# USFS Bankhead National Forest Health and Restoration Initiative

# LIAISON PANEL AND MONITORING WORK GROUPS

# July 8, 2004 Meeting Summary

Community Recreation Center - Moulton, Alabama

www.ces.ncsu.edu/NRLI/Bankhead.html

#### Bankhead Liaison Panel Members:

Myra Ball, Multiple Use

Charles Borden; Forest Resident

Randy Feltman, Logger and Local Resident

Gene Gold, Echota Cherokee

Mike Henshaw, Alabama Cooperative Extension

Service

Quentin Humphries, Winston County

Commissioners

Rob Hurt, US Fish & Wildlife Service

Randall LouAllan, Lawrence County Commissioners

Vince Meleski, Wild South

Bill Snoddy, Treasure Forests

Jeff Still, Recreation Interests (Alternate)

#### **USFS Bankhead National Forest Personnel:**

Kerry Clark John Creed Allison Cochran Glen Gaines, District Ranger

dien dames, District Ranger

Al Tucker

#### Bankhead Facilitator:

Mary Lou Addor, *Natural Resources Leadership Institute* 

#### Interested People/ Other Attendees

Eugene Carnes, Back Country Trail Riders Rebecca Carnes, Back Country Trail Riders Vicki Gerstman, NATRA

Jordan Green, Wild South Kristen Hawley, Cherokee

Anthony Hood, Local Resident

Anthony Hunt, Local Resident

Stuart Horn, Wild South

David Kelly, NATRA

Ted Kuzma, Wild South

Richard Linholm, Local Resident

Kreig McCourt, Brindlee Saddle Club

Barbara Richey, Local Resident

Dennis Robertson, NATRA

Jane Rowe, Local Resident

Tammy Skarpton, NATRA

Joe Tankersley, Local Resident

Athel Wilhite, Local Resident

# Mouton Meeting Agenda July 8, 2004 5:30pm - 9:00pm

Meeting Orientation: 5:30-5:45pm\*

- Review of Meeting Objectives
- Review of Meeting Ground Rules
- Review/ Approval of May 4 Meeting Summary

Recreational Monitoring Group: Presentation and

Trails Discussion: 5:45-7:30pm\*

**BREAK** 

Update on Forest Health and Restoration Initiative Update on Timber & Thinning Monitoring Group Presentation on Prescribed Burns

Questions for Prescribed Burn I mpacts

Next Steps: Meeting Dates

LIAISON PANEL AND MONITORING WORK GROUPS

#### July 8 Handouts Provided

- May 4, 2004 Meeting Summary.
- Recreation Monitoring Group Bankhead Trail Considerations
- Research Questions on Prescribed Burns
- Updated Monitoring Work Groups Contact and Description Information.
- Timber & Thinning Monitoring Group Report

July 8, 2004 MEETING SUMMARY

#### KEY POINTS/ACTION ITEMS/NEXT MEETING DATES AND GOALS:

### Meeting Dates:

- 1. Timber & Thinning Monitoring Work Group: in process of making plans to meet with US Forest Service staff to review a prescribed burn site prior to the August 12 meeting.
- 2. Recreation Monitoring Work Group: may schedule a meeting prior to the August 12 meeting to discuss the trails proposal developed at the July 8th meeting.
- 3. Liaison Panel and Monitoring Groups: Thursday, August 12, Double Springs, Ala. Double Springs Bank Building. 5:30- 9:30pm.

#### PROPOSED AGENDA:

- a. Meeting Orientation: 5:30-5:45pm (Mary Lou)
  - Review Meeting Objectives
  - Review Meeting Ground Rules
  - Introductions of Bankhead Liaison Panel and Others
  - Review/Approve July 8 Meeting Summary
  - Evaluation of Bankhead Process
- b. Review of Charter and Group Procedures: 5:45-6:15 (Bankhead Liaison Panel)
  - How to Maintain Open Process While At Same Time Maintain Role of Liaison Panel
  - Establish an Attendance Policy for Bankhead Liaison Panel Members
- c. Schedule Future Meetings and Agendas: 6:15-7:15 (Bankhead Liaison Panel & USFS)
  - Looting and Desecration of Cultural Resources
  - Establishment of Interpretative Center
  - Emerging I ssues
  - Determining Future Recreational Use on Bankhead
  - Beyond the Forest Health and Restoration Initiative
  - Safeguarding property rights

#### BREAK 7:15-7:30

- d. Review Membership of Liaison Panel: 7:30-800pm (Bankhead Liaison Panel & USFS)
  - Representation of Interests on the Bankhead Liaison Panel or Through Current Membership (i.e., missing interests; not attending meetings or sending alternates).
- e. Preparation for Facilitation Team Transition: 8:00-8:30pm (Mary Lou)
- f. Updates on Forest Health and Restoration Initiative: 8:30- 8:45 (Glen Gaines)
- g. Monitoring Group Updates: 8:45-9:30pm

Timber & Thinning Report: report on August 9 visit. Feltman, Henshaw, Meleski (15min)

Recreation Report: status of trail proposal #1 and other highlights: Still (15min)

Cultural Group Report: status of group -Weeks (5min)

Desired Future Conditions Report: status of group - Snoody (5min)

Wildlife Group Report: status of group -Eakes (5min)

Format Key:

Questions (Q), Responses (R) Comment (C), Liaison Panel (LP), Monitoring Group (MG), Forest Service (FS)

#### I. WELCOME/MEETING ORIENTATION

#### A. Welcome

- 1. Mary Lou Addor (Natural Resources Leadership Institute), introduced herself, welcomed the Liaison Panel and Monitoring Group members and other guests present. Those in attendance also introduced themselves.
- 2. Mary Lou went over the meeting objectives and agenda. She also provided a brief explanation of the handouts.

#### B. July 8th Meeting Objectives

- 1. Provide a brief welcome and orientation.
- 2. Continue to encourage attendance by anyone who has an interest in the Bankhead Forest Health and Restoration I nitiative to attend the meeting.
- 3. Provide an update on the Forest Health and Restoration Initiative
- 4. Provide an update on Timber and Thinning Monitoring Group Reports
- 5. Provide Presentation from the Recreation Monitoring Group; Determine Some Potential Next Steps.
- 6. Provide Presentation on Prescribed Burns

#### C. Review of May 4, 2004 Meeting Summary

- 1. Meeting Summary approved with changes and posted on the NRLI website along with presentations and handouts at: <a href="https://www.ces.ncsu.edu/nrli/bankhead.html">www.ces.ncsu.edu/nrli/bankhead.html</a>
- 2. Approval of the May 4 Meeting Summary with the following changes:
  - a. Page 4, Status of Current Timber Sales, item #1, point h.
    - h. FY 2004 Final Sale Handout (Appendix A): Changes Compartment (C) 32 is rescheduled for 2007 and C159 for 2008. Compartments 94/95 and C104/116 reschedule for 2004.
  - b. Page 6, Presentation on Additional Thinnings, item #4

    Compartment 116, Stand 6: Large portion of Stand 6, Compartment 116 was left out of the ELS. The ELS accounts for 24 acres, but in reality another 69 acres need to be included in the sale. This portion of the stand is significantly overstocked and needs to be thinned.
  - c. Page 7, Response to question on about opening up some of the areas for wildlife.

    R: Yes. The areas will be opened for wildlife. These stands will add to actual
    treatment areas but will not increase treatment areas over the original 9,452 due
    to acres being set aside for Stream Management Zones, blufflines, etc.

- d. Page 8, Response to question on what is the possibility of finding more missed stands? R: More stands will be found. Missed stands are often located during the planning of a sale, when the FS gets to the micro level of working with the site prep of the various compartments. The FS probably will propose the use of the Categorical Exclusion (CE) process on other missed stands. The CE process seems to be the most efficient method to meet NEPA requirements on missed stands that will fall within the context of this EIS. The FS wants to keep each annual sale in front of the public. In the future, FS will get ahead of future sales and have more time to plan for missed stands.
- e. Page 11, Appendix A: FY 2004 Bankhead National Forest Timber Sale Plan h. FY 2004 Final Sale Handout (Appendix A): Changes Compartment (C) 32 is rescheduled for 2007 and C159 for 2008. Compartments 94/95 and C104/116 reschedule for 2004.

# II. RECREATIONAL MONITORING GROUP TRAILS PRESENTATION - JEFF

#### A. Presentation on Trail

Jeff Still provided a presentation for the Recreational Monitoring Group. The presentation resulted from a trail working group meeting held May 18, 2004, at the Greenbriar Café. The purpose of the meeting was to consider existing trail needs; to consider the needs of other users in the proposal as well as potential impacts to the forest; and sources of funding to support proposed changes Where appropriate.

The Liaison Panel and members of the public discussed several major points regarding existing motorized and non-motorized use trail use; and proposals for trail expansion for both motorized and non-motorized use. One overall recommendation included the formation of sub-groups to work on the Flint Creek & Owl Creek trail systems in conjunction with the USFS staff efforts. Two major priorities included stopping illegal riding activity on Flint Creek; and correcting water drainage problems on Brushy Loop and Key Mill Loop.

For specific suggestions resulting from the May 18th meeting and reported out at the July 8th meeting, please refer to Appendix A for the full report and matrixes for future discussions.

#### B. Interests, Concerns, and Opportunities Raised During the Trail Discussions

During the trails discussion lead by Jeff Still with contributions from other members of the monitoring group, various concerns, interests, as well as opportunities were brought forward up, resulting from the monitoring group meeting. During the July 8th meeting, attendees began to develop an understanding about the outdoor recreation needs on the Bankhead including: what are unexplored opportunities to meet outdoor recreational needs; what are the competing uses; what are some of the associated impacts and risks resulting from the competing uses; and what are the long- term expectations and trends.

In general, the discussions considered:

- 1) The types of recreation or user activity on the Bankhead:
  - a). Camping, Hunting, Hiking, Fishing, Bird Watching, Horse Riding, ATV, Off Road vehicles
- 2) Whether one activity interferes or effects activities of another use (see assessment of impact in Appendix A)
- 3) Briefly-what are the costs to the Forest Service for providing the activities, both short and long-term including construction and maintenance costs, as well as operational costs?
- 4) What are emerging trends regarding use on the Bankhead?

Opportunity/Use/Impact/Trends Matrix

DETERMINE	COMPETING USES	IMPACTS/RISKS	LONG-TERM
OPPORTUNITIES			EXPECTATIONS/TRENDS
Role for perimeter of camps and then series of trails from the perimeters.  Role of Partners in	Understanding legal constraints: USFS limitations of activities; state & federal regs that may limit activities: NEPA, ESA, NHPA, AIRFA, CAA, CWA Determine Capacity	Multiple use policies and role of supporting not only state and federal policy but also local operational rules.  Impacts to ecosystems	Expectations for long-term maintenance needs.  Trends in Southeast
expanding outdoor recreation use or opportunities in the Southeast?  - Interested organizations such as timber or hydropower industries.  - Interested state agencies.  - Others?	of Bankhead to legal requirements and user requests now and in the future.  Kind of use: Motorized (OHV - dirt bikes, ATVs) Non-Motorized (fishing, hiking, cultural, spiritual, riding, bird watching, picnicking, solace, open space).	- Erosion - Sedimentation - Impacts to air & water quality - Flora & fauna - Cultural & Spiritual Sites - Unable to maintain activity areas Unable to ensure compliance at activity areas  Impacts to other users - Spiritual use - Reduction in natural and open space - Motorized and non-motorized use - Illegal uses - Unable to maintain use activity areas Unable to maintain use activity areas Unable to ensure compliance at activity areas.  Resulting from -Concentration of use - Kinds of use (low to high impact use).	for outdoor recreational use. Trends in Southeast for outdoor recreational sites.

#### C. Flint Creek Trail Proposal #1

- a. trail is used one way for motorized users (OHVs)
- b. all other users access trail in opposite direction. .

Except in emergencies-, directions for a. and b. are preferred/recommended. Billboard near trail access should serve to communicate changes and other notices that impact safety and the experience of the user.

Jeff Still, Anthony Hood, Tammy Skarpton, Vicki Gertsman, Gene Carnes, Dennis Robertson, and David Kelly will work with USFS to determine the feasibility of this proposal; actions to take if feasibility is determined and by whom; and will keep Liaison Panel apprised of proposal, especially if intent of proposal changes. Jeff Still is the point of contact for this proposal.

# III: UPDATE: STATUS OF BANKHEAD FOREST HEALTH AND RESTORATION PROJECT - Glen Gaines and John Creed

#### A. Status of Alabama A& M Research Proposal

The word is that the proposal from Alabama A&M University for the Center for Forest Ecosystem Assessment (CEFA): Integration of Science and Research into the Bankhead Forest Health and Restoration Initiative to the National Science Foundation is looking promising.

The research niche will be the upland hardwood forests of the southern Cumberland Plateau. Funds to establish a Center for Ecosystem Assessment at AAMU would be useful to academia, the US Forest Service, the residents of the Bankhead, the Bankhead Liaison Panel and the Monitoring Groups. Although the award is not finalized, project duration is expected for five years. Goal of the project is to understand the "synergy" in the changes in the forest across the landscape within and between the ecosystem and the social system (see January 2004 meeting summary for the CEFA summary proposal and Liaison Panel letter of support).

Forest health and restoration will be a subject of significant future research and forest management so many people outside Alabama will be interested in learning what is occurring in Alabama. The research focus is to investigate how well the forest health and restoration plan works to reach its goals through 5 subprojects. The project will focus primarily on Area 1 and impacts of the thinning and prescribed burning actions. The idea is to look at the impact of the disturbances (changes) resulting from the Forest Health and Restoration Initiative. The 5 subprojects are:

• *Vegetative Community:* How the vegetation responds to the changes (trees and mid-story vegetation);

- *Macro-Invertebrate:* I mpacts on macro invertebrate (birds specifically) and invertebrate (insect) communities;
- Biogeochemical Nutrient Cycling: Changes to soil and water systems biochemical and nutrient cycling;
- Molecular Biology: Changes in genetic makeup of biological systems; and
- *Human Dimensions:* How people are impacted by these changes and influence the forest. Specifically interested in how people are responding to and interacting with the new plan.

## B. Status of Other Bankhead Projects

- 1. Water Line being installed near horse camp, to connect to Brushy Creek Loop. Lawrence County Commissioners are supporting this initiative.
- 2. Working with Faron Weeks, Billy Shaw, and Rob Hurt to decommission road to Indian Tomb Holler.
- 3. Invasive or Non-Native Species removal work has begun on the Bankhead. This is being accomplished by a combined effort of treatment (removal of species); informing of both public and private sources of the invasive species and consequences for allowing invasives to flourish. Currently working on the removal of the mimosa pigra, a viney shrub that shuts off wildlife openings and invades stream corridors.

#### C. Status of Stewardship Authority

- There is a new authority from Congress entitled the Stewardship Authority. Its purpose is two-fold: 1) to use agreements and contracts to implement stewardship projects; and 2) to achieve land management goals that meet community needs. Funds generated in part from a project can be used to accomplish other project needs as well as to enhance public participation and partnerships. The Stewardship Proposal has been sent to the Supervisor for review and will be forwarded to the Regional Forester for final approval. The Stewardship Components include:
  - Thinning (will generate funds)
  - Restoration of SPB Spots
  - Prescribe Burns
  - Silvicultural Treatments
  - Wildlife Habitat
     Enhancement

- Nonnative I nvasive Plant Control
- Hazard Tree Removal on Roads and Trails
- American Chestnut Demonstration Site
- Inventory and Monitoring

Specific Wildlife Habitats Improvements include:

- Wildlife Opening Improvements
- Mid-story and Understory Treatments
- Early Successional Habitat Enhancement
- Native Upland Plant Establishment
- North Alabama Birding Trail Interpretive Signs

#### Potential Stewardship Partners include:

- Bankhead Liaison Panel
- The Nature Conservancy
- National Wild Turkey Federation

- Quail Unlimited
- Buckmasters
- North Alabama Birding Trail
- Alabama A & M University

 USDA Southern Research Station

- American Chestnut Foundation
- Backcountry Trail Riders

# III. UPDATE: TIMBER AND THINNING MONITORING WORK GROUP - Randy Feltman, Mike Henshaw, and Vince Meleski.

- A. **Timber and Monitoring Work Group Presentation: Team Leadership -** Randy Feltman, Mike Henshaw, & Vince Meleski
  - 1. Attached as Appendix B is the Timber and Thinning Monitoring Group report from the May 10th site visits to Compartment 15 and Compartment 148.
    - a. Highlights of Visit to Compartment 15. Stand #11 well marked. Only loblolly pines are being cut in this stand. Some areas of the stand were almost completely hardwoods (areas will remain untouched. Stand 11 will not be in the frequent controlled burning rotation.

A loblolly stand near #11 was not included in the EIS, assumed to be pine beetle damaged. It Stand actually is there and request to include in summer's thinning to avoid coming back to area.

Compartment 15. Stand #10 originally included in the EIS to be thinned but has naturally regenerated on its own. No plans to do any further work on this stand.

b. Highlights of Visit to Compartment 148.

Revisited first thinned stand, #46 in Compartment 148, south of Double Springs. The team's overall view of the thinning was a job well done: trees removed with minimal damage to remaining trees; skidder trails did not do any serious damage; though a few areas that did not have adequate coverage. It was recommended that the contractor return and cover these areas. Riparian areas were honored with no tree removal and no equipment incursions. It was observed that the contractor saw head was dull and as a result shredded many tree stumps.

Visit to Stand #46 showed a two-acre wildlife opening prepared for planting by grading. Unfortunately, preparation led to soil movement from the field piling of debris on the perimeter of the field, and possibly crossing of a property line. Originally, site was covered in blackberry briars and other brush. When the harvesting and thinning committee visited the site on May 10th, the site had been scraped to clear the brush for wildlife planting. This operation moved soil to the margins of the field forming mounds. The height of some of these mounds are over 3 feet high. It is possible that such mounds were already present from previous clearing operations in earlier years, but this operation added to the problem considerably. Further, water that would have normally flowed freely off the field and into a wooded area was blocked by the mounded soil. Several large oaks located in the field were not removed, but several inches of topsoil were removed damaging the root zone of the trees. There is a good chance that these trees will decline, possibly die from root damage in future years.

Wildlife plantings are desirable, and it is important that they be installed in such a way as to minimize top soil removal by machinery and soil erosion. *The following is a list of questions related to wildlife openings and some responses from Allison Cochran and John Creed:* 

#### 1) What standard or criteria should have been used on this job?

At one time, wildlife openings were constructed in this way, with a berm around the edge of the opening. We try not to create a berm around the opening when we construct new openings now. The mound (berm)located onsite is from original construction.

#### 2) Why was the project done in an unsatisfactory manor?

This wildlife opening was grown up with shrubs and saplings and was beyond the capability of a bush hog or other mowing implement. Using a dozer to salvage the opening was the selected option. When you have done business in a certain way- you continue the same habitats until you are shown something different or a better way of doing business. Dozing disturbs soil. (Group discussed the idea that use of a backhoe might lessen disturbance).

- 3) Can parts of it be repaired and is it worth doing?
- 4) How many other openings have been done this way this year and previously? Can or should they be corrected?

No openings have been rehabilitated/salvaged with a dozer in the past 3 years at least. This year, 5 +/- wildlife openings were salvaged with a dozer.

5) Will future openings be prepared in a better manner?

Note: during the prescribed burn field trip, the group will discuss the questions in length and address the following questions that were not fully addressed at the July 8th meeting due to time constraints.

- 3) Can parts of it be repaired and is it worth doing?
- 4) How many other openings have been done this way this year and previously? Can or should they be corrected?
- 5) Will future openings be prepared in a better manner?

## IV. PRESCRIBED BURNS - Kerry Clark, Allison Cochran, Stewart Horn, John Creed

#### A. Purpose of Growing Season Prescribed Burn Presentation

Purpose of presentation is to inform the Liaison Panel about the use of growing season burns as a tool here on the Bankhead. Growing season burns are to be distinguish from site preps burns. There are 189 acres scheduled for FY05, and 509 acres for FY06 using the growing season burns as a restoration tool. In the Bankhead, there are a total of 120,488 acres (72%) that are not part of the prescribed burn program; about 16,522 acres (9%) is on the long rotation (3-10 year rotation); and 33,990 acres (19%) is on the short rotation burn (or 3 year rotation).

#### B. Benefits of Prescribed Burning to Wildlife Habitat

- Stimulates growth and sprouting of many native plant species
- Releases nutrients to enhance plant growth
- Physically opens up the forest
- Creates snags and openings allowing for regeneration
- Aid in restoring woodland ecosystems and associated species

#### C. Benefits to Forest Communities

- Promotes fire influenced communities such as oak woodlands
- Reduces Ladder fuels
- Reduces Competition for Long-leaf and improves habitat for native herbaceous plants.

## D. Monitoring Criteria and Research Partners

- Ten criteria checked after each burn
  - Litter, Understory vegetation, Scorch %, Spotting, Tree Damage, Smoke Violations,
     Adverse effects, Restoration Needs, Objectives, Complaints
- Permanent Annual Monitor points
  - Pre and Post Burn
  - Six plots per year

Litter, Duff, Dead Woody Fuels, Photo Points, Basal Area, Midstory, and Understory

- Monitoring Research Partners
  - Nature Conservancy
  - Alabama A&M University

# E. Questions for Liaison Panel and Scientists Concerning Impacts of Prescribed Burning on Short Rotation Basis (Stewart Horn)

Stewart Horn prepared eight eights questions regarding prescribed burns for consideration into the research planning process. The context for the eight questions is located in Appendix C.

- 1. How can it be demonstrated that the amount of stream sedimentation is not being significantly increased because of the prescribed burning process?
- 2. Can the Forest Service pick areas that are planned to be burned a few years in the future and conduct a good baseline measurement program over several years prior to initiating burning? Can the Forest Service follow through with a thorough data collection through-out the burning process and afterward? This will provide the real data that will demonstrate the long-term effects of prescribed burning. How will the Forest Service design and fund a good monitoring program?
- 3. How can it be demonstrated that the prescribed burning that will be undertaken has not removed or significantly damaged the small layer of replenished organic matter that is so critical to the health and hydrology of the ecosystem?
- 4. What techniques and procedures does the Forest Service use to assure that a severe burn will not occur. In past burns on the Bankhead, how often has prescribed burning resulted in hot fires occurring? How is this determined and how is it recorded as part of the record?

- 5. Given the (March 8, 2003 Liaison Panel discussions with visiting scientists), why has the Forest Service chosen to burn these areas every 3 years versus choosing a more natural longer period between burns?
- 6. Can the Forest Service provide copies of the Gene McGee research to the Liaison Panel?

  Also on page 10 is of the March 8, 2003 Meeting Summary, it states "Read research reports of John Stanturf, Jim Guldin, etc. Can these be provided?
- 7. Is there other fire research data that would be pertinent to the Bankhead area. Has there been any fire research done in other places on soils and/or forests similar to the Bankhead, and can these be made available to the Liaison Panel?
- 8. Can the Forest Service provide arguments as to why the by S. J. Ursic, research is not pertinent to the Bankhead. If it is pertinent to Bankhead, then it provides a very strong argument against prescribed burning on a short rotation basis because of the damage to both soil and hydrology.

#### F. Discussion, Questions, and Comments on the Prescribed Burns

- C. The role of prescribed burns must be done correctly. Suggestion- set up a Monitoring Subcommittee for Prescribed Burns. Include Stewart Horn, Bill Snoddy, and others who are interested in taking a field trip with the USFS to a recent site (site may be on cut over land or pine tree plantation) to explore some of the questions posed by Stewart Horn.
- C. I mpacts regarding growing season burns are based on assumptions about hydrologic effects. Moisture content can be tested using field sticks (indicators for fire intensity).
- C. Has been an increase in prescribed burns since 2001 on the Bankhead. Various monitoring points are used as described in section D.
- C. Eastern forests are not subject to the same kind of crown fires as western forests. Reasoning:
- C. Dormant fire season alone will not provide a woodland conditions need growing season burns. Is a cheaper way to acquire Oakland conditions (less expensive than herbicides).

## VI. Future Topics of Discussion - Mary Lou

- a. Topics for Future Discussions and Meeting Agendas: (not listed in order of importance- see criteria for determining how to schedule topics of discussion)
  - Trail needs on the Bankhead (Horseback Riding, ATV, and Hiking).
     Status: Discussions have begun. One proposal is before the Recreational Monitoring Work Group to present to the USFS. (refer to the July 8 meeting summary).
  - 2) Management of stands not included in the current EIS.

**Status:** Discussed during the May 4, 2004 meeting (refer to the May 4 meeting summary) on how the USFS intends to use Categorical Exclusions and how the Bankhead Panel and public can expect to be informed and involved in this activity.

3) Updates on scientific research projects and studies.

**Status:** Discussion on anticipated research projects occurred during the January 2004 meeting and during the July 8th meeting, in particular referencing the Alabama A & M University proposal for the Integration of Science and Research into the Bankhead Forest Health and Restoration Initiative: the Center for Forest Ecosystem Assessment (CEFA):

4) Unmanaged Recreational Activities (illegal use)

**Status:** Recreational Monitoring Work Group is in the process of offering ideas or proposals on how to deal with unmanaged or illegal recreational activities to the USFS. (refer to the July 8 meeting summary).

- 5) Looting of Cultural Resources
- 6) Safeguarding property rights
- 7) Invasive species:

Status: USFS is actually moving forward in responding to invasive species and will be reporting out to the Bankhead Liaison Panel and Community during the Forest Health and Restoration I nitiative updates. Removal is being accomplished by a combined effort of treatment (removal of species); informing of both public and private sources of the invasive species and consequences for allowing invasives to flourish. Currently working on the removal of the mimosa pigra, a viney shrub that shuts off wildlife openings and invades stream corridors.

- 8) Next steps toward Desired Future Conditions: Hardwood Component and other loblolly pine stands.
- 9) Wildlife Habitat Plantings

**Status:** Some discussion and have questions has resulted from the Timber and Thinning Monitoring Group (see July 8, Appendix B). The Timber and Thinning Monitoring Group is in the process of offering ideas or proposals on how to deal with unmanaged or illegal recreational activities to the USFS. (refer to the July 8 meeting summary).

10) Road maintenance, access, and decommissioning

Status: USFS is working with Gene Gold, Margret Dunn, Faron Weeks, Billy Shaw, and Rob Hurt to decommission part of the road to Indian Tomb Hollow.

- 11) Sustainable economic development
- 12) Anticipating Emerging I ssues
- 13) User Conflicts
- 14) Oil and gas extraction; coal mining
- 15) Expanding Community Outreach

### b. Determination of Topic Schedule

- 1) Criteria to determine scheduling of topics:
  - a) Timing: when does it make sense to discuss topic?
  - b) Level of Bankhead Liaison Panel and public interest
  - c) Environmental need

# VII: Next Meeting: August 12, 2004, Double Springs Bank Building. Proposed Meeting Agenda Listed on Page 2

#### VIII: ITEMS OF INTEREST:

- 1. Final Report submitted to the US Forest Service and the Bankhead Community by the Natural Resources Leadership Institute and RESOLVE is online at: <a href="https://www.ces.ncsu.edu/nrli/bankhead.html">www.ces.ncsu.edu/nrli/bankhead.html</a>
- 2. The National Forest Service provides an online glossary of ecosystem management terms to assist in learning about agency and scientific words. A glossary can assist in facilitating communication between citizens, management, and scientists. The glossary is located at: www.fs.fed.us/land/emterms.html
- 3. A new database, titled Treesearch, allows access to Forest Service research publications online. With Treesearch, customers can locate and download Agency-authored or sponsored publications, including those in journals, books, and conference proceedings. The research results behind these publications have been peer reviewed to ensure the highest quality science. The publications in Treesearch can be accessed from www.treesearch.fs.fed.us.
- Treesearch is a unique collaborative effort bringing together a team of scientists, science communicators, and computer specialists from the field, with coordination and assistance from the Washington Office. Treesearch started as a recognized need by the field, rather than as a Washington Office initiative. To cover technical assistance and other expenses, the team members committed resources from their own budgets. The team is self-directed, with decisions based on customer preferences and the ability to afford desired features. If you would like additional information or have suggestions to offer about Treesearch, please feel free to contact the Treesearch team at: www.treesearch.fs.fed.us/team or Hao Tran at 202-205-1293.

### Appendix A: Recreational Monitoring Group Report

Met: May 18, 2004 Greenbriar Café

**Present:** Jeff Still, Tammy Skarpton, Vickie Gertsman, David Kelly, Dennis Robertson, Connie & Alan Edwards, Mary Lee Ratliff & Mike Cook (USFS)

#### **EXISTING TRAILS SUGGESTIONS**

- Tammy Trails worn out at drainages, causing ditches. Need bridges, culverts, rock to improve tread.
- Dave Increase the frequency of signs at Flint Creek & use mile markers on all trails.
- Alan Put dirt bikes on separate trails move them off Flint Creek to reduce speed & noise problems.
- Connie Need more patrols at Flint Creek especially noise compliance because it bothers people & wildlife. Alcohol is also problem.
- Jeff Reduce pressure on Key Mill Loop by connecting horse camp with picnic area on Owl Creek something around Johnny's Ranch road.
- Dennis rock the mud holes on Flint Creek trails and at the bridge.
- Tammy Need new rules with big letters on the Flint Creek information board. Put the cost of fines for illegal riding on boards, too.
- Vickie Key Mill rehab needed on the section between picnic (Owl Creek) and the west side of road at Ms Garrison's.
- Jeff Wet spots at drainages along trails need attention to keep them from developing into big mud holes.
- Dave Use NATRA signing instead of forest signing at Flint Creek.
- Mary Lee Existing trails with some trees across are ok because they make more challenging rides.
- Dennis When trails are being worked or closed for some reason, the information should be posted at all trailheads.
- Jeff Wagon routes in wilderness are grown up and need clearing.
- Dennis Flint Creek Bridge is slick. Need sand or rough surface.

#### TRAIL EXPANSION SUGGESTIONS

- Jeff Leave Owl Creek Campground as it is and develop new trailhead/campground near Leola Road.
- Dave Use timber harvest areas for motorized use trails before timber removal.
- Alan Develop trail for motorcycle and remove them from Flint Creek because they scare families due to the high speed.
- Dennis Locate motorcycle trail away from other people due to noise they make.
- Jeff Develop more horse trails to lighten pressure on current Owl Creek trails. Develop picnic areas such as the informal one at Owl Creek.
- Mary Lee Paving Leola Road will impact horse riding & wagon use that occurs at present. Will also impact High Town Path.
- Dave create mud puddle sacrifice area near the Flint Creek trailhead to minimize mudding on trail.
- Several The use of road riding is not favored by all riders, so connecting trails to make road loops may be a waste of resources
- Jeff- Build sidewalk trails along roads rather than use roads for riding.
- Dennis Put water at Flint Creek trailhead so people can wash their bikes & atv's before heading home.

#### **VOLUNTEERS**

Recommended people form groups to work on the Flint Creek & Owl Creek trail systems. Suggested focus at Flint Creek be on stopping the illegal riding. Suggested focus on Owl Creek be correcting water drainage problems on Brushy Loop and Key Mill Loop.

#### May 17, 2004: Assessment of Use and Impact

Greetings Fellow Committee Members: (prepared by Anthony Hood).

Since I am unable to attend the meeting on Tuesday, May 18, I thought I would write a few notes of my thoughts and questions. I probably have more questions than answers. In addition, before we can make recommendations, I feel we need to keep the following thoughts and questions in mind before we come to any conclusion. I hope we can meet again before the July 8 meeting in Moulton.

#### Recreation:

- Types Since we are working with the Bankhead Forest, these are the types of recreation that may be of our concern. There may be others. Camping, Hunting, Hiking, Fishing, Bird Watching, Horse Riding, ATV, Off Road vehicles
- Does activity of one type interfere or adversely effect activities of another type? See Chart 1. (These are my own assessment and opinions)
- What are the costs to the Forest Service for providing the activities? The Forest Service will have to provide this information and it will have to include construction and maintenance for the activity.
- Is the cost and impact acceptable when compared to other activities?
- Which activities provide the most benefit to the public both perceived and actual? (Surveys)
- Which activities have the least impact on the environment?

Camping	- M	Bird Watching -	L
Hunting	- L	Horse Riding -	Μ
Hiking	- L	ATV -	Н
Fishing	- L	Off Road -	Н

- How does each activity effect other Work Group's direction and the desired future condition of the forest?
- Article in The Decatur Daily, May 9, 2004 regarding illegal ATV use

Chart 1 - L - LOW, M - MEDIUM, H - HIGH

\*1 - COULD CHANGE TO HIGHER IMPACT IF EROSION AND POLLUTION OF STREAMS OCCURS \*2 - SEASONAL

# What impact does the top row

have on the activity on the					BIRD	HORSE		OFF
side	CAMPI NG	<b>HUNTI NG</b>	HIKING	FISHING	WATCHING	RI DI NG	ATV	ROAD
CAMPI NG		M	L	L	L	L	M	M
<b>HUNTI NG</b>	H *2		L	L	L	L	Н	Н
HIKING	L	L		L	L	L	L	L
FISHING	L	L	L		L	L*1	L*1	L*1
BIRD								
WATCHING	L	L	L	L		L	Н	Н
HORSE RIDING	L	L	L	L	L		M	M
ATV	L	M	L	L	L	M		M
OFF ROAD	L	M	L	L	L	M	M	

# Mary Lou Addor's Proposed Exploratory and Discussion Maps PROPOSED DISCUSSION MAP FOR FLINT CREEK TRAIL

WHAT	WHY	HOW	FUNDING SOURCE & COSTS	IMPACTS TO OTHER INTERESTS & DESIRED FUTURE CONDITIONS
Bridge	Safety I ssue - Reduce Slickness	Roughen surface	?	?
I llegal Riding Activities	Reduce noise pollution to people and wildlife; prohibit alcohol use	Increase Compliance through increase patrols	Set up volunteer groups to police; other means?	?
Mud Holes	Safety & Sedimentation Issue	Use rock fill on trails and at bridge.	?	?
Muddy Trails	Improve User Use	Create dummy mud holes near trailhead to let rain or drainage.	?	?
Change Dirt Bike Usage	Safety I ssue- reduce motorized speed & noise	Disallow Dirt Bike Usage on Flint Creek Trail	?	Still need to determine potential for separate Dirt Bikes Trails and resulting impacts
Flint Creek Signage	Information & Safety Issues	Use NATRA Signage	?	?
Flint Creek Information Board	Information & Safety Issues	New or Updated Rules in Big or Bold Letters; Costs of Illegal Activities	?	?
Increase Flint Creek Signage	Information & Safety Issues	Signage frequency; use of mile markers	?	?
Trailhead Water	User Request	Water at Trailhead to wash bikes and ATVs	?	?

	before	
	heading	
	home	

WHAT	WHY	HOW	FUNDI NG	IMPACTS TO
			SOURCE &	OTHER
			COSTS	INTERESTS &
				DESTRED
				FUTURE
				CONDITIONS
Wagon Routes	Vegetative	Clear Vegetation		
	Covering; Cultural		?	?
	or Interpretative		f	,
	Sites			
Keep Some	Make Trails More	Leave Some		
Existing	Challenging	existing trees on	?	?
Trees on		trails	f	f
Trails				
Key Mill Loop	Reduce Use	Connect Horse		Private
	pressure	Camp with Owl		interests?
		Creek Picnic Area	?	Reroute
		via Johnny's		impacts to
		Ranch Road		resources?
Key Mill Loop	?	Rehab Needed		
		Between Owl		
		Creek Picnic area	?	Ms Garrison's
		and the west side	f	Interests?
		of road at Ms		
		Garrison's		
Mile Markers	Information &	Place mile markers	?	?
on All Trails	Safety Issues	on all trails	f	f
All Trails	Safety &	Bridges, culverts,		
	Sedimentation	rock to improve		
	Issues due to	traction.		
	worn out trails at			
	drainages which			
	create permanent			
	ditches or big mud			
	holes; I mprove			
	User Activity			
Trail	Informational &	Posted at all Trails		
Maintenance	Safety Issues	heads prior to	?	?
or Closures		Maintenance or	į	,
		Closure.		

## PROPOSED DISCUSSION MAP FOR TRAIL EXPANSION

WHAT	WHY	HOW	FUNDING SOURCE &	IMPACTS TO OTHER
			COSTS	INTERESTS & DESIRED
				FUTURE
				CONDITIONS
Develop New	Accommodate	Leave Owl		
Trailhead&	Increase	Creek		
Campground	Recreational Use	Campground as	?	?
near Leola		is.		
Road				
Develop More	Reduce Use on	Map out		
Horse Trails	Owl Creek trails	proposed trail		
and informal	and picnic area.	and picnic areas		
picnic areas.				
Increase	Accommodate	Use timber		
Motorized Use	Use	harvest areas		
Areas		for motorized	?	?
		use trails before timber		
		removal.		
Develop New	Reduce Noise	Create New		Private
Dirt Bike Trail	Pollution; Safety	Trail for Dirt		interests?
	I ssues on Flint	Bike Use	?	Reroute
	Creek			impacts to
				resources?
Paving of roads	Accommodate	Pave Leola		Non-motorized
& trails or	Use of User	Road; connect		interests -
creation of	Group	trails to make		Horseback
road loops?		road loops; set	?	riding
		aside sidewalk		interests;
		trails along		hiking
		roads for		Interests;
		riding.		Others?

### Appendix B: Timber and Thinning Monitoring Group Report

Summary of field trip of Timber and Thinning Team May 10, 2004: Compartment 15, Stand #11 (prepared for July 8 Meeting/V. Meleski)

Present: Charlie Mackaravitz, John Creed, Glen Gaines, Mike Henshaw, Ted Kuzma, Stewart Horn, Dr. Wes Stone (Alabama A&M University), Walters Arrey (A&M), Richard Linholm, Bobby Ayers, Vince Meleski.

We met at Brushy Lake and then drove to the thinning site at Compartment 15 Stand #11. The site had again been well marked by the Forest Service. Only loblolly pines are being cut in this stand. Some areas in the stand were almost completely hardwoods and these areas will remain untouched. Due to the large quantity of hardwoods already present in this stand, this site will be close to the desired future condition of an oak, hickory, pine forest when thinned. Stand 11 will not be in the frequent controlled burning rotation.

Stand #10 was originally included in the ELS to be thinned. This stand, however, was an early pine beetle target and has naturally regenerated on its own. There are no plans to do any further work on this stand.

Also determined near Stand #11 was a loblolly stand not included in the ELS since it was assumed to be pine beetle damaged. It actually is there and should be included in this summer's thinning so as not to require coming back at another time. Areas such as this can probably be covered by inclusion in a categorical exclusion to cover areas that turn out to be different than as included in the ELS.

We then went to Compartment 148 Stand #46 south of Double Springs to see the first thinned stand. The work had been done by Carl Alexander. The team's overall view of the thinning was a job well done. The trees had been removed with minimal damage to remaining trees. Skidder trails did not do any serious damage and in general were covered with branches to minimize erosion. There were a few areas that did not have adequate coverage. It was recommended that the contractor return and cover these areas. Riparian areas were honored with no tree removal and no equipment incursions. It was observed that the contractor saw head was dull and as a result shredded many tree stumps.

There was a wildlife opening adjacent to the thinned stand. A small piece of this was used as the loading area for removing the logs. When we visited, the wildlife area had been cleared for renewal and it was not possible to tell where the loading area had actually been.

#### Supplemental report from the Timber and Thinning Team: Compartment 148, stand #46

At the loblolly pine site near O'Bryan's Restaurant (compartment 148, stand #46), a two-acre wildlife opening was prepared for planting by grading. Unfortunately, this led to soil movement from the field piling of debris on the perimeter of the field, and possibly crossing of a property line.

Originally, the site was covered in blackberry briars and other brush. When the harvesting and thinning committee visited the site on May 10th, the site had been scraped to clear the brush for wildlife planting. This operation moved soil to the margins of the field forming mounds. The height of some of these mounds are over 3 feet high. These mounds are made up of topsoil moved from the middle of the opening. To varying degrees, these mounds were found around parts of the perimeter of the opening. These mounds will be visible in the forest for several decades following the planting operation. It is possible that such mounds were already present from previous clearing operations in earlier years, but this operation added to the problem considerably.

In one location, water that would have normally flowed freely off the field and into a wooded area was blocked by the mounded soil. The resulting pool of water caught a good deal of erosion from the field, but it seemed as if it was just an unplanned result of the mounding of soil around the field.

On one side of the field, these mounds were pushed over what appears to be a property line, and in one location, debris from an illegal dump was pushed across this line. This action does not have a major environmental impact, but shows a less than desirable result for the project.

Several large oaks are located in the field. These trees were not removed, but several inches of topsoil were removed damaging the root zone of the trees during the scraping operation. There is a good chance that these trees will decline and possibly die from root damage in future years.

The field was revisited briefly on June 29<sup>th</sup>. The field has been planted to grass and peas or soybeans. Some soil movement due to erosion has occurred, but some of this may have been unavoidable during heavy spring rains. Had more plant residue been left during the brush clearing operation, soil erosion would have been reduced.

Wildlife plantings are desirable, and it's important that they be installed in such a way as to minimize top soil removal by machinery and soil erosion.

The following is a list of questions related to wildlife openings:

- What standard or criteria should have been used on this job?
- Why was the project done in an unsatisfactory manor?
- Can parts of it be repaired and is it worth doing?
- How many other openings have been done this way this year and previously? Can or should they be corrected?
- Will future openings be prepared in a better manner?

# Appendix C: Questions to Liaison Panel and Scientists Concerning Impacts of Prescribed Burning on Short Rotation Basis

Liaison Panel Questions Concerning the Impacts of Prescribed Burning on a Short Rotation Basis in Bankhead National Forest. Prepared by Stewart Horn for July 8, 2004 Liaison Panel meeting in Moulton, AL.

- 1. Prescribed burning destroys a significant part of the soil organic matter, and it changes the composition and volume of soil litter and fermentation layers leaving the soil exposed and subject to significant erosion. This will reduce the water retention ability of the soil, which will increase storm flows, overland flows and peak discharges, and these will increase soil erosion beyond that caused by the burning itself. Sedimentation of streams has been identified by state water authorities as one of the top water pollution problems in the state. How can it be demonstrated that the amount of stream sedimentation is not being significantly increased as a result of the prescribed burning process?
- 2. The Forest Service needs to conduct scientific monitoring of the Bankhead prescribed burning program to validate that the experiments they are conducting are having a positive effect versus a negative one. A critical part of this monitoring will be the thorough gathering of baseline data on soil volume, composition, and hydrology (water retention ability, storm run-off, , etc.), to determine the pre-burn conditions on which measurements can be compared. Good baseline data requires several years of monitoring conditions prior to the initiation of the prescribed burning. The Forest Service is starting a prescribed burn program. Can the Forest Service pick areas that are planned to be burned a few years in the future and conduct a good baseline measurement program over several years prior to initiating burning? Can the Forest Service follow through with a thorough data collection through-out the burning process and afterward? This will provide the real data that will demonstrate the long-term effects of prescribed burning. How will the Forest Service design and fund a good monitoring program?
- 3. The Bankhead soil condition is considered to be heavily eroded and very fragile. The following are quotes from a study by Rickman and Luvall entitled Soils and Streams: Hydrology in the William B Bankhead National Forest done in 1996. "We find there is clear and abundant evidence of extensive and intensive erosion of the soil over the area studied (Bankhead Forest)." "Over much of the upland forest, probably even a majority, virtually all the top soil and much of the "B" horizon soil has been completely removed." "In areas that have regained forest cover for 60 or more years, the soil has redeveloped an organic layer. This layer is approximately ½ inch deep and quite distinct. This redeveloped soil is apparently very fragile, it is completely missing from all of the areas that have been recently clear cut." How can it be demonstrated that the prescribed burning that will be undertaken has not removed or significantly damaged the small layer of replenished organic matter that is so critical to the health and hydrology of the ecosystem?
- 4. Prescribed burns also come with the risk of severe burns. Severe burns can be devastating to the soil. As described on page 73 of the National Forest Service Draft EIS for the Revised Land and Resource Plan, National Forests in Alabama, "burning has the potential to consume organic matter, change the surface physical properties of the soil, and kill soil biota through soil heating. Loss of organic matter results in the loss of nutrients and increases the susceptibility of a soil to erosion. Soil heating can affect soil biota and surface soil structure indirectly affecting the soil capacity to absorb water. The potential for negative effects increases with the severity of the burn." In other words, severe burn can be very bad for soils. What techniques and procedures does the Forest Service use to assure that a severe burn will not occur. In past burns on the Bankhead, how often has prescribed

burning resulted in hot fires occurring? How is this determined and how is it recorded as part of the record?

5. Forest Service historical records indicate that fires do not occur broadly across the landscape on a short rotation periodic basis. There has been recent media publicity about the forest service's own research and historical data compiled by long time forest service employee and archaeologist, Quinton Bass. The data indicates that large-scale burns may have never occurred across a majority of the Southern Appalachian landscape due to the high annual rainfall conditions and soil moisture content existing over most of the area. His research indicates that the forest service ecological data shows that Southern Appalachian forests do not require large-scale logging or prescribed burns to mimic natural conditions, and that periodic fires on a short rotation basis have not occurred naturally here over the majority of the landscape. This type of burning has occurred naturally in this area only on the dry, thin-soiled steep slopes and mountain ridge crests. This would indicate that if periodic burns were imposed across a significant portion of the Bankhead Upland landscape by the forest service, it is highly probable that the ecology would be permanently changed. The scientists that the Forest Service (and Liaison Panel) arranged to answer questions for the Liaison Panel in the March 8, 2003 meeting provided the following comments (page 10 of the March 8 Liaison Panel Meeting Summary) in response to a question about historical frequencies of fire regimes:

A. "No specific dates. Uplands: 2-10 years is ballpark/average, but may have taken 15 in some areas. It is a range. As it depends upon the specific area. If the whole area burned < 1/10 years, this would be pine – and it's not. Do not think short-leaf savannahs were here." B. "Think frequency of 1/3 years is too often and no more than 1/5 years, and 10 might be enough.

Another comment offered by the experts as a "Critical Keep-in-Mind" (pg. 5 of March 8 Summary) is "For instance, the shortleaf (blue stem) and longleaf (blue stem) require fire to sustain their habitat usually once every 2-10 years.

Given the above why has the Forest Service chosen to burn these areas every 3 years versus choosing a more natural longer period between burns?

- 6. The Liaison Panel March 8, 2003 Meeting Summary states on page 9 that "Fire research has been done in the Bankhead in the 1970s Gene McGee." Can the Forest Service provide copies of this research to the Liaison Panel? Also on page 10 is stated "Read research reports of John Stanturf, Jim Guldin, etc. Can these be provided?
- 7. Is there other fire research data that would be pertinent to the Bankhead area. Has there been any fire research done in other places on soils and/or forests similar to the Bankhead, and can these be made available to the Liaison Panel?
- 8. One research paper found by a Liaison Panel member describes a research project conducted on uplands in Northern Mississippi. This experiment entitled "Hydrologic Effects of Prescribed Burning and Deadening Upland Hardwoods in Northern Mississippi" by S. J. Ursic, Forest Service Research Paper SO-54, Southern Forest Experiment Station, Dept. of Agriculture. This research started with a 6 year calibration period prior to any burning with extensive soil and water testing, followed by prescribed burning and poisoning, followed by three years of follow-up soil and water testing. These tests show clear evidence that burning is bad for the soil and the water. The following are from the report:
  - a. "The L (litter) layer on the two treated (*burned and poisoned*) watersheds prior to the burn weighed an average of 1,500 pounds per acre; the F (fermentation) layer weighed 6,870 pounds per acre. The fire consumed the L layer but reduced the F layer by less than 1

percent. Leaves from the dying hardwoods restored the L layer during the first year after burning, but 60 percent of the F layer disintegrated during this time. Thus, the loss of forest floor material during the first year after burning was greater than during the burn itself. The total weight of the forest floor 1 year after the burn averaged 55 percent of the preburn weight; after 3 years, it averaged 51 percent of the preburn weight." This shows that after 3 years, the soil weight was only 51% of the preburn weight. This implies that if you burn the area 3 years apart 3 times (in 6 years), there would only be 1/8 of the mass of soil that was there preburn. The soil would be devastated with most of it gone. This is direct evidence that burning destroys the soil. It appears that erosion in the first year after the burn (loss of the organic matter) removes more of the soil than the burning itself.

- b. "During the first 3 years after treatment, about one-fourth of the stormflows were increased by significant amounts. Annual increases ranged form 16 to over 50 percent. Estimated overland and flows and peak discharges also increased." This implies that there was a significant loss of the water that was absorbed by the soil implying less available water for the uplands and for the slow release into the canyons.
- c. "The fire removed 18 percent of the organic matter making up the forest floor." Direct evidence that fire destroys organic matter in the soil.
- d. "During the first post-treatment year, sediment production from one watershed exceeded the expected value by 48percent. On the other watershed it was more than double the predicted value. Thus, burning contributes significantly to stream sedimentation.
- e. This is the short summary description of the report by the Southern Research Station Publications "A winter burn and deadening of hardwoods with herbicide significantly increased stormflows, overland flows, peak discharges, and sediment production from two small watersheds in nothern Mississippi. Most of the hydrologic effects were still evident 3 years after the fire." In other words, there were significant effects to the soil hydrology.

Can the Forest Service provide arguments as to why this research is not pertinent to the Bankhead. If it is pertinent to Bankhead, then it provides a very strong argument against prescribed burning on a short rotation basis because of the damage to both soil and hydrology.