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Studies on Water Resources in Forested East Texas

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STUDIES ON WATER RESOURCES IN FORESTED EAST TEXAS

Sponsoring Institution	National Institute of Food and Agriculture	Project Status	TERMINATED
Reporting Frequency	Annual	Funding Source	MCINTIRE-STENNIS
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Proposal No.	(N/A)	Project No.	TEXYMCBROOM
Program Code	(N/A)	Multistate No.	(N/A)
Project End Date	Oct 1, 2013	Project Start Date	Oct 1, 2007
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Performing Department
College of Forestry & Agriculture

Non Technical Summary

Intensive silvicultural practices have the potential to negatively impact water resources. The effectiveness of forestry best management practices in minimizing potential water resources impacts should be evaluated. The purpose of this study is to conduct urgently needed research on water quality and quantity problems in forested East Texas.

Animal Health Component (N/A)

Research Effort Categories

Basic (N/A)
 Applied (N/A)
 Developmental (N/A)

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
112	0320	2050	30%
112	0320	3100	30%
112	0399	2050	20%
132	0420	2070	10%
133	0320	2050	10%

Knowledge Area

133 - Pollution Prevention and Mitigation; 112 - Watershed Protection and Management; 132 - Weather and Climate;

Subject Of Investigation

0420 - Weather; 0320 - Watersheds; 0399 - Watersheds and river basins, general;

Field Of Science

3100 - Management; 2070 - Meteorology and climatology; 2050 - Hydrology;

Keywords

nonpoint source pollution water quality water quantity erosion
 nutrients forest fertilization silviculture forestry
 clearcutting best management practiceslarge woody debris total maximum daily load
 streamside management
 zone

Goals / Objectives

1. Assessing the effects of various intensive silvicultural activities with best management practices on hydrologic

processes, sediment movement, nutrient losses. 2. Evaluating the woody debris loadings of Texas rivers including total quantity, transport, and debris budgets. 3. Collecting and analyzing climatic data for research and management applications.

Project Methods

1. Nine small (2.5 ha) and four large (70-135 ha) watersheds were gauged and instrumented with automatic samplers and level recorders at Alto, Texas in 1999 to evaluate the effects on water resources of intensive silvicultural management with best management practices. The small watersheds are nested within the large watersheds to evaluate scale-dependent effects of management on water quality. A paired watershed approach was employed, with three years of calibration data, followed by the initial round of harvest treatments in 2002. Three of the small watersheds and one of the large watersheds served as control, while the other six small and two large watersheds received one two levels of treatment with best management practices, one set intensive and the other set conventional. One large watershed with a five year old pine plantation received an herbicide release and fertilization. Data collected included streamflow, nutrients (TKN, NO₃, NH₄, TP, PO₄, K), sediment (TSS, Turbidity), herbicides (imazapyr, hexazinone, sulfometuron methyl, and glyphosate), climatic conditions, soil effects (soil compaction and moisture content) and vegetation effects. Preliminary results have been analyzed, and monitoring of the intensity and duration of treatment effects continues. Since the small watersheds were re-activated from the sites that were studied by Texas A&M University in the early 1980s, the results will also be compared to data collected from this previous study to evaluate the effects of increasingly intensive management practices mitigated by best management practices over time. In addition, effects of thinning streamside management zones and forest thinning on water resources will be evaluated. 2. Large woody debris loading and dynamics is to be measured on the lower Sabine River in southeast Texas. Woody debris has not been studied adequately in the southeast, and these data are crucial for understanding effects on aquatic ecosystems from continuing water resources development due to increasing anthropogenic demands. 3. Long-term climate monitoring continues with the SFASU weather station. This station has over 100 years of continuous monitoring and is very important for studying climatic dynamics over time and for providing data for other research and technical programs.

Progress 10/01/07 to 10/01/13

Outputs

Target Audience: Scientists and Researchers: Presented at professional meetings. - Landowners and Forestry Professionals: Presented at local forestry related meetings. - Undergraduate and Graduate students: Classroom instruction and laboratory instruction on the project locations and results. - Extension and Outreach: Presentations to Texas Forestry Association, Society of American Foresters, National Council for Air and Stream Improvement Southern Regional Meeting, Lone Star Native Plant Center Conference, SFASU Bright Ideas Conference. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Nothing Reported How have the results been disseminated to communities of interest? Professional and scientific meetings, publications in journals and proceedings. Local landowner meetings and workshops. What do you plan to do during the next reporting period to accomplish the goals? This is the final report for this project.

Impacts

What was accomplished under these goals? Outcomes for this time period include first evaluating the relative

impacts between forestry and oil and gas development. With increasing energy prices, more forestland in East Texas is being converted to gas well locations. Furthermore, these locations often are not installed with the same sensitivity to surface water resources that silvicultural operations are. This results in sediment losses many times greater than forestry operations, at a time when Texas reservoir capacity is being rapidly diminished by deposition of eroded sediments. However, when well locations are located away from streams, water quality impacts are negligible in terms of sediment. In addition, concerns about accidental salt water releases are still significant. In a well that was offset about 15 m from the stream, a saltwater spill resulted in mortality of many of the riparian buffer trees. Other changes in knowledge include the importance of woody debris in southern rivers. This has added to the knowledge and importance of instream woody debris for aquatic ecosystems. Furthermore, it was found that riparian forest structure and density are the most important factor. River flow characteristics are less significant, especially where riparian forests have been compromised by bankside land use changes or forest degradation. Under these conditions, instream woody debris was less optimum. However, where streamflows are more important to woody debris loading, as was found on the San Antonio River, a balance must be maintained between instream flow and riparian forest structure. Addressing water quality impairments is another impact of this project. Hydrologic data collection combined with recreational use-attainability surveys and a stakeholder-driven watershed protection plan will address the bacterial impairments of the Attoyac River. These studies are helping to lead to a change in conditions of water resources as practices are implemented that reduce water quality degradations. Weather and climate data continue to enhance knowledge and conditions for the region by making these data available to various users.

Publications

- Type: Journal Articles Status: Published Year Published: 2013 Citation: McBroom, M.W., Louch, J., Beasley, R.S., Chang, M., and Ice, G.G. 2013. Water Quality Effects of Silvicultural Herbicide Applications with Best Management Practices. *Forest Science*, 95(2):197-210. doi:<http://dx.doi.org/10.5849/forsci.11-012>.
- Type: Journal Articles Status: Published Year Published: 2013 Citation: Sanders, L.E., and M.W. McBroom. 2013. The effects on surface water quality and quantity of select timber harvesting of a streamside management zone in East Texas. *Southern Journal of Applied Forestry*, 37(1):45-52. doi:<http://dx.doi.org/10.5849/sjaf.11-015>.
- Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: McBroom, M. W. (Presenter & Author), Zhang, Y. (Author Only), Hydraulic Fracturing and the Environment, "Soil Erosion and Surface Water Quality Impacts of Natural Gas Development in East Texas, USA," Engineering Conferences International, Boulder, CO. (August 8, 2013).
- Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: McBroom, M. W. (Presenter & Author), NCASI Southern Regional Meeting, "WATER QUALITY EFFECTS OF HERBICIDE APPLICATIONS AT THE ALTO EXPERIMENTAL WATERSHEDS IN EAST TEXAS," NCASI, Chattanooga, TN. (June 8, 2013).
- Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: McBroom, M. W. (Presenter & Author), Zhang, Y. (Author Only), Brown, A. (Author Only), 2012 Society of American Foresters Annual Meeting, "Large Woody Debris in Texas Rivers, the Lower Sabine versus the Lower San Antonio," SAF, Spokane, WA. (October 26, 2012)

Progress 01/01/12 to 12/31/12

Outputs

OUTPUTS: For the Alto Watershed Study, analysis water quality parameters collected from storm events in previous years on research watersheds was conducted. The research evaluating the effects of oil and gas development on water quality was completed and a journal article in the journal Water was published. Recommendations for future oil and gas development were made Analysis of large woody debris and riparian forest structure data was conducted on the lower San Antonio River, Texas. Results from the continuing analysis of these data were presented at the 2012 Society of American Foresters Convention in Spokane, Washington. Another study that was begun in 2010 was the development of a Watershed Protection Plan for the Attoyac River. Equipment purchased with McIntire-Stennis funds was used as match on this EPA 319 project. This project will address the bacterial impairment of the Attoyac River, determine bacterial sources among land uses in the basin, and develop a watershed protection plan with a goal to ultimately remove the Attoyac from EPA's 303d list. Several presentations to local groups have been made relating to this project including two interviews on the local TV news. Water quality survey work on other water quality studies. Weather and climate data continue to be collected and archived on a web site (weather.sfasu.edu), and weather data are collected and are displayed real-time following the acquisition of new hardware and software. This provides a great service to the region. These data have been disseminated to researchers, local officials and citizens. These projects have resulted in the teaching and mentoring of both graduate and undergraduate students. The project locations are incorporated into teaching classes on forest hydrology, environmental hydrology, and water resources management. Results are presented to the class and the class conducts field exercises and laboratory assignments on the research watersheds. PARTICIPANTS: Persons working on this project: Matthew McBroom, principal investigator/project director, SFASU; Darinda Dans, field technician, WET Center SFASU, Todd Thomas, Sarah Schwab, Sean Pessarra, graduate students, SFASU, Field data collection and analysis. Partner Organizations: Waters of East Texas Center, SFASU, Texas Water Development Board, Texas Forest Service, National Council for Air and Stream Improvement, University of Texas at Tyler Health Science Center, National Weather Service, Texas Institute for Applied Environmental Research, Blackland Research Center, Sabine River Authority, Angelina Neches River Authority, Texas State Soil and Water Conservation Board, Texas Forest Service, Texas A&M University, Castilaw Environmental Services. Collaborators and Contacts: Drs. Yanli Zhang, Ken Farrish, Leon Young, Hans Williams, and Ray Arnold and Darinda Dans and Wayne Weatherford, WET Center, SFASU; Greg Malstaff, Texas Water Development Board; Luke Sanders, Sabine River Authority; George Ice, National Council for Air and Stream Improvement; Ali Saleh, Texas Institute for Applied Environmental Research; Jimmy Williams and Susan Wang, Blackland Research Center; Anthony Castilaw, Castilaw Environmental Services; Lucas Gregory, Texas Water Resources Institute; Dr. Terry Gentry and Dr. R. Karthikeyan, Texas A&M University; Brian Sims and Kelly Holcomb, Angelina-Neches River Authority; Mitch Conine, Texas State Soil and Water Conservation Board. TARGET AUDIENCES: Scientists and Researchers: Presented at professional meetings. - Landowners and Forestry Professionals: Presented at local forestry related meetings. - Undergraduate and Graduate students: Classroom instruction and laboratory instruction on the project locations and results. - Extension and Outreach: Presentations to Texas Forestry Association, Texas Southern Silviculture Research Seminar, Society of American Foresters, Lone Star Native Plant Center Conference, A Watershed Perspective on BioEnergy Sustainability, Oak Ridge National Laboratory, SFASU Bright Ideas Conference. PROJECT MODIFICATIONS:

Nothing significant to report during this reporting period.

Impacts

Outcomes for this time period include first evaluating the relative impacts between forestry and oil and gas development. With increasing energy prices, more forestland in East Texas is being converted to gas well locations. Furthermore, these locations often are not installed with the same sensitivity to surface water resources that silvicultural operations are. This results in sediment losses many times greater than forestry operations, at a time when Texas reservoir capacity is being rapidly diminished by deposition of eroded sediments. However, when well locations are located away from streams, water quality impacts are negligible in terms of sediment. In addition, concerns about accidental salt water releases are still a significant concern. In the well that was offset about 15 m from the stream, a saltwater spill resulted in mortality of many of the riparian buffer trees. Other changes in knowledge include the importance of woody debris in southern rivers. This has added to the knowledge and importance of instream woody debris for aquatic ecosystems. Furthermore, it was found that riparian forest structure and density are the most important factor. River flow characteristics are less significant, especially where riparian forests have been compromised by bankside land use changes or forest degradation. Under these conditions, instream woody debris was less optimum. However, where streamflows are more important to woody debris loading, as was found on the San Antonio River, a balance must be maintained between instream flow and riparian forest structure. Addressing water quality impairments is another impact of this project. Hydrologic data collection combined with recreational use-attainability surveys and a stakeholder-driven watershed protection plan will address the bacterial impairments of the Attoyac River. These studies are helping to lead to a change in conditions of water resources as practices are implemented that reduce water quality degradations. Weather and climate data continue to enhance knowledge and conditions for the region by making these data available to various users.

Publications

- . McBroom, M.W. T. Thomas, and Y. Zhang. (2012). Soil erosion and surface water quality impacts of natural gas development in East Texas, USA. *Water*, 4, 944-958, doi:10.3390/w4040944
- McBroom, M.W. Y. Zhang and A. Brown. 2012. Large woody debris in Texas rivers, the lower Sabine versus the lower San Antonio. In: Proceedings abstracts of the Society of American Foresters National Convention, Spokane, WA, *Journal of Forestry*, 110(18) p. 518.
- Brown, A., M. McBroom, and Y. Zhang. 2012. Large woody debris dynamics in the lower San Antonio River. In: Proceedings abstracts of the Society of American Foresters National Convention, Spokane, WA, *Journal of Forestry*, 110(18) p. 560.
- McBroom, M.W. and Y. Zhang. 2012. Best Management Practices (BMPs). In: Anderson, R., ed., *Berkshire Encyclopedia of Sustainability, Volume 6, Measurements, Indicators, and Research Methods for Sustainability*. Berkshire Publishing, Barrington, MA, USA. ISBN: 978-1-933782-40-9.
- Zhang, Y., McBroom, M. W., Unger, D. R., Brown, A. (2012). A Spatial Analysis of the Forestry Industries in East Texas. AAG Annual Meeting.

Progress 01/01/11 to 12/31/11

Outputs

OUTPUTS: For the Alto Watershed Study, analysis water quality parameters collected from storm events in previous years on research watersheds was conducted. Working with Dr. Yanli Zhang at SFASU, an evaluation of biofuel harvesting practices on water quality using the APEX model was completed. A student ran the model and compared conventional clearcut harvesting (using previously collected data for calibration) with biofuel harvesting, in which more of the logging residues are removed. Results from this study were presented at the 2011 Society of American Foresters Annual Meeting in Honolulu, HI. In addition, the effects of oil and gas development on water quality were evaluated. Two streams were instrumented, one with a gas location in the middle of an intermittent stream, the other where the location is about 15 m from the stream, along with existing controls. Data collection was completed in 2010 and the relative impacts of oil and gas development versus forest management were compared. Recommendations for future oil and gas development were made. Analysis of large woody debris and riparian forest structure data was conducted on the lower San Antonio River, Texas. Another study that was begun in 2010 was the development of a Watershed Protection Plan for the Attoyac River. Equipment purchased with McIntire-Stennis funds was used as match on this EPA 319 project. This project will address the bacterial impairment of the Attoyac River, determine bacterial sources among land uses in the basin, and develop a watershed protection plan with a goal to ultimately remove the Attoyac from EPA's 303d list. Several presentations to local groups have been made relating to this project including two interviews on the local TV news. Weather and climate data continue to be collected and archived on a web site (weather.sfasu.edu), and weather data are collected and are displayed real-time following the acquisition of new hardware and software. This provides a great service to the region. These data have been disseminated to researchers, local officials and citizens. These projects have resulted in the teaching and mentoring of both graduate and undergraduate students. The project locations are incorporated into teaching classes on forest hydrology, environmental hydrology, and water resources management. Results are presented to the class and the class conducts field exercises and laboratory assignments on the research watersheds.

PARTICIPANTS: Persons working on this project: Matthew McBroom, principal investigator/project director, SFASU; Darinda Dans, field technician, WET Center SFASU, Todd Thomas, Sarah Schwab, Sean Pessarra, graduate students, SFASU, Field data collection and analysis. Partner Organizations: Waters of East Texas Center, SFASU, Texas Water Development Board, Texas Forest Service, National Council for Air and Stream Improvement, University of Texas at Tyler Health Science Center, National Weather Service, Texas Institute for Applied Environmental Research, Blackland Research Center, Sabine River Authority, Angelina Neches River Authority, Texas State Soil and Water Conservation Board, Texas Forest Service, Texas A&M University, Castilaw Environmental Services. Collaborators and Contacts: Drs. Yanli Zhang, Ken Farrish, Leon Young, Hans Williams, and Ray Arnold and Darinda Dans and Wayne Weatherford, WET Center, SFASU; Greg Malstaff, Texas Water Development Board; Luke Sanders, Sabine River Authority; George Ice, National Council for Air and Stream Improvement; Ali Saleh, Texas Institute for Applied Environmental Research; Jimmy Williams and Susan Wang, Blackland Research Center; Anthony Castilaw, Castilaw Environmental Services; Lucas Gregory, Texas Water Resources Institute; Dr. Terry Gentry and Dr. R. Karthikeyan, Texas A&M University; Brian Sims and Kelly Holcomb, Angelina-Neches River Authority; Mitch Conine, Texas State Soil and Water Conservation Board.

TARGET AUDIENCES: Scientists and Researchers: Presented at professional meetings. - Landowners and Forestry Professionals: Presented at local forestry related meetings. - Undergraduate and Graduate students: Classroom instruction and laboratory instruction on the project locations and results. - Extension and Outreach: Presentations to Texas Forestry Association, Texas Southern Silviculture Research Seminar, Society of American Foresters, Lone Star Native Plant Center Conference, A Watershed Perspective

on BioEnergy Sustainability, Oak Ridge National Laboratory, SFASU Bright Ideas Conference. PROJECT MODIFICATIONS: Not relevant to this project.

Impacts

Outcomes for this time period include first evaluating the relative impacts between forestry and oil and gas development. With increasing energy prices, more forestland in East Texas is being converted to gas well locations. Furthermore, these locations often are not installed with the same sensitivity to surface water resources that silvicultural operations are. This results in sediment losses many times greater than forestry operations, at a time when Texas reservoir capacity is being rapidly diminished by deposition of eroded sediments. However, when well locations are located away from streams, water quality impacts are negligible in terms of sediment. In addition, concerns about accidental salt water releases are still a significant concern. In the well that was offset about 15 m from the stream, a saltwater spill resulted in mortality of many of the riparian buffer trees. Other changes in knowledge include the importance of woody debris in southern rivers. This has added to the knowledge and importance of instream woody debris for aquatic ecosystems. Furthermore, it was found that riparian forest structure and density are the most important factor. River flow characteristics are less significant, especially where riparian forests have been compromised by bankside land use changes or forest degradation. Under these conditions, instream woody debris was less optimum. Addressing water quality impairments is another impact of this project. Hydrologic data collection combined with recreational use-attainability surveys and a stakeholder-driven watershed protection plan will address the bacterial impairments of the Attoyac River. These studies are helping to lead to a change in conditions of water resources as practices are implemented that reduce water quality degradations. Weather and climate data continue to enhance knowledge and conditions for the region by making these data available to various users.

Publications

- No publications reported this period

Progress 01/01/10 to 12/31/10

Outputs

OUTPUTS: For the Alto Watershed Study, analysis water quality parameters collected from storm events in previous years on research watersheds was conducted. Working with Dr. Yanli Zhang at SFASU, an evaluation of biofuel harvesting practices on water quality using the APEX model has begun. A doctoral student is running the model to compare conventional clearcut harvesting (using previously collected data for calibration) with biofuel harvesting, in which more of the logging residues are removed. In addition, the effects of oil and gas development on water quality are being evaluated. Two streams were instrumented, one with a gas location in the middle of an intermittent stream, the other where the location is about 15 m from the stream, along with existing controls. Data collection was completed in 2010 and the relative impacts of oil and gas development versus forest management are being compared. Recommendations for future oil and gas development will be made. Results from this study were presented at the Texas Forestry Association's annual meeting and the Texas Southern Silviculture Research Seminar. Soil compaction and infiltration data were collected following harvest on another watershed and these data were presented at the 2010 Society of American Foresters

Annual Meeting in Albuquerque, NM. Another component of land use and water resources that was investigated was the water quality from residential rainfall collection systems. These results have been written up in a manuscript for submission to a peer reviewed journal. Analysis of large woody debris and riparian forest structure data was completed, and a final report was submitted to the Texas Water Development Board. Another contract has been awarded for similar work on the lower San Antonio River, Texas. Equipment purchased using McIntire-Stennis funds will be used on this project as well. Another study that was begun in 2010 was the development of a Watershed Protection Plan for the Attoyac River. Equipment purchased with McIntire-Stennis funds was used as match on this EPA 319 project. This project will address the bacterial impairment of the Attoyac River, determine bacterial sources among land uses in the basin, and develop a watershed protection plan with a goal to ultimately remove the Attoyac from EPA's 303d list. Several presentations to local groups have been made relating to this project including two interviews on the local TV news. Weather and climate data continue to be collected and archived on a web site (weather.sfasu.edu), and weather data are collected and are displayed real-time following the acquisition of new hardware and software. This provides a great service to the region. These data have been disseminated to researchers, local officials and citizens. These projects have resulted in the teaching and mentoring of both graduate and undergraduate students. The project locations are incorporated into teaching classes on forest hydrology, environmental hydrology, and water resources management. Results are presented to the class and the class conducts field exercises and laboratory assignments on the research watersheds. PARTICIPANTS: Persons working on this project: Matthew McBroom, principal investigator/project director, SFASU; Darinda Dans, field technician, WET Center SFASU, Todd Thomas, Sarah Schwab, Sean Pessarar, Festus Nero, graduate students, SFASU, Field data collection and analysis; Elizabeth Loomis, Wayne Jackson and Su-Chen Hung, undergraduate research assistant, SFASU, Field data collection and analysis. Partner Organizations: Waters of East Texas Center, SFASU, Texas Water Development Board, Texas Forest Service, National Council for Air and Stream Improvement, University of Texas at Tyler Health Science Center, National Weather Service, Texas Institute for Applied Environmental Research, Blackland Research Center, Sabine River Authority, Angelina Neches River Authority, Texas State Soil and Water Conservation Board, Texas Forest Service, Texas A&M University, Castilaw Environmental Services. Collaborators and Contacts: Drs. Yanli Zhang, Ken Farrish, Leon Young, Hans Williams, and Ray Arnold and Darinda Dans and Wayne Weatherford, WET Center, SFASU; Greg Malstaff, Texas Water Development Board; Luke Sanders, Sabine River Authority; George Ice, National Council for Air and Stream Improvement; Ali Saleh, Texas Institute for Applied Environmental Research; Jimmy Williams and Susan Wang, Blackland Research Center; Anthony Castilaw, Castilaw Environmental Services; Lucas Gregory, Texas Water Resources Institute; Dr. Terry Gentry and Dr. R. Karthikeyan, Texas A&M University; Brian Sims and Kelly Holcomb, Angelina-Neches River Authority; Mitch Conine, Texas State Soil and Water Conservation Board. Training or Professional Development: Texas Southern Silviculture Research Seminar, Texas Watershed Stewards Program; 3 Graduate Students and 6 undergraduate students. TARGET AUDIENCES: Scientists and Researchers: Presented at professional meetings. - Landowners and Forestry Professionals: Presented at local forestry related meetings. - Undergraduate and Graduate students: Classroom instruction and laboratory instruction on the project locations and results. - Extension and Outreach: Presentations to Texas Forestry Association, Texas Southern Silviculture Research Seminar, Society of American Foresters, Lone Star Native Plant Center Conference, A Watershed Perspective on BioEnergy Sustainability, Oak Ridge National Laboratory, SFASU Bright Ideas Conference. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

Impacts

Outcomes for this time period include first evaluating the relative impacts between forestry and oil and gas development. With increasing energy prices, more forestland in East Texas is being converted to gas well locations. Furthermore, these locations often are not installed with the same sensitivity to surface water resources that silvicultural operations are. This results in sediment losses many times greater than forestry operations, at a time when Texas reservoir capacity is being rapidly diminished by deposition of eroded sediments. However, when well locations are located away from streams, water quality impacts are negligible in terms of sediment. In addition, concerns about accidental salt water releases are still a significant concern. In the well that was offset about 15 m from the stream, a saltwater spill resulted in mortality of many of the riparian buffer trees. Other changes in knowledge include the importance of woody debris in southern rivers. This has added to the knowledge and importance of instream woody debris for aquatic ecosystems. Furthermore, it was found that riparian forest structure and density are the most important factor. River flow characteristics are less significant, especially where riparian forests have been compromised by bankside land use changes or forest degradation. Under these conditions, instream woody debris was less optimum. The effects of the Toledo Bend dam were found to be less consequential than riparian forest structure, with effects only extending at most about 20 river km downstream. Addressing water quality impairments is another impact of this project. Hydrologic data collection combined with recreational use-attainability surveys and a stakeholder-driven watershed protection plan will address the bacterial impairments of the Attoyac River. These studies are helping to lead to a change in conditions of water resources as practices are implemented that reduce water quality degradations. Weather and climate data continue to enhance knowledge and conditions for the region by making these data available to various users.

Publications

- McBroom, M. W., Young, J. L. 2010, In Kudret Ertuo and Ilker Mizra (Ed.), The Poultry Litter Land Application Rate Study Assessing the Impacts of Broiler Litter Applications on Surface Water Quality. Hauppauge, New York: Nova Publishers.
- McBroom, M. W. 2010, Lone Star Native Plant Conference, "Texas Water: Issues, Solutions, and the Role of Native Plants," Proceedings of the Piney Woods Native Plant Center, Nacogdoches TX. June 3, 2010, 164 pp.
- McBroom, M. W. 2010, Developing Large Woody Debris Budgets for Texas Rivers. Final Project Report to Texas Water Development Board, TWDB Contract No 0704830783, 148 pp.

Progress 01/01/09 to 12/31/09

Outputs

OUTPUTS: For the Alto Watershed Study, activities include first collecting and analyzing field water quality data. These data include nutrients, sediment, metals, and other water quality parameters from storm events on research watersheds. Using these data, the water quality effects of different land use practices were evaluated. The effects of oil and gas development compared with silviculture on water quality are being evaluated. Two streams were instrumented, one with a gas location in the middle of an intermittent stream, the other where the location is about 15 m from the stream, along with existing controls. These data are being collected and the relative impacts of oil and gas development versus forest management are being compared.

Recommendations for future oil and gas development will be made. Results from this study have been presented at the Society of American Forester's annual meeting in Orlando, Florida. Alto Watershed streamside management zone width study results were also presented at the Tri-State Foresters meeting in Longview, Texas. General Alto findings were presented at the Watershed Perspective on Bioenergy Sustainability Workshop at the Oak Ridge National Laboratory in Oak Ridge, Tennessee. Another component of land use and water resources that was investigated was the water quality from residential rainfall collection systems. These results were presented at the Texas Rainwater Catchment Association annual meeting and to the Texas Water Development Board. Additional work was conducted on the harvest effects of soil compaction at the Alto Watersheds as well. Field work on the quantification of large woody debris and riparian forest structure has been completed, and a draft final report was submitted to the Texas Water Development Board. Results were also presented at the Society of American Forester's annual meeting in Orlando, Florida. Weather and climate data continue to be collected and archived on a web site (weather.sfasu.edu), and weather data are collected and will be displayed real-time with the acquisition of new hardware and software. This provides a great service to the region. These data have been disseminated to researchers, local officials and citizens. These projects have resulted in the teaching and mentoring of both graduate and undergraduate students. The project locations are incorporated into teaching classes on forest hydrology, environmental hydrology, and water resources management. Results are presented to the class and the class conducts field exercises and laboratory assignments on the research watersheds. PARTICIPANTS: Persons working on this project: Matthew McBroom, principal investigator/project director, SFASU; Udendra Dongol, MS student, SFASU, Field data collection and analysis; Elizabeth Loomis, Wayne Jackson and Sean Pessara, undergraduate research assistant, SFASU, Field data collection and analysis. - Partner Organizations: Waters of East Texas Center, SFASU, Texas Water Development Board, Texas Forest Service, National Council for Air and Stream Improvement, University of Texas at Tyler Health Science Center, National Weather Service, Texas Institute for Applied Environmental Research, Blackland Research Center, Sabine River Authority. - Collaborators and Contacts: Drs. Yanli Zhang, Ken Farrish, Leon Young, Hans Williams, and Jack McCullough and Adam Miller and Wayne Weatherford, WET Center, SFASU; Greg Malstaff, Texas Water Development Board; Luke Sanders, Sabine River Authority; George Ice, National Council for Air and Stream Improvement; Ali Saleh, Texas Institute for Applied Environmental Research; Jimmy Williams and Susan Wang, Blackland Research Center. - Training or Professional Development: Tri-State BMP Foresters Annual Meeting, SMZ Width Study; 2 Graduate Students and 6 undergraduate students. TARGET AUDIENCES: Scientists and Researchers: Presented at professional meetings. - Landowners and Forestry Professionals: Presented at local forestry related meetings. - Undergraduate and Graduate students: Classroom instruction and laboratory instruction on the project locations and results. - Extension and Outreach: SMZ width study was presented to Texas BMP Revisions Committee and State SFI Committee to inform BMP development and implementation. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

Impacts

Outcomes for this time period include first evaluating the relative impacts between forestry and oil and gas development. With increasing energy prices, more forestland in East Texas is being converted to gas well locations. Furthermore, these locations often are not installed with the same sensitivity to surface water resources that silvicultural operations are. This results in sediment losses many times greater than forestry operations, at a time when Texas reservoir capacity is being rapidly diminished by deposition of eroded sediments. However, when well locations are located away from streams, water quality impacts are negligible

in terms of sediment. However, concerns about accidental salt water releases are still a major concern. In the well that was offset about 15 m from the stream, a saltwater spill resulted in mortality of many of the riparian buffer trees. Other changes in knowledge include the importance of woody debris in southern rivers. This has added to the knowledge and importance of instream woody debris for aquatic ecosystems. Furthermore, it was found that riparian forest structure and density are very important. River flow characteristics are also important, but where riparian forests have been compromised by bankside land use changes or forest degradation, instream woody debris was less optimum. The effects of the Toledo Bend dam were less significant than riparian forest structure. These studies are helping to lead to a change in conditions of water resources as practices are implemented that reduce water quality degradations. Weather and climate data continue to enhance knowledge and conditions for the region by making these data available to various users.

Publications

- McBroom, M. W., Thomas, T., Ringer, M. 2009. Large Woody Debris Dynamics in the Lower Sabine River, Texas. In: Proceedings from 2009 Society of American Foresters Annual Meeting, Opportunities in a Forested World, Orlando, FL, Society of American Foresters, Bethesda, MD.
- Thomas, T., McBroom, M. W. 2009. Hydrologic Impacts of Oil and Gas Development Compared with Silviculture. In: Proceedings from 2009 Society of American Foresters Annual Meeting, Opportunities in a Forested World, Orlando, FL, Society of American Foresters, Bethesda, MD.
- Ringer, M.S. 2009. Characterization of Large Woody Debris in the Lower Sabine River. M.S. Thesis, May 2009, Stephen F. Austin State University, Nacogdoches, Texas.

Progress 01/01/08 to 12/31/08

Outputs

OUTPUTS: Activities that have been conducted for this project include first collecting and analyzing field water quality data. These data include nutrients, sediment, metals, and other water quality parameters from storm events on forested watersheds. Using these data, modeling was conducted using the agricultural policy extender (APEX) model to evaluate the effects of different streamside management zone widths on water quality parameters. In addition, the best management practices guidelines for the 13 southern states were compared. These results were presented through written publications (see below). In addition, results were presented to various groups including the local forest landowners association, the Sierra Club, the Rotary Club, a group of university students and forestry professors at Nanjing Forestry University in China, the Bright Ideas Conference at SFASU, and federal, state, and local elected officials at a legislative summit. Results were also presented in a private meeting with state representatives and their aids. In addition, results were presented to the public on a local television news broadcast (KTRE News) and a local public access program, The Brick Street News. Results and publications are also available on the SFA web site. Weather and climate data were collected and archived on a web site (weather.sfasu.edu), and weather data were collected and displayed real-time with the acquisition of new hardware and software. This provides a great service to the region. These data have been disseminated to local officials and citizens, particularly for the period when Hurricane Ike struck the region. The SFA weather station had one of the few anemometers in the local area that was not damaged by the hurricane, providing a continuous record. Data on woody debris loadings in the Sabine

River continue to be collected and evaluated. A section of the river was desnagged following Hurricane Rita, and recruitment rates were evaluated along this reach, along with the other 3 existing sections. The effects of oil and gas development on water quality continue to be monitored. Two additional streams were instrumented, one with a gas location in the middle of an intermittent stream, the other where the location is about 15 m from the stream, along with existing controls. These data will be collected and the relative impacts of oil and gas development versus forest management will be compared. Recommendations for future oil and gas development will be made. These projects have resulted in the teaching and mentoring of both graduate and undergraduate students. The project locations are incorporated into teaching classes on forest hydrology, environmental hydrology, and water resources management. Results are presented to the class and the class conducts field exercises and laboratory assignments on the research watersheds. PARTICIPANTS: Matthew McBroom, PI. Brian King, Luke Sanders, Michael Ringer, Todd Thomas, Graduate Students. Ike Newton, Lizzy Loomis, Chris Brown undergraduate student workers. Adam Miller, Technician. Partner Organizations: Texas Water Development Board, Sabine River Authority, Texas Commission on Environmental Quality, Texas Forest Service, National Weather Service, Texas Institute for Applied Environmental Research, Waters for East Texas Center, Forest Resources Institute, Campbell Group. Collaborators and Contacts: Brian Gowin, Ali Saleh, Susan Wang, Scott Beasley, Mingteh Chang, George Ice, Brian King, Luke Sanders, John Payne, Greg Malstaff, Hughes Simpson. Training: Graduate and Undergraduate students, staff, community members. TARGET AUDIENCES: Target Audience: Community members, policy and decision makers, and environmental interest groups with a stake in water resources issues. Efforts: Presentations to local forest landowners association, the Sierra Club, the Rotary Club, a group of university students and forestry professors at Nanjing Forestry University in China, the Bright Ideas Conference at SFASU, and federal, state, and local elected officials at the Lone Star Legislative Summit. Results were also presented in a private meeting with state representatives and their aids. In addition, results were presented to the public on a local television news broadcast (KTRE News) and a local public access program, The Brick Street News. Results and publications are also available on the SFA web site. PROJECT MODIFICATIONS: Not relevant to this project.

Impacts

Outcomes for this time period include first evaluating the effects of thinning streamside management zones on water quality. This resulted in a change of knowledge which established that while riparian areas are sensitive to disturbance, silvicultural thinnings do not cause sufficient disturbance to change water quality or quantity. Furthermore, by using these data to calibrate the APEX model, it was then possible to model the effects of different SMZ widths and densities on water quality. Also, the BMPs of the 13 southern states were then compared. This provided necessary information on the rationale behind BMPs. One example of a change in action resulting from these data was that when initial recommendations were made for revisions in Texas BMPs, it was decided that sufficient scientific justification existed to not lower SMZ widths or densities. Another change in action occurred as a result of SFA deciding set up a water resources center, the Waters of East Texas Center. Due to the importance of water resources issues, and the strength of water resources research at the university, the administration decided to enhance this by establishing this center. Other changes in knowledge include the importance of woody debris in southern rivers. This has added to the knowledge and importance of instream woody debris for aquatic ecosystems. These studies are helping to lead to a change in conditions of water resources as practices are implemented that reduce water quality degradations. Weather and climate data continue to enhance knowledge and conditions for the region by making these data available to various users.

Publications

- McBroom, M. W., Beasley, R. S., Chang, M., Louch, J., Ice, G. 2007. Water Quality Effects of Silvicultural Herbicide Applications with BMPs. Sustaining America's Forests, Proceedings of the Society of American Foresters 2007 Annual Meeting, Portland, OR.
- Sanders, L. 2008. The Effects of Select Timber Harvesting of a Streamside Management Zone on Surface Water Quality and Quantity at the Alto Experimental Watersheds in East Texas. M.S. Thesis, May 2008, Stephen F. Austin State University, Nacogdoches, Texas.
- Sanders, L., McBroom, M. W., Beasley, R. S., Chang, M., Ice, G. 2007. Modeling Water Quantity and Quality Effects from an SMZ Thin. Sustaining America's Forests, Proceedings of the Society of American Foresters 2007 Annual Meeting, Portland, OR.
- Sanders, L., McBroom, M. W., Beasley, R. S., Chang, M., Ice, G. 2007. Physiographic Effects from thinning an SMZ on an Intermittent Forested Headwater Stream in East Texas. Sustaining America's Forests, Proceedings of the Society of American Foresters 2007 Annual Meeting, Portland, OR.
- McBroom, M.W., Beasley, R.S., Chang, M., and Ice, G.G. 2008. Water Quality Effects of Clearcut Harvesting and Forest Fertilization with Best Management Practices. *J. Env. Qual.*, 37(1):114-124.
- McBroom, M.W., Beasley, R.S., Chang, M., and Ice, G.G. 2008. Storm runoff and sediment losses from forest clearcutting and stand reestablishment with best management practices in the Southeastern United States. *Hydrological Processes*, 22(10):1509-1522.