio Grande near San Antonio, NM	Hermes	7/7/2008	26	52	76	96	16.5	272.6
Water Quality Summary by Season								
Site Name	Season of Deployment		N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Spring		612	50	92	106	14.6	214.4
Rio Grande at Alameda, NM	Spring		1,917	50	91	121	13.6	185.5
Rio Grande at Los Padillas, NM	Spring		1,926	50	84	109	13.7	186.4
Rio Grande at Los Lunas, NM	Spring		379	50	77	102	14.7	216.9
Rio Grande at La Joya, NM	Spring		1,072	50	88	102	10.0	100.4
Rio Grande near San Antonio, NM	Spring		852	53	93	106	4.9	24.2
Rio Grande at Bernalillo, NM	Summer		1,224	50	84	115	14.9	223.4
Rio Grande at Alameda, NM	Summer		1,581	50	79	105	14.2	203.1
Rio Grande at Los Padillas, NM	Summer		146	50	81	95	12.8	163.2
Rio Grande at Los Lunas, NM	Summer		635	77	98	143	15.7	245.8
Rio Grande at La Joya, NM	Summer		700	50	81	116	21.2	450.5
Rio Grande near San Antonio, NM	Summer		708	50	91	120	17.9	319.1
Rio Grande at Bernalillo, NM	Fall		1,932	82	97	115	6.7	45.5

Table 10. Summary statistics for oxygen saturation in water by sample year, date of deployment, season, and site listed from upstream to downstream. [Oxygen saturation in percent; N, number of observations; Min*, minimum of the censored data; Max, maximum; Std.Dev., standard deviation; Var., variation. See narrative text for information on device name. "Nike," "Athena," and "Apollo" are Troll 9500s by In-Situ, Inc. and used optical sensors; "Hermes," "Homer," "Marge," and "Phoebe" are Sondes by Hydrolab, Inc. and used membrane electrodes. Note: Oxygen saturations were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Water Quality Device "Name"	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Alameda, NM	Fall		1,608	51	81	111	14.4	206.3
Rio Grande at Los Padillas, NM	Fall		2,928	50	86	115	11.5	132.3
Rio Grande at Los Lunas, NM	Fall		1,462	50	82	130	13.7	188.4
Rio Grande at La Joya, NM	Fall		1,293	50	89	106	8.9	78.3
Rio Grande near San Antonio, NM	Fall		754	55	88	106	10.9	118.8
Rio Grande at Bernalillo, NM	Winter		1,661	81	97	115	6.7	45.5
Rio Grande at Alameda, NM	Winter		1,145	50	94	107	9.9	98.6
Rio Grande at Los Padillas, NM	Winter		1,602	51	93	111	12.9	167.7
Rio Grande at Los Lunas, NM	Winter		938	58	92	103	5.7	32.0
Rio Grande at La Joya, NM	Winter		1,308	50	87	99	9.5	91.2
Rio Grande near San Antonio, NM	Winter		1,709	50	98	111	6.4	41.6
Water Quality Summary by Site								
Site Name	(Site # upstream to down)		N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	1		5,429	50	93	115	11.5	132.2
Rio Grande at Alameda, NM	2		6,251	50	86	121	14.7	216.0
Rio Grande at Los Padillas, NM	3		6,602	50	87	115	13.0	169.2
Rio Grande at Los Lunas, NM	4		3,414	50	87	143	14.5	209.1
Rio Grande at La Joya, NM	5		4,373	50	87	116	12.4	153.4
Rio Grande near San Antonio, NM	6		4,023	50	94	120	10.7	114.4
All Rio Grande Sites	All		30,092	50	89	143	13.30	176.8

Table 11. Summary statistics for 24-hour ecosystem respiration by sample year, date of deployment, season, and site listed from upstream to downstream. [Ecosystem respiration in $gO_2/m^2/day$; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. Ecosystem Respiration statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Water Quality Summary by Sampling Year 1							
Rio Grande at Bernalillo, NM	7/21/2006	8	-37	-17.9	1	12.5	156.7
Rio Grande at Alameda, NM	7/21/2006	7	-81	-32.1	-7	28.7	823.9
Rio Grande at Los Lunas, NM	7/17/2006	4	-1	-0.1	0	0.4	0.2
Rio Grande at La Joya, NM	7/17/2006	4	-13	-10.8	-9	1.6	2.5
Rio Grande near San Antonio, NM	7/17/2006	4	-21	-12.4	-4	7.4	54.3
Rio Grande at Bernalillo, NM	10/6/2006	9	-7	-4.3	-3	1.7	3.0
Rio Grande at Alameda, NM	10/6/2006	12	-60	-28.8	-1	20.3	412.9
Rio Grande at Los Padillas, NM	10/6/2006	24	-77	-24.2	-3	20.1	406.0
Rio Grande at Los Lunas, NM	10/13/2006	12	-64	-25.8	-11	18.0	323.8
Rio Grande at La Joya, NM	10/13/2006	10	-52	-23.4	-3	17.2	294.4
Rio Grande at Bernalillo, NM	1/22/2007	8	-5	-1.4	2	2.9	8.5
Rio Grande at Alameda, NM	1/22/2007	4	-47	-21.7	-6	18.2	332.6
Rio Grande at Los Padillas, NM	1/22/2007	8	-3	-0.9	2	2.1	4.4
Rio Grande at Los Lunas, NM	1/26/2007	6	-14	-8.5	-6	3.2	10.1
Rio Grande at La Joya, NM	1/26/2007	7	-37	-14.4	-6	12.2	149.4
Rio Grande near San Antonio, NM	1/26/2007	12	-61	-7.8	0	17.3	299.6
Rio Grande at Bernalillo, NM	4/20/2007	7	-72	-59.1	-43	9.6	91.7
Rio Grande at Alameda, NM	4/20/2007	14	-61	-20.8	0	21.8	477.1
Rio Grande at Los Padillas, NM	4/20/2007	14	-49	-25.6	-2	14.5	209.3
Rio Grande at Los Lunas, NM	4/13/2007	3	-47	-22.2	-9	21.1	443.8

Table 11. Summary statistics for 24-hour ecosystem respiration by sample year, date of deployment, season, and site listed from upstream to downstream. [Ecosystem respiration in $gO_2/m^2/day$; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. Ecosystem Respiration statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at La Joya, NM	4/17/2007	5	-13	-7.4	-2	4.8	22.6
Rio Grande near San Antonio, NM	4/17/2007	6	-9	-7.7	-5	1.9	3.5
Water Quality Summary by Sampling Year 2							
Rio Grande at Bernalillo, NM	10/26/2007	12	-9	-4.0	1	4.8	22.7
Rio Grande at Alameda, NM	10/26/2007	12	-52	-30.0	-15	12.9	165.7
Rio Grande at Los Padillas, NM	10/26/2007	12	-22	-13.7	-6	5.4	28.8
Rio Grande at Los Lunas, NM	10/22/2007	8	-52	-23.0	-4	21.1	445.4
Rio Grande at La Joya, NM	10/22/2007	8	-45	-30.2	-14	10.0	99.6
Rio Grande near San Antonio, NM	10/22/2007	8	-41	-15.0	-5	11.4	129.9
Rio Grande at Bernalillo, NM	1/26/2008	10	-13	-5.7	2	6.2	38.2
Rio Grande at Alameda, NM	1/26/2008	10	-19	-4.4	1	7.6	57.9
Rio Grande at Los Padillas, NM	1/26/2008	10	-103	-27.1	-3	31.2	975.8
Rio Grande at Los Lunas, NM	1/24/2008	4	-3	-3.1	-3	0.4	0.1
Rio Grande at La Joya, NM	1/22/2008	8	-9	-7.0	-5	1.9	3.6
Rio Grande near San Antonio, NM	1/22/2008	8	-60	-12.5	-3	19.5	378.8
Rio Grande at Bernalillo, NM	4/11/2008	9	-81	-31.6	0	37.1	1374.6
Rio Grande at Alameda, NM	4/11/2008	10	-22	-10.5	-1	9.0	80.3
Rio Grande at Los Padillas, NM	4/11/2008	10	-19	-6.9	-4	4.3	18.8
Rio Grande at Los Lunas, NM	4/7/2008	8	-64	-41.9	-13	19.3	372.8
Rio Grande at La Joya, NM	4/7/2008	6	-25	-13.4	-4	8.4	70.2
Rio Grande near San Antonio, NM	4/7/2008	3	-6	-6.1	-6	0.3	0.1

Table 11. Summary statistics for 24-hour ecosystem respiration by sample year, date of deployment, season, and site listed from upstream to downstream. [Ecosystem respiration in $gO_2/m^2/day$; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. Ecosystem Respiration statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	7/11/2008	6	-18	-14.3	-11	2.6	6.7
Rio Grande at Alameda, NM	7/11/2008	12	-37	-17.6	-6	10.0	100.4
Rio Grande at Los Padillas, NM	7/11/2008	6	-57	-42.8	-11	16.3	264.9
Rio Grande at Los Lunas, NM	7/7/2008	3	-13	-12.0	-11	1.3	1.7
Rio Grande at La Joya, NM	7/7/2008	7	-66	-40.9	-22	16.4	268.7
Rio Grande near San Antonio, NM	7/7/2008	4	-3	-1.2	1	1.8	3.3
Water Quality Summary by Season							
Site Name	Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Spring	16	-81	-43.6	0	31.1	967.8
Rio Grande at Alameda, NM	Spring	24	-61	-16.5	0	18.1	328.2
Rio Grande at Los Padillas, NM	Spring	24	-49	-17.8	-2	14.6	214.1
Rio Grande at Los Lunas, NM	Spring	11	-64	-36.5	-9	20.8	434.5
Rio Grande at La Joya, NM	Spring	11	-25	-10.6	-2	7.3	53.9
Rio Grande near San Antonio, NM	Spring	9	-9	-7.2	-5	1.7	2.9
Rio Grande at Bernalillo, NM	Summer	14	-37	-16.3	1	9.5	90.4
Rio Grande at Alameda, NM	Summer	19	-81	-22.9	-6	19.7	387.5
Rio Grande at Los Padillas, NM	Summer	6	-57	-42.8	-11	16.3	264.9
Rio Grande at Los Lunas, NM	Summer	7	-13	-5.2	0	6.4	41.3
Rio Grande at La Joya, NM	Summer	11	-66	-30.0	-9	19.8	392.3
Rio Grande near San Antonio, NM	Summer	8	-21	-6.8	1	7.8	60.7
Rio Grande at Bernalillo, NM	Fall	21	-9	-4.1	1	3.7	13.7

Table 11. Summary statistics for 24-hour ecosystem respiration by sample year, date of deployment, season, and site listed from upstream to downstream. [Ecosystem respiration in $gO_2/m^2/day$; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. Ecosystem Respiration statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Alameda, NM	Fall	24	-60	-29.4	-1	16.6	277.1
Rio Grande at Los Padillas, NM	Fall	36	-77	-20.7	-3	17.4	301.2
Rio Grande at Los Lunas, NM	Fall	20	-64	-24.7	-4	18.8	353.4
Rio Grande at La Joya, NM	Fall	18	-52	-26.4	-3	14.5	209.1
Rio Grande near San Antonio, NM	Fall	8	-41	-15.0	-5	11.4	129.9
Rio Grande at Bernalillo, NM	Winter	18	-13	-3.8	2	5.3	28.5
Rio Grande at Alameda, NM	Winter	14	-47	-9.4	1	13.5	182.3
Rio Grande at Los Padillas, NM	Winter	18	-103	-15.4	2	26.4	698.5
Rio Grande at Los Lunas, NM	Winter	10	-14	-6.3	-3	3.7	13.6
Rio Grande at La Joya, NM	Winter	15	-37	-10.5	-5	9.0	80.2
Rio Grande near San Antonio, NM	Winter	20	-61	-9.7	0	17.9	318.8

Table 11. Summary statistics for 24-hour ecosystem respiration by sample year, date of deployment, season, and site listed from upstream to downstream. [Ecosystem respiration in $gO_2/m^2/day$; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. Ecosystem Respiration statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Water Quality Summary by Site							
Site Name	Site Number	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	1	69	-81	-15.7	2	22.5	504.6
Rio Grande at Alameda, NM	2	81	-81	-20.6	1	18.5	342.2
Rio Grande at Los Padillas, NM	3	84	-103	-20.3	2	19.7	389.0
Rio Grande at Los Lunas, NM	4	48	-64	-20.7	0	19.7	388.3
Rio Grande at La Joya, NM	5	55	-66	-19.6	-2	15.7	246.2
Rio Grande near San Antonio, NM	6	45	-61	-9.6	1	13.3	176.5
All Rio Grande Sites	All	382	-103	-18.2	2	19.1	363.0

Table 12. Summary statistics for gross primary productivity by sample year, date of deployment, season, and site listed from upstream to downstream. [Gross primary productivity in gO2/m2/day; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variation. Gross primary productivity statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Average	Min*	Max	Var.	Std.Dev.
Water Quality Summary by Sampling Year 1							
Rio Grande at Bernalillo, NM	7/21/2006	5	4.9	1.8	8.4	7.1	2.7
Rio Grande at Alameda, NM	7/21/2006	4	4.9	1.4	8.8	11.3	3.4
Rio Grande at Los Lunas, NM	7/17/2006	3	2.2	1.3	3.1	0.9	0.9
Rio Grande at La Joya, NM	7/17/2006	3	4.2	3.3	4.9	0.7	0.9
Rio Grande near San Antonio, NM	7/17/2006	3	3.7	2.6	4.9	1.4	1.2
Rio Grande at Bernalillo, NM	10/6/2006	7	1.7	0.9	2.0	0.2	0.4
Rio Grande at Alameda, NM	10/6/2006	5	1.5	1.0	1.8	0.1	0.3
Rio Grande at Los Padillas, NM	10/6/2006	13	2.1	1.1	3.2	0.5	0.7
Rio Grande at Los Lunas, NM	10/13/2006	9	2.6	0.8	7.7	4.9	2.2
Rio Grande at La Joya, NM	10/13/2006	5	1.1	0.3	2.1	0.6	0.7
Rio Grande at Bernalillo, NM	1/22/2007	6	5.2	3.9	6.4	1.2	1.1
Rio Grande at Alameda, NM	1/22/2007	2	9.0	8.2	9.7	1.2	1.1
Rio Grande at Los Padillas, NM	1/22/2007	6	2.0	1.7	2.2	0.0	0.2
Rio Grande at Los Lunas, NM	1/26/2007	4	1.7	1.3	2.2	0.2	0.4
Rio Grande at La Joya, NM	1/26/2007	3	1.2	1.1	1.5	0.1	0.3
Rio Grande near San Antonio, NM	1/26/2007	8	1.8	1.1	2.5	0.2	0.5
Rio Grande at Bernalillo, NM	4/20/2007	0					
Rio Grande at Alameda, NM	4/20/2007	5	1.1	0.5	2.0	0.3	0.6
Rio Grande at Los Padillas, NM	4/20/2007	6	1.7	0.9	3.6	0.9	1.0
Rio Grande at Los Lunas, NM	4/13/2007	0					

Table 12. Summary statistics for gross primary productivity by sample year, date of deployment, season, and site listed from upstream to downstream. [Gross primary productivity in gO2/m2/day; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variation. Gross primary productivity statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Average	Min*	Max	Var.	Std.Dev.
Rio Grande at La Joya, NM	4/17/2007	4	1.7	1.0	2.3	0.3	0.6
Rio Grande near San Antonio, NM	4/17/2007	4	1.9	1.7	2.2	0.0	0.2
Water Quality Summary by Sampling Year 2							
Rio Grande at Bernalillo, NM	10/26/2007	10	3.3	2.7	3.8	0.2	0.4
Rio Grande at Alameda, NM	10/26/2007	9	7.5	2.1	17.6	30.5	5.5
Rio Grande at Los Padillas, NM	10/26/2007	9	4.9	3.4	7.0	1.3	1.1
Rio Grande at Los Lunas, NM	10/22/2007	3	8.4	7.0	9.8	1.9	1.4
Rio Grande at La Joya, NM	10/22/2007	6	2.1	1.2	2.9	0.4	0.6
Rio Grande near San Antonio, NM	10/22/2007	5	3.4	2.2	4.0	0.6	0.8
Rio Grande at Bernalillo, NM	1/26/2008	8	9.1	6.2	12.9	4.1	2.0
Rio Grande at Alameda, NM	1/26/2008	7	3.4	2.1	5.1	1.5	1.2
Rio Grande at Los Padillas, NM	1/26/2008	7	2.0	1.2	3.1	0.7	0.8
Rio Grande at Los Lunas, NM	1/24/2008	2	9.5	8.0	11.0	4.6	2.1
Rio Grande at La Joya, NM	1/22/2008	6	1.8	1.2	2.2	0.2	0.4
Rio Grande near San Antonio, NM	1/22/2008	3	2.5	1.3	3.1	1.1	1.0
Rio Grande at Bernalillo, NM	4/11/2008	4	3.4	2.5	4.2	0.6	0.8
Rio Grande at Alameda, NM	4/11/2008	4	9.5	7.1	11.7	4.5	2.1
Rio Grande at Los Padillas, NM	4/11/2008	8	3.6	2.4	5.7	1.2	1.1
Rio Grande at Los Lunas, NM	4/7/2008	4	3.8	3.4	4.3	0.2	0.5
Rio Grande at La Joya, NM	4/7/2008	4	1.0	0.4	1.8	0.4	0.6
Rio Grande near San Antonio, NM	4/7/2008	2	1.6	0.9	2.2	0.9	1.0

Table 12. Summary statistics for gross primary productivity by sample year, date of deployment, season, and site listed from upstream to downstream. [Gross primary productivity in gO2/m2/day; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variation. Gross primary productivity statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Average	Min*	Max	Var.	Std.Dev.
Rio Grande at Bernalillo, NM	7/11/2008	5	4.4	2.9	5.7	1.1	1.0
Rio Grande at Alameda, NM	7/11/2008	8	4.1	1.5	6.9	4.7	2.2
Rio Grande at Los Padillas, NM	7/11/2008	0					
Rio Grande at Los Lunas, NM	7/7/2008	2	3.4	3.1	3.6	0.1	0.4
Rio Grande at La Joya, NM	7/7/2008	0					
Rio Grande near San Antonio, NM	7/7/2008	2	4.2	3.9	4.4	0.1	0.3
Water Quality Summary by Season							
Site Name	Season	N	Average	Min*	Max	Var.	Std.Dev.
Rio Grande at Bernalillo, NM	Spring	4	3.4	2.5	4.2	0.6	0.8
Rio Grande at Alameda, NM	Spring	9	4.8	0.5	11.7	21.3	4.6
Rio Grande at Los Padillas, NM	Spring	14	2.8	0.9	5.7	2.0	1.4
Rio Grande at Los Lunas, NM	Spring	4	3.8	3.4	4.3	0.2	0.5
Rio Grande at La Joya, NM	Spring	8	1.3	0.4	2.3	0.4	0.7
Rio Grande near San Antonio, NM	Spring	6	1.8	0.9	2.2	0.2	0.5
Rio Grande at Bernalillo, NM	Summer	10	4.7	1.8	8.4	3.7	1.9
Rio Grande at Alameda, NM	Summer	12	4.4	1.4	8.8	6.2	2.5
Rio Grande at Los Padillas, NM	Summer	0					
Rio Grande at Los Lunas, NM	Summer	5	2.7	1.3	3.6	0.9	0.9
Rio Grande at La Joya, NM	Summer	3	4.2	3.3	4.9	0.7	0.9
Rio Grande near San Antonio, NM	Summer	5	3.9	2.6	4.9	0.8	0.9
Rio Grande at Bernalillo, NM	Fall	17	2.6	0.9	3.8	0.8	0.9

Table 12. Summary statistics for gross primary productivity by sample year, date of deployment, season, and site listed from upstream to downstream. [Gross primary productivity in gO2/m2/day; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variation. Gross primary productivity statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Average	Min*	Max	Var.	Std.Dev.
Rio Grande at Alameda, NM	Fall	14	5.4	1.0	17.6	27.8	5.3
Rio Grande at Los Padillas, NM	Fall	22	3.2	1.1	7.0	2.9	1.7
Rio Grande at Los Lunas, NM	Fall	12	4.1	0.8	9.8	10.8	3.3
Rio Grande at La Joya, NM	Fall	11	1.6	0.3	2.9	0.7	0.8
Rio Grande near San Antonio, NM	Fall	5	3.4	2.2	4.0	0.6	0.8
Rio Grande at Bernalillo, NM	Winter	14	7.4	3.9	12.9	6.6	2.6
Rio Grande at Alameda, NM	Winter	9	4.6	2.1	9.7	7.4	2.7
Rio Grande at Los Padillas, NM	Winter	13	2.0	1.2	3.1	0.4	0.6
Rio Grande at Los Lunas, NM	Winter	6	4.3	1.3	11.0	17.2	4.1
Rio Grande at La Joya, NM	Winter	9	1.6	1.1	2.2	0.2	0.5
Rio Grande near San Antonio, NM	Winter	11	2.0	1.1	3.1	0.5	0.7

Table 12. Summary statistics for gross primary productivity by sample year, date of deployment, season, and site listed from upstream to downstream. [Gross primary productivity in gO2/m2/day; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variation. Gross primary productivity statistics were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Average	Min*	Max	Var.	Std.Dev.
Water Quality Summary by Site							
Site Name	Site Number	N	Average	Min*	Max	Var.	Std.Dev.
Rio Grande at Bernalillo, NM	1	45	4.6	0.9	12.9	7.2	2.7
Rio Grande at Alameda, NM	2	44	4.8	0.5	17.6	15.5	3.9
Rio Grande at Los Padillas, NM	3	49	2.8	0.9	7.0	2.1	1.5
Rio Grande at Los Lunas, NM	4	27	3.8	0.8	11.0	8.4	2.9
Rio Grande at La Joya, NM	5	31	1.8	0.3	4.9	1.1	1.1
Rio Grande near San Antonio, NM	6	27	2.6	0.9	4.9	1.2	1.1
All Rio Grande Sites	All	223	3.5	0.3	17.6	7.4	2.7

Table 13. Summary statistics for the ratio of gross primary productivity to ecosystem respiration (PR Ratios) by sample year, date of deployment, season, and site listed from upstream to downstream. [Values are PR Ratios; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. PR Ratios were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Water Quality Summary by Sampling Year 1							
Rio Grande at Bernalillo, NM	7/21/2006	5	-0.8	0.1	2.7	1.5	2.2
Rio Grande at Alameda, NM	7/21/2006	4	-0.8	-0.3	-0.1	0.3	0.1
Rio Grande at Los Lunas, NM	7/17/2006	3	-8.3	1.9	9.9	9.3	86.9
Rio Grande at La Joya, NM	7/17/2006	3	-0.5	-0.4	-0.4	0.1	0.0
Rio Grande near San Antonio, NM	7/17/2006	3	-0.7	-0.5	-0.3	0.2	0.1
Rio Grande at Bernalillo, NM	10/6/2006	7	-0.7	-0.5	-0.1	0.2	0.1
Rio Grande at Alameda, NM	10/6/2006	5	-1.4	-0.5	0.0	0.6	0.4
Rio Grande at Los Padillas, NM	10/6/2006	13	-1.0	-0.2	-0.1	0.3	0.1
Rio Grande at Los Lunas, NM	10/13/2006	9	-0.5	-0.1	0.0	0.1	0.0
Rio Grande at La Joya, NM	10/13/2006	5	-0.5	-0.2	0.0	0.2	0.0
Rio Grande at Bernalillo, NM	1/22/2007	6	-4.7	0.3	7.3	4.2	17.6
Rio Grande at Alameda, NM	1/22/2007	2	-1.3	-1.1	-0.8	0.3	0.1
Rio Grande at Los Padillas, NM	1/22/2007	6	-0.9	0.5	3.2	1.6	2.7
Rio Grande at Los Lunas, NM	1/26/2007	4	-0.3	-0.2	-0.2	0.0	0.0
Rio Grande at La Joya, NM	1/26/2007	3	-0.3	-0.2	-0.2	0.1	0.0
Rio Grande near San Antonio, NM	1/26/2007	8	-4.9	0.0	11.7	4.9	24.4
Rio Grande at Bernalillo, NM	4/20/2007	0					
Rio Grande at Alameda, NM	4/20/2007	5	-2.5	-1.0	-0.1	1.1	1.2
Rio Grande at Los Padillas, NM	4/20/2007	6	-0.2	-0.1	-0.1	0.0	0.0

Table 13. Summary statistics for the ratio of gross primary productivity to ecosystem respiration (PR Ratios) by sample year, date of deployment, season, and site listed from upstream to downstream. [Values are PR Ratios; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. PR Ratios were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Los Lunas, NM	4/13/2007	0					
Rio Grande at La Joya, NM	4/17/2007	4	-0.6	-0.4	-0.2	0.2	0.0
Rio Grande near San Antonio, NM	4/17/2007	4	-0.4	-0.3	-0.2	0.1	0.0
Water Quality Summary by Sampling Year 2							
Rio Grande at Bernalillo, NM	10/26/2007	10	-0.4	4.9	20.7	7.5	56.1
Rio Grande at Alameda, NM	10/26/2007	9	-0.5	-0.3	0.0	0.1	0.0
Rio Grande at Los Padillas, NM	10/26/2007	9	-0.9	-0.5	-0.3	0.2	0.1
Rio Grande at Los Lunas, NM	10/22/2007	3	-2.0	-1.5	-1.0	0.5	0.3
Rio Grande at La Joya, NM	10/22/2007	6	-0.2	-0.1	0.0	0.1	0.0
Rio Grande near San Antonio, NM	10/22/2007	5	-0.8	-0.4	-0.2	0.2	0.0
Rio Grande at Bernalillo, NM	1/26/2008	8	-5.5	6.8	52.0	18.6	346.5
Rio Grande at Alameda, NM	1/26/2008	7	-8.3	2.7	20.9	9.2	85.3
Rio Grande at Los Padillas, NM	1/26/2008	7	-0.4	-0.2	-0.1	0.1	0.0
Rio Grande at Los Lunas, NM	1/24/2008	2	-3.4	-2.9	-2.4	0.7	0.5
Rio Grande at La Joya, NM	1/22/2008	6	-0.4	-0.3	-0.1	0.1	0.0
Rio Grande near San Antonio, NM	1/22/2008	3	-0.9	-0.7	-0.4	0.3	0.1
Rio Grande at Bernalillo, NM	4/11/2008	4	-11.0	-4.1	-0.9	4.6	21.3
Rio Grande at Alameda, NM	4/11/2008	4	-6.1	-4.9	-3.4	1.2	1.5
Rio Grande at Los Padillas, NM	4/11/2008	8	-0.9	-0.7	-0.3	0.2	0.0
Rio Grande at Los Lunas, NM	4/7/2008	4	-0.1	-0.1	-0.1	0.0	0.0
Rio Grande at La Joya, NM	4/7/2008	4	-0.4	-0.2	0.0	0.2	0.0

Table 13. Summary statistics for the ratio of gross primary productivity to ecosystem respiration (PR Ratios) by sample year, date of deployment, season, and site listed from upstream to downstream. [Values are PR Ratios; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. PR Ratios were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande near San Antonio, NM	4/7/2008	2	-0.4	-0.3	-0.2	0.2	0.0
Rio Grande at Bernalillo, NM	7/11/2008	5	-0.4	-0.3	-0.2	0.1	0.0
Rio Grande at Alameda, NM	7/11/2008	8	-1.0	-0.4	-0.1	0.3	0.1
Rio Grande at Los Padillas, NM	7/11/2008	0					
Rio Grande at Los Lunas, NM	7/7/2008	2	-0.3	-0.3	-0.2	0.0	0.0
Rio Grande at La Joya, NM	7/7/2008	0					
Rio Grande near San Antonio, NM	7/7/2008	2	-5.5	-3.4	-1.4	2.9	8.4
Water Quality Summary by Season							
Site Name	Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Spring	4	-11.0	-4.1	-0.9	4.6	21.3
Rio Grande at Alameda, NM	Spring	9	-6.1	-2.7	-0.1	2.3	5.4
Rio Grande at Los Padillas, NM	Spring	14	-0.9	-0.4	-0.1	0.3	0.1
Rio Grande at Los Lunas, NM	Spring	4	-0.1	-0.1	-0.1	0.0	0.0
Rio Grande at La Joya, NM	Spring	8	-0.6	-0.3	0.0	0.2	0.0
Rio Grande near San Antonio, NM	Spring	6	-0.4	-0.3	-0.2	0.1	0.0

Table 13. Summary statistics for the ratio of gross primary productivity to ecosystem respiration (PR Ratios) by sample year, date of deployment, season, and site listed from upstream to downstream. [Values are PR Ratios; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. PR Ratios were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	Summer	10	-0.8	-0.1	2.7	1.0	1.0
Rio Grande at Alameda, NM	Summer	12	-1.0	-0.4	-0.1	0.3	0.1
Rio Grande at Los Padillas, NM	Summer	0					
Rio Grande at Los Lunas, NM	Summer	5	-8.3	1.0	9.9	6.7	44.8
Rio Grande at La Joya, NM	Summer	3	-0.5	-0.4	-0.4	0.1	0.0
Rio Grande near San Antonio, NM	Summer	5	-5.5	-1.6	-0.3	2.2	4.7
Rio Grande at Bernalillo, NM	Fall	17	-0.7	2.7	20.7	6.3	39.1
Rio Grande at Alameda, NM	Fall	14	-1.4	-0.4	0.0	0.4	0.1
Rio Grande at Los Padillas, NM	Fall	22	-1.0	-0.3	-0.1	0.3	0.1
Rio Grande at Los Lunas, NM	Fall	12	-2.0	-0.5	0.0	0.7	0.4
Rio Grande at La Joya, NM	Fall	11	-0.5	-0.1	0.0	0.1	0.0
Rio Grande near San Antonio, NM	Fall	5	-0.8	-0.4	-0.2	0.2	0.0
Rio Grande at Bernalillo, NM	Winter	14	-5.5	4.0	52.0	14.3	204.5
Rio Grande at Alameda, NM	Winter	9	-8.3	1.9	20.9	8.2	66.8
Rio Grande at Los Padillas, NM	Winter	13	-0.9	0.1	3.2	1.1	1.3
Rio Grande at Los Lunas, NM	Winter	6	-3.4	-1.1	-0.2	1.4	2.0
Rio Grande at La Joya, NM	Winter	9	-0.4	-0.2	-0.1	0.1	0.0
Rio Grande near San Antonio, NM	Winter	11	-4.9	-0.2	11.7	4.1	17.2

Table 13. Summary statistics for the ratio of gross primary productivity to ecosystem respiration (PR Ratios) by sample year, date of deployment, season, and site listed from upstream to downstream. [Values are PR Ratios; N, number of observations; Min*, minimum of the censored values; Max, maximum; Std. Dev., standard deviation; Var., variance. PR Ratios were censored when probes were considered covered with sediment (i.e., identified by less than 50 percent oxygen saturation)].

Site Name	Date of Device Deployment or Season	N	Min*	Average	Max	Std.Dev.	Var.
Water Quality Summary by Site							
Site Name	Site Number	N	Min*	Average	Max	Std.Dev.	Var.
Rio Grande at Bernalillo, NM	1	45	-11.0	1.9	52.0	9.1	82.1
Rio Grande at Alameda, NM	2	44	-8.3	-0.4	20.9	4.0	15.7
Rio Grande at Los Padillas, NM	3	49	-1.0	-0.2	3.2	0.7	0.4
Rio Grande at Los Lunas, NM	4	27	-8.3	-0.3	9.9	2.8	8.0
Rio Grande at La Joya, NM	5	31	-0.6	-0.2	0.0	0.2	0.0
Rio Grande near San Antonio, NM	6	27	-5.5	-0.5	11.7	2.8	7.6
All Rio Grande Sites	All	223	-11.0	0.1	52.0	4.7	22.0

Note that at Bernalillo, Alameda & San Antonio in October 2006; and Los Lunas in April 2007, photography was not conducted. Some photos are distorted.

Plate 1. Rio Grande at Bernalillo, NM in July 2006.

Plate 2. Rio Grande at Alameda, NM in July 2006.

Plate 3. Rio Grande at Los Padillas, NM in July 2006.

Plate 4. Rio Grande at Los Lunas, NM in July 2006.

Plate 5. Rio Grande at La Joya, NM in July 2006.

Plate 6. Rio Grande near San Antonio, NM in July 2006.

Plate 7. Rio Grande at Los Padillas, NM in October 2006.

Plate 8. Rio Grande at Los Lunas, NM in October 2006.

Plate 9. Rio Grande at La Joya, NM in October 2006.

Plate 10. Rio Grande at Bernalillo, NM in January 2007.

Plate 11. Rio Grande at Alameda, NM in January 2007.

Plate 12. Rio Grande at Los Padillas, NM in January 2007.

Plate 13. Rio Grande at Los Lunas, NM in January 2007.

Plate 14. Rio Grande at La Joya, NM in January 2007.

Plate 15. Rio Grande near San Antonio, NM in January 2007.

Plate 16. Rio Grande at Bernalillo, NM in April 2007.

Plate 17. Rio Grande at Alameda, NM in April 2007.

Plate 18. Rio Grande at Los Padillas, NM in April 2007.

Plate 19. Rio Grande at La Joya, NM in April 2007.

Plate 20. Rio Grande near San Antonio, NM in April 2007.

Plate 21. Rio Grande at Bernalillo, NM in October 2007.

Plate 22. Rio Grande at Alameda, NM in October 2007.

Plate 23. Rio Grande at Los Padillas, NM in October 2007.

Plate 24. Rio Grande at Los Lunas, NM in October 2007.

Plate 25. Rio Grande at La Joya, NM in October 2007.

Plate 26. Rio Grande near San Antonio, NM in October 2007.

Plate 27. Rio Grande at Bernalillo, NM in January 2008.

Plate 28. Rio Grande at Alameda, NM in January 2008.

Plate 29. Rio Grande at Los Padillas, NM in January 2008.

Plate 30. Rio Grande at Los Lunas, NM in January 2008.

Plate 31. Rio Grande at La Joya, NM in January 2008.

Plate 32. Rio Grande near San Antonio, NM in January 2008.

Plate 33. Rio Grande at Bernalillo, NM in April 2008.

Plate 34. Rio Grande at Alameda, NM in April 2008.

Plate 35. Rio Grande at Los Padillas, NM in April 2008.

Plate 36. Rio Grande at Los Lunas, NM in April 2008.

Plate 37. Rio Grande at La Joya, NM in April 2008.

Plate 38. Rio Grande near San Antonio, NM in April 2008.

Plate 39. Rio Grande at Bernalillo, NM in July 2008.

Plate 40. Rio Grande at Alameda, NM in July 2008.

Plate 41. Rio Grande at Los Padillas, NM in July 2008.

Plate 42. Rio Grande at Los Lunas, NM in July 2008.

Plate 43. Rio Grande at La Joya, NM in July 2008.

Plate 44. Rio Grande near San Antonio, NM in July 2008.