Plumas Watershed Forum

Plumas County Flood Control & Water Conservation District

California Department of Water Resources

State Water Project Contractors

Annual Report

Fiscal Year 2007-2008

CLEAN WATER

UPPER FEATHER RIVER WATERSHED

STARTS HERE

Plumas Watershed Forum

Annual Report
2007-2008 Fiscal Year

October 28, 2008

Plumas Watershed Forum

Part I - Overview

The watershed for California's State Water Project encompasses the mountains and waterways around the Feather River, most of which lie within Plumas County. The State Water Project is the nation's largest state-built water and power development and conveyance system. Planned, designed, constructed and now operated and maintained by the California Department of Water Resources, this unique facility provides water supplies for 23 million Californians and 755,000 acres of irrigated farmland.

The Plumas Watershed Forum was formed on May 5, 2003, as part of a larger settlement agreement resolving a lawsuit related to the State Water Project. The Department of Water Resources, the Plumas County Flood Control and Water Conservation District, and the 28 other State Water Project Contractors created the Watershed Forum to implement watershed management and restoration activities for the mutual benefit of Plumas County and the State Water Project.

The Watershed Forum was funded by the Department of Water Resources with a commitment of $1 million dollars per year for the first four years or the program (2003 through 2006). Depending on whether a new environmental impact report (the "Monterey Plus" EIR) is completed for certain changes to the water supply contracts between the Department of Water Resources and the State Water Project Contractors, the funding will be extended for an additional four years. A draft EIR was released in October 2007 and the final EIR is expected to be issued in the near future. Future funding for the Forum is not triggered until the new EIR withstands any legal challenges.

The following sections of this report provide a review of activities and projects undertaken by the Watershed Forum, reports of past expenditures and a budget for the current fiscal year, and the agendas and minutes from meetings of the Forum.

For more information, please visit the following websites or contact Plumas County or DWR staff at the addresses below. The Plumas County web page provides information about the Watershed Forum and specific projects that have been implemented. The Department of Water Resources web page includes the settlement agreement which created the Watershed Forum, as well as the Feather River Watershed Management Strategy, the document that was created to guide the Forum's watershed investments.

Plumas County – Plumas Watershed Forum
http://www.featherriverwater.com/plumaswatershedforum.html

California Department of Water Resources – Monterey Agreement Overview
http://www.montereyamendments.water.ca.gov/

Plumas County Flood Control and Water Conservation District
520 Main Street, Room 413
Quincy, CA 95971
(530) 283-6243

Northern District
California Department of Water Resources
2440 Main Street
Red Bluff, CA 96080
(530) 529-7342

Plumas Watershed Forum Timeline

6/20/03 – First Settlement payment ($1,000,000)
7/28/03 – First Watershed Forum Meeting – *Adopted Bylaws*
8/13/03 – Watershed Forum Meeting
11/7/03 – First TAC Meeting
1/9/04 – TAC Meeting
1/27/04 – Watershed Forum Meeting
3/15/04 – TAC Meeting
5/14/04 – Watershed Forum Meeting – *Adopted Feather River Management Strategy*
6/21/04 – Second Settlement Payment ($1,000,000)
6/18/04 – Deadline for Submittal of Initial Project Proposal
8/6/04 – Deadline for Submittal of Final Project Proposal
8/20/04 – TAC Meeting
8/31/04 – Watershed Forum Meeting
9/10/04 – TAC Meeting
10/26/04 –Watershed Forum Meeting – *Adopted Process for Awarding Grant Money*
12/15/04 –Request for Concept Proposals
1/21/05 – Deadline for Submittal of Initial Project Proposals
2/22/05 – TAC Meeting
4/1/05 – Deadline for Submittal of Final Project Proposals
4/28/05 – AC Meeting
5/23/05 – Watershed Forum Meeting
6/17/05 – Third Settlement Payment ($1,000,000)
10/25/05 – Watershed Forum Meeting – *Adopted Project Administration Policy, Cost Share Policy, and Unspent Fund Policy; Approved First Annual Report*
12/14/05 – Request for Concept Proposals
1/20/06 – Deadline for submittal of Initial Project Proposals
2/17/06 – TAC Meeting
2/24/06 – CORE TAC Meeting
3/31/06 – Deadline for Submittal of Final Project Proposals
4/28/06 – CORE TAC Meeting
5/15/06 – Pre-recommendation Project Tours
5/23/06 – Forum Meeting on Full Proposals including approval or other disposition
6/15/06 – Fourth Settlement Payment ($1,000,000)
10/23/06 – Project Tours to View Results of Restoration Construction
10/24/06 – Watershed Forum Meeting
5/22/07 – Watershed Forum Meeting
7/27/07 – IRWM Coordination Meeting with Natural Heritage Institute
9/21/07 – CORE TAC Meeting
10/15/07 – RFP issued to conduct Program Review of the Plumas Watershed Forum
10/19/07 – Draft Monterey Plus EIR issued for public comment
10/23/07 – Watershed Forum Meeting
4/8/08 – Watershed Forum Meeting via teleconference
5/27/08 – Watershed Tour
5/28/08 – Watershed Forum Meeting - *Presentation of Program Review*
10/28/08 – Watershed Forum Meeting

Part II – Summary of Activities

The final payment in the initial round of funding was made to the Watershed Forum in June of 2006. Funding is suspended until the Monterey Plus EIR is successfully completed, and the Watershed Forum has not approved any new projects since May of 2006.

Project sponsors continue to implement the previously approved projects, with final major work scheduled for the 2008 construction season. Descriptions of individual projects are included in Part VI of this report, and a table showing all approved projects and expenditures to date is included on the following page.

New funding for the Watershed Forum will resume upon completion of the Monterey Plus EIR or upon a decision to resume funding before completion of the new EIR. To assist the Department of Water Resources and the State Water Project Contractors in deciding whether to voluntarily resume funding, in May of 2007 the Watershed Forum authorized a review of the program by an independent third party. Jones & Stokes was selected through a competitive process to conduct the review, and the results were presented at the Forum meeting in May 2008. The recommendations from Jones & Stokes are presented in Part III of this report.

The Department of Water Resources and the State Water Project Contractors declined to make a decision on continuing funding for the Forum based on the Jones & Stokes report. At the May 2008 meeting, there was consensus that a subcommittee should be formed to review and refine the water supply and economic analyses performed by Jones & Stokes and to address new questions regarding water delivery that were not covered in the review's scope of work.

Project Inventory and Expenditures
As of October 1, 2008

Project	Sponsor	Funding	Approved	Expenditures
A Fund				
Sulfur Creek Data Collection	UCCE	$ 3,000.00		$ 3,000.00
Charles Creek	FRCRM	$ 35,000.00	8/31/2004	$ 35,000.00
SVGMD Monitoring Wells	SVGMD	$ 120,984.24	8/31/2004	$ 120,984.24
Rogers Creek Road Relocation	USFS	$ 63,500.00	10/26/2004	$ 59,466.01
Charles Creek and Hosselkus Creek	FRCRM	$ 80,000.00	10/26/2004	$ 79,603.21
Low Water Crossing	USFS	$ 35,000.00	10/26/2004	$ 35,000.00
Feather River College	FRCRM	$ 92,453.00	5/23/2005	$ 92,420.25
Sierra Valley Groundwater Mgmt District	SVGMD	$ 30,000.00	5/23/2005	$ 10,723.90
Red Clover Monitoring	PluGeo	$ 28,000.00	5/23/2005	$ 24,565.62
Plumas National Forest - Aspen Restoration	PNF	$ 84,500.00	5/23/2005	$ 57,088.67
Four Creeks - Monitoring	FRCRM	$ 25,308.00	5/23/2005	$ 25,308.00
Jordan Flat	FRCRM	$ 64,000.00	5/23/2005	$ 63,994.98
Silver Creek - Burney's	FRCRM	$ 51,000.00	5/23/2006	$ 28,049.99
Spanish Creek - Kellet's	FRCM	$ 147,000.00	5/23/2006	$ 50,404.75
Ramelli Ditch	PNF	$ 85,000.00	5/23/2006	$ 85,000.00
Little Last Chance Creek	FRCRM	$ 92,977.00	5/23/2006	$ 91,837.04
Dixie Creek	FRCRM	$ 56,704.00	5/23/2006	$ 56,704.00
Ferris Fields	FRCRM	$ 107,011.00	5/23/2006	$ 107,011.00
Lake Davis Water Treatment Plant	PCFCD	$ 588,260.00	10/23/2007	$ 588,260.00
Jones & Stokes Program Review	Forum	$ 75,000.00	5/22/2007	$ 62,270.96
Total		**$ 1,864,697.24**		**$ 1,591,692.62**

B Fund				
Isotope Monitoring	PluGeo	$ 23,000.00	10/26/2004	$ 22,973.91
Project Coordination and Monitoring	FRCRM	$ 70,000.00	10/26/2004	$ 70,000.00
QLG and Forest Watershed	PluCorp	$ 50,000.00	10/26/2004	$ 50,000.00
Sierra Valley RCD Capacity Building	SVRCD	$ 50,000.00	5/23/2005	$ 50,000.00
Feather River RCD Capacity Building	FRRCD	$ 47,750.00	5/23/2005	$ 47,750.00
Forest Canopy Interception Study	PluGeo	$ 21,000.00	5/23/2005	$ 20,978.64
Plumas Corp Upland Vegetation Management	PluCorp	$ 75,000.00	5/23/2005	$ 70,471.44
Feather River CRM Outreach	FRCRM	$ 33,668.00	5/23/2005	$ 23,493.20
Four Creeks - Development	FRCRM	$ 50,000.00	5/23/2005	$ 50,000.00
Total		**$ 420,418.00**		**$ 405,667.19**

Part III – Program Review

In May 2007, the Watershed Forum authorized an independent review of all aspects of the Forum program. Jones & Stokes, a planning and environmental consulting firm based in Sacramento, was selected to conduct the review through a competitive process. The Forum directed that the review evaluate all expenditures of settlement funds by the Forum in terms of meeting the goals of the Monterey settlement agreement, the Forum's bylaws and policies, and the Feather River Watershed Management Strategy. The latter document is a planning document to guide watershed restoration and management consistent with the goals of the settlement agreement and the bylaws and policies. It was prepared by a contractor for the Forum using "A" funds.

The recommendations from Jones & Stokes are presented below. The full report is available on-line at:
http://www.featherriverwater.com/plumaswatershedforum/documentsandpolicies.html

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Recommendations from Jones & Stokes Program Review

Relationship of Funded Projects to Forum Goals and Policies

- **Focus Future Forum Funding**. Funding of direct intervention should be increased so as to accelerate the restoration of basin storage capacity, augment base flow, and reduce bank erosion. Other funding levels should be increased as needed to ensure that local watershed education/awareness, landowner outreach, and fuel-reduction activities in the watershed are functionally compatible. Funding among project types according to Table 2-4 would be beneficial.

Table 2-4. Recommended Funding Levels

Type of Forum-Funded Project	Percent of Forum Project Funding	
	2003–2007	Recommended
Planning Expenditures	1.2	3
Stream Intervention Projects (includes planning and monitoring by interveners)	46.8	67
Upland Watershed Intervention	8.3	15
Research	10.1	5
Landowner Outreach (including landowner intervention support)	4.4	5
Public Outreach	3.0	5
Other	26.2	0

- **Document Funding Rationale.** The Forum make written findings documenting how each proposed project is expected to further the goals of the Agreement and is consistent with the Forum's strategies and other policies. The Forum should establish a project record and funding agreement for all projects, even for projects sponsored by one of its members.

- **Amend the Feather River Watershed Management Strategy.** The WMS should be amended in several ways:

- The maps and list of priority watersheds should be reconciled since they are not in agreement (see maps on WMS page 12 and 18 and the list on WMS page 18); for example, Sulphur Creek is listed, but its watershed is not shown on the maps.
- The tier-type descriptions of projects need to be improved, others added, and all prioritized. Tier types are needed for upland vegetation management projects, for example. The first-tier Type 1 description should be clarified to include pond-and-plug or, more generally, stream profile restoration.
- The strategy of "increasing upland vegetation cover" in upland areas of the watershed should be refocused to manage natural fuels and reduce the extent and severity of wildland fire while maintaining continuous vegetation cover.
- Project selection criteria should be expanded to include a focus on each of the four goals of the Agreement: improved groundwater storage, augmented base flow, improved upland vegetation management, and reduced bank erosion

- **Allow Project Development Projects.** If the project is the development of direct intervention projects, the Forum's funding agreement should require submittal of the resultant project proposal(s). A reimbursement reservation may be used for this purpose.

- **Ensure Goal-Attainment Focus of Proposals.** Proposals to the Forum should continue to be organized around the goals of the Agreement that are to be addressed. Proposed monitoring and evaluation (i.e., identification of monitoring indicators and evaluation criteria) should be designed to document the degree to which the goals of the Agreement will be advanced.

- **Revise Monitoring Provisions of RFPs.** Distinguish monitoring of project performance/success from monitoring of project implementation. Both types of "monitoring" are important but are confused in the project proposal process.

    - **Project Implementation Verification.** Project proposals should continue to specify project implementation milestones and performance criteria for them, and the Forum should establish a tracking system to ensure that all elements of the funded project are implemented.

    - **Project Success Monitoring**. Proposal guidelines should be revised to ensure that proposed project performance monitoring is focused on performance indicators that measure success in advancing the four goals of the Agreement.

- **Verify Post-Project Land Management Plans**. The Forum should require and fund development and submittal of post-project land management plans or agreements so that it can ensure that a long-term benefit at each site is likely. A reimbursement reservation may be used to ensure plan completion.

- **Establish a Monitoring Plan**. A scientific panel of the Forum TAC should be convened to establish a monitoring plan for direct intervention projects funded by the Forum. The plan should identify issues to be addressed through monitoring, feasible monitoring indicators, and types of monitoring data analyses to be conducted. The Forum should provide funding to the Feather River CRM, and perhaps other organizations if coordinated with the CRM, to conduct the monitoring work. (See also recommendation for a monitoring plan in Section 5.)

- **Establish a Research Plan**. A scientific panel of the Forum TAC should be convened to establish a research plan germane to the goals of the Agreement to guide funding of research

proposals. Rather than responding only to proposals, the Forum should proactively establish scientific issues regarding the restoration program that cannot be addressed through project monitoring alone but require other scientific analysis. (See also recommendation for a research plan in Section 5.)

- **Define Leveraging**. In achieving the strategy of leveraging other funding with Forum funds, the Forum should consider construing this as applicable when Forum funds are used to restore a river segment adjacent to a segment restored with funds from other sources.

Uses of Forum B Funds

- **Redefine Majority/Minority Funds.** The Agreement requires that the "majority" of the funds shall be spent for watershed restoration purposes. Rather than the 50.1% to 49.9% split currently assumed, this provision should be interpreted to mean that at least 60% of the funds should be spent on direct watershed restoration and support of watershed restoration, with a target of 75%. The recommended minimum is about the actual amount for the 4-year funding period (61.5%) if administrative funds are included. The higher target is important if alluvial basin storage is to be increased and base flow augmented, as described in Section 5 of this report. This would leave 25%–40% of Forum funding usable by Plumas County at its discretion.

- **Continue Use of a Portion of B Funds for Plumas County Flood Control and Water Conservation District Purposes at the County's Sole Discretion.** Plumas County should be able to continue using a portion of the B Funds for district-related purposes at its discretion, limiting such funding to water resource protection, watershed restoration, and existing public health and safety issues related to water resources. Of the independent expenditures to date (Table 3-1), repayment of loans to the district, some of the activities of the district's consultants, and the monitoring of state legislative activity may not have met this suggested criteria fully, but review of Table 3-1 clearly indicates that Plumas County limited use of its discretionary funds to projects related to the purposes of the Plumas County Flood Control and Water Conservation District. Accordingly, the Forum does not have an interest in the specific uses of the discretionary funds for district purposes once its needs have been given due consideration (such as per the first recommendation above).

- **Accelerate Direct Intervention.** The most effective way for the county to use B Funds to further its long-term interests is to help accelerate the direct watershed intervention program led by the Feather River CRM and the U.S. Forest Service so that as substantial level of watershed-wide restoration is attained, as described in Section 5. To this end, Plumas County should strive to commit one-half of its discretionary funds to B-Fund projects that the Forum approves to advance the goals of the Agreement.

- **Reassess Local Organization Capacity When Funding Becomes Available.** If new funding becomes available, the Forum should determine at that time the capacity of the CRM, Plumas Corporation, the Feather River and Sierra Valley RCDs, and the Plumas Unified School District to continue to support watershed restoration. It may be that additional capacity building of the RCDs and schools may not be needed since the organizations successfully leveraged Forum funding to attract other funding. The CRM capacity would need to be increased commensurate with an increase in restoration activity; this capacity increase might be met through more project-development funding. Capacity of the Plumas Corporation to continue to improve upland vegetation management may need to be sustained with Forum funding if other funding for administrative purposes has not been acquired.

- **Improve Local Practices Affecting Water Quality.** New uses for discretionary funds should involve improving local government and public utility best management practices for water resource protection in furtherance of the water quality goal of the Agreement.

Review of Program Administration

- **Focus Annual Reports on Goal Advancement.** Improve the Forum's annual reports and thereby focus the achievements of the Forum by adding a section that analyzes how annual funding advanced the goals of the Agreement. Quantify results to the degree possible, using parameters described in Section 5 of this report.

- **Establish Guidelines or Fund Allocations.** Definitions should be articulated about the types of projects that are A-Fund expenditures, B-Fund expenditures approved by the Forum, or independent B-Fund expenditures by Plumas County. Guidelines should be established to help determine if an expenditure from the B Fund should approved by the Forum or designated as a truly independent expenditure of Plumas County.

- **Use a Proposal Evaluation Process Similar to but Improved Upon the Process Specified in the Feather River Watershed Management Strategy.** The adopted Feather River Watershed Management Strategy appears to call for an objective proposal scoring system, which would inject a high level of transparency and objectivity into the funding process. However, scoring, using specified scoring system, does not produce a funding decision. The process should also involve identifying and documenting, in addition to criteria-based scores, any special circumstances or special considerations that would justify overriding the scoring results. This approach would set forth objective data and explain in writing the subjective judgments that confirmed or overrode the objective data.

- **Establish Reimbursement Reservation.** The Forum should withhold a certain percentage of project funding (e.g., 5%–10%, depending upon the funded amount) until the required final project report and other required documents are submitted by the project sponsor. Where projects are planned for implementation for more than a 1-year period, similar reservations should be made to ensure submittal of required annual reports.

- **Improve Project Implementation Tracking.** Forum files in the Plumas County courthouse should be better organized and more complete. A central tracking system should be established that lists funded projects, funded amounts, and approval dates and indicates whether project funding agreements have been executed, whether annual and final project reports have been submitted, the status of invoicing and payments; and whether reserved funds (see item above) have been released.

- **Improve Project Success Tracking.** Final invoices should not be paid unless required annual and final reports and ancillary documents have been submitted and compared to provisions of the funding agreement. These reports should each contain all of the elements in Standard Contract Section 16 – Annual Progress and Final Report, including the five items listed in the Project Evaluation Process section above.

- **Separate Files for Successive Grants.** Separate project files should be maintained for each separate Forum-approved project, i.e., documentation of subsequent funding for continuation of earlier projects should not be combined with original project documents.

- **Separate Projects.** Disparate projects conducted by a particular sponsor should not be combined in proposals to the Forum or in Forum funding agreements (e.g., Plumas Corporation's administrative support of the Plumas County Fire Safe Council and the Quincy Library Group should be separated into distinct proposals and funding agreements) since they are separate activities and meet the goals of the Agreement differently.

Assessment of Program Effectiveness

- **Recognize Cost Effectiveness.** Recognize that the upper Feather River watershed restoration program—in the aggregate, including intervention and intervention-support efforts of several organizations—is likely cost effective in augmenting base flow and improving water quality and watershed condition, even considering only some market values (i.e., power generation benefits of augmented baseflow were not assessed in this analysis).

- **Increase Intervention Funding.** Increase funding of direct intervention to accelerate the restoration of basin storage capacity and augmentation of base flow but maintain other funding levels as needed to ensure that education/outreach and fuel-reduction activities in the watershed are maintained.

- **Seek Long-Term Restoration Funding for the Upper Feather River Watershed**. Use initial new Forum funding to develop a long-term funding arrangement involving water users and state and federal agencies such that a multi-decade restoration effort can be sustained.

- **Assume Mitigation Credits and Benefits**. Recognize that ancillary benefits of watershed restoration, especially benefits to biological resources, are significant, and seek to use these benefits to offset impacts of other DWR water-supply and flood-control enhancement actions in the state.

- **Empower CRM Leadership**. Empower the Feather River CRM to lead the watershed restoration program locally, and ensure that Forum funds are sufficient to maintain the organization's functions. The CRM is ideally suited to develop projects involving multiple ownerships and track restoration progress in meeting the goals of the Agreement through watershed-wide monitoring. It is also ideally suited as a funding recipient, being composed of a number of federal, state, and local agencies.

- **Develop Research Plan**. Develop a Forum-sponsored research plan to improve understanding of actual benefits of a long-term restoration program. The plan should focus attention on water-supply parameters in watershed restoration to expand and make more cost effective the restoration of usable water resources. The plan, developed by an expanded TAC of the Forum, would specify important technical/scientific issues/questions that warrant research. Future research funding by the Forum would be in response to proposals addressing those specified issues. The expanded TAC would comprise in-watershed technical experts, agency and water user technical experts, and water-supply, watershed restoration, and water-resource experts from academia and the consulting community.

- **Develop Monitoring Plan**. Develop a monitoring plan focused upon parameters of interest to water user's and the DWR's/ State Water Resources Control Board's needs regarding the watershed intervention program, coordinated with the current monitoring program of the Feather River CRM and delegated to the CRM for implementation via a new funding agreement.

- **Increase School Program Funding**. Increase funding of schools' watershed awareness programs to increase support for regional watershed restoration.

- **Maintain Landowner Outreach Capacity**. Fund additional landowner outreach activities as needed to ensure landowner education/outreach/ cooperation with projects of the various sponsors.

- **Continue Advancing Upland Vegetation Management Goal**. Continue funding upland vegetation management actions focused on reduced ladder and canopy fuels at a level similar to the initial funding period.

- **Examine Water Rights Implications**. Commission an examination of the relationship between base flow augmentation resulting from the watershed restoration program and existing and future water rights.

- **Amend the FRWMS**. Amend the Feather River Watershed Management Strategy to improve the focus of Forum expenditures, as described in Section 2.

- **Improve Project Results/Success Tracking**. Improve the tracking of project success in meeting the goals of the Agreement and the strategies of the Forum, as also described in Section 2.

Part IV

Financial Reports

Majority/A Fund Budget

Minority/B Fund Budget

2008-2009 Majority "A" Fund Budget

	07-08 Budget		07-08 Actual		08-09 Budget	
Beginning Fund Balance	$ 864,013.88		$ 864,013.88		$ 328,776.15	
Revenue						
46611 Revenue from Settlement						
43010 Interest	$ 15,000.00		$ 30,286.21		$ 6,000.00	
Total Assests	**$ 879,013.88**		**$ 894,300.09**		**$ 334,776.15**	
Expenditures - District Staff						
5100 Regular Wages	$ 21,962.00		$ 21,805.31		$ 28,550.60	
51020 Other Wages	$ 15,000.00		$ -		$ -	
51070 UI	$ 110.00		$ 108.99		$ 143.00	
51080 Retirement	$ 4,126.00		$ 4,138.98		$ 5,362.50	
51090 Group Insurance	$ 1,832.00		$ 1,741.76		$ 2,381.60	
51100 OASDI	$ 1,680.00		$ 1,668.15		$ 2,184.00	
51110 Workers Comp	$ 322.00		$ 322.08		$ 400.00	
51119 Liability	$ 133.00		$ 132.84		$ 115.00	
Total Salary & Benefits	**$ 45,165.00**		**$ 29,918.11**		**$ 39,136.70**	
Service & Supplies						
52020 Communications	$ 85.00					
52170 Miscellaneous						
52180 Office Expense	$ 275.00					
52190 Professional Services/Projects	$ 680,822.03		$ 534,143.03		$ 233,609.21	
CRM - Hosselkus		$ 720.14		$ 323.35		$ 396.79
Feather River College (1)		$ 2,222.33		$ 2,189.58		$ -
SVGMD Well Enhancement		$ 19,276.10		$ -		$ 19,276.10
Plumas Geohydrology - Red Clover (2)		$ 7,901.24		$ 4,466.86		$ 3,434.38
USFS - Clark's Creek Aspen Restoration		$ 60,230.71		$ 21,552.85		$ 38,677.86
CRM - Dixie (2)(3)		$ 42,744.88		$ 43,448.88		$ -
CRM - Ferris (2)(3)		$ 78,130.94		$ 99,141.94		$ -
CRM - Meadow Valley Silver Ck		$ 49,959.75		$ 9,264.31		$ 40,695.44
CRM - Meadow Valley Spanish		$ 145,653.62		$ 15,778.90		$ 129,874.72
CRM - Little Last Chance Ck (3)		$ 113,982.32		$ 90,819.36		$ 1,139.96
Lake Davis Water Treatment Plant (4)		$ -		$ 100,000.00		$ -
USFS - Ramelli Ditch (5)		$ 85,000.00		$ 85,000.00		$ -
Program Review (6)		$ 75,000.00		$ 62,157.00		$ 113.96
		$ 680,822.03		$ 534,143.03		$ 233,609.21
52370 Publications	$ 600.00		$ 888.99		$ 300.00	
52740 Routine Travel	$ 750.00		$ 447.00		$ 600.00	
52775 In County Hosting	$ 400.00		$ 126.81		$ 400.00	
Total Service & Supplies	**$ 682,932.03**		**$ 535,605.83**		**$ 234,909.21**	
Total Expenditures	**$ 728,097.03**		**$ 565,523.94**		**$ 274,045.91**	
Reserved Funding for Program Mgmnt	**$ 50,000.00**		**$ 50,000.00**		**$ -**	
Uncommitted Funds (7)	**$ 100,916.85**		**$ 45,166.94**		**$ 60,730.24**	

Notes

1. Feather River College project budget balance of $32.75 was returned to Uncommitted Funds.
2. The Red Clover, Dixie Creek, and Ferris Fields completed project reports are included in the 2007 Annual Report.
3. On April 8, 2008, the Forum reduced the Little Last Chance budget by $22,023 and increased Ferris Fields by $21,011, Dixie Creek by $704, and the B-Fund CRM Project Coord. & Dev. by $308.
4. Lake Davis Water Treatment Plant - $100,000 to be reimbursed to A funds upon receipt of future B funds.
5. The Ramelli Ditch project was completed in 06-07 but not invoiced until 07-08. The completed project report is included in the 2007 Annual Report.
6. The Program Review performed by Jones & Stokes was completed at $12,729.04 under budget and the balance was returned to Uncommitted Funds.
7. On October 23, 2007, the Forum allocated $100,000 of the uncommitted A funds for the Lake Davis water treatment plant.

2008-2009 Minority "B" Fund Budget

	07-08 Budget		07-08 Actual		08-09 Budget	
Beginning Fund Balance	$ 50,293.64		$ 50,293.64		$ 17,734.61	
Revenue						
46611 Revenue from Settlement	$ -		$ -		$ -	
43010 Interest	$ 300.00		$ 1,620.51		$ 150.00	
Total Assests	**$ 50,593.64**		**$ 51,914.15**		**$ 17,884.61**	
Expenditures - District Staff						
5100 Regular Wages	$ -		$ -		$ -	
51020 Other Wages	$ 140.00		$ 140.00		$ -	
51070 UI	$ 13.00		$ 0.70		$ -	
51080 Retirement	$ 63.00		$ 48.00		$ -	
51090 Group Insurance	$ 110.00		$ 84.00		$ -	
51100 OASDI	$ 42.00		$ 34.00		$ -	
51110 Workers Comp	$ -		$ -		$ -	
51300 Per Diem	$ 4,500.00		$ 200.00		$ -	
Total Salary & Benefits	**$ 4,868.00**		**$ 506.70**		**$ -**	
Service & Supplies						
52020 Communications	$ 600.00		$ 100.00		$ -	
52170 Miscellaneous	$ -		$ -		$ -	
52180 Office Expense	$ 550.00		$ -		$ -	
52190 Professional Services/Projects	$ 37,875.01		$ 33,572.84		$ 17,884.61	
Plumas Geohydrology - LC Base Flow (1)		$ 656.09		$ 630.00		$ -
Plumas Corp - Upland Vegetation (2)		$ 11,588.22		$ 11,588.22		$ -
Plumas Geohydrology - Forest Canopy (3)		$ 5,540.15		$ 5,518.79		$ -
CRM - Outreach & Awareness		$ 19,023.55		$ 8,643.01		$ 10,380.54
CRM - Proj Coord. & Development (4)		$ -		$ 308.00		$ -
Leah Wills - Consultant		$ -		$ 5,818.35		$ 7,504.07
Advocation Inc.		$ 1,067.00		$ 1,066.47		$ -
		$ 37,875.01		$ 33,572.84		$ 17,884.61
52370 Publications	$ 150.00		$ -		$ -	
52420 Rents & Leases	$ -		$ -		$ -	
52440 Special Dept. Expenses	$ -		$ -		$ -	
52550 Auditor Fees	$ -		$ -		$ -	
52740 Routine Travel	$ 1,200.00		$ -		$ -	
52750 Special Travel	$ 5,000.00		$ -		$ -	
52775 In County Hosting	$ 350.00		$ -		$ -	
Total Service & Supplies	**$ 45,725.01**		**$ 33,672.84**		**$ 17,884.61**	
Total Expenditures	**$ 50,593.01**		**$ 34,179.54**		**$ 17,884.61**	
Balance Available	**$ 0.63**		**$ 17,734.61**		**$ -**	

Notes

1. Balance of $26.09 reallocated to other uses.
2. The Plumas Corporation Upland Vegetation completed project report is included in the 2007 Annual Report.
3. Balance of $21.36 reallocated to other uses.
4. On April 8, 2008, the Forum approved a transfer of $308 from the A-Fund Little Last Chance project budget to the CRM Project Coordination and Development project.

Part V

Watershed Forum Agendas and Meeting Minutes

PLUMAS WATERSHED FORUM
PLUMAS COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT

AGENDA FOR MEETING OF OCTOBER 23, 2007
TO BE HELD AT 10:00 A.M.
IN THE BOARD OF SUPERVISORS CHAMBERS
COURTHOUSE, QUINCY, CALIFORNIA

ROBERT MEACHER, CHAIRMAN

www.countyofplumas.com

Note: Department of Water Resources and State Water Project Contractors may participate via teleconference.

1. 10:00 A.M. **INTRODUCTIONS**

2. **PUBLIC COMMENT OPPORTUNITY**
   Any member of the public may address the Forum on matters which are within the jurisdiction of the Forum. If you are addressing the Forum regarding a matter listed on the agenda, you are requested to hold your comments until the Forum takes up that matter. Please limit your comments to three (3) minutes or less.

3. **Monterey Plus EIR**
   Report from DWR on status of Monterey Plus EIR.

4. **Forum Website**
   Discussion regarding updates to Forum website.

5. **Annual Report**
   Review and approve 2007 annual report, including 07-08 budget.

6. **Plumas Watershed Forum Program Review**
   Staff report on status of third-party review of Plumas Watershed Forum program.

7. **Lake Davis Water Treatment Plant**
   Staff report on progress of project and consider request from Plumas County for additional funding.

8. **Integrated Regional Water Management**
   Staff report on Upper Feather IRWM program.

9. **Scheduling**
   Schedule next Forum meeting for Tuesday, May 22, 2008?
   Schedule Forum tour (Almanor/North Fork/Central Plumas) for Monday, May 21, 2008?

ADJOURNMENT

REASONABLE ACCOMMODATIONS: In compliance with the Americans with Disabilities Act, if you need special assistance to participate in this meeting please contact the Clerk of the Board at (530) 283-6170. Notification 72 hours prior to the meeting will enable the County to make reasonable arrangements to ensure accessibility to this meeting

PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
PLUMAS WATERSHED FORUM
COUNTY OF PLUMAS, STATE OF CALIFORNIA

MEETING OF THE PLUMAS WATERSHED FORUM
HELD IN QUINCY ON OCTOBER 23, 2007

1. Introductions

The Plumas Watershed Forum meeting convenes at 10:00 a.m. with Plumas County Flood Control and Water Conservation District board members Robert Meacher, Sharon Thrall, and Bill Powers. Members from the Department of Water Resources include Dwight Russell. Members from the State Water Contractors include David Okita and Tom Hurlbutt.

2. Public Comment

Holly George, University of California Cooperative Extension, reports that a meeting of the Upper Feather River Watershed Group is scheduled for November 15 to present the results of their water quality monitoring. The group is the local coalition for the Regional Water Quality Control Board's irrigated lands/ag waiver program.

Robert Meacher reports that the CalFED watershed program and its staff have been moved to the Department of Conservation and Resources Secretary Mike Chrisman has directed the Department of Conservation to create a statewide watershed program. An organizational meeting with representatives from around the state is scheduled for November 2. Mr. Meacher and Martha Davis from Inland Empire Utilities Agency will be co-chairing the advisory committee and spearheading public outreach.

Dwight Russell reports that the alternative representative for the Department of Water Resources at Forum meetings will be Rob Cooke, chief of the State Water Project Analysis Office.

David Okita reports that he is working with the Metropolitan Water District to appoint a representative to the Forum to replace Tim Quinn.

3. Monterey Plus EIR

Nancy Quan from the Department of Water Resources reports that a draft of the Monterey Plus EIR has been released for a 60-day public comment period and that a hearing to accept public comments is scheduled for the end of November in Quincy. The Department of Water Resources estimates it will take four to five months at least to respond to the public comments. Mr. Russell states that the actual length of time to respond to comments will depend on the volume of comments and the issues that may be raised.

4. Forum Website

Brian Morris from the Plumas County Flood Control District reports that Todd Hillaire from the Department of Water Resources had requested a discussion about updating project reports on the Forum web site.
Mr. Morris states that the Forum web site was originally created with an individual web page for each project sponsored by the Forum, and that for a period of time each page was individually updated whenever there was any action, permitting, or expenditures related to a project. Mr. Hillaire states that the information available on the web site was helpful in monitoring project progress and ensuring transparency for the program.
Mr. Morris states that he reviewed the web site architecture with the Plumas County Information Technology staff, and the design with so many separate pages is not conducive to effective updates. Mr. Morris suggests a monthly update of any project activity using a single document based on the format for project reports in the Annual Report, with updates highlighted. Mr. Russell requests that the update take place by a scheduled date each month. Following discussion, it is the consensus of the Forum that it is acceptable to post one file for completed projects and one file for ongoing projects in PDF format and that the update be posted by the first of each month.

5. Annual Report

Mr. Morris presents a draft of the annual report and provides an overview of the contents.

Mr. Russell requests that the overview and timeline be revised to include the release of the draft Monterey Plus EIR and that the timeline include the closing date for the request for proposals for the Watershed Forum Program Review.

Mr. Morris reviews the financial statements and proposed budget for 07-08. Mr. Hillaire notes that unspent funds from the Forest Service's Beckwourth road relocation project have been returned to the pool of uncommitted funds and requests a footnote stating as such.

Mr. Morris notes that the Sierra Valley Groundwater Management District's project for Sierra Valley aquifer testing has not proceeded in consecutive years as originally set forth in the project proposal and funding agreement. Mr. Russell states that if the purpose of the testing is to determine aquifer characteristics, it does not necessarily matter if the testing occurs in consecutive years but it would be useful to test different locations each year. Holly George states that the information from the aquifer testing will be useful in supporting upcoming modeling work under the Prop. 50/IRWM grant. Following discussion, it is the consensus of the Forum to request that the Sierra Valley Groundwater Management District be asked to explain the additional testing that will be conducted, with a rationale for re-testing the wells that were already tested or testing wells in new locations, and determine how any further testing will support the Prop. 50 modeling work. The district's response will be reviewed by the Technical Advisory Committee.

Mr. Russell states that he has raised questions in the past about reviewing the effectiveness of the Forum's funding for capacity building activities, particularly to the Feather River and Sierra Valley Resource Conservation Districts. Mr. Morris states that the capacity building activities will be evaluated as part of the program review.

Following discussion, upon a motion made by David Okita, seconded by Bill Powers, and unanimously carried, the Forum approves the budget for 07-08 as presented in the draft annual report.

Mr. Morris reports that project reports from Feather River College and the Forest Service's Ramelli ditch project are still forthcoming, and it is the consensus of the Forum that the Technical Advisory Committee can review the project reports before the annual report is finalized.

Gia Martynn from the Feather River Coordinated Resource Management Group presents the Forum with an educational map of the Upper Feather River Watershed that was prepared as part of an education and outreach project sponsored by the Forum. Mr. Russell requests that the map be distributed to Forum members as well as local legislators and the members of the State Water Resources Control Board.

Russell Reid from Feather River College reports that the college's Forum project has been completed and a great deal of water quality data has been collected. Mr. Reid would like to make the data available to anyone who would like to assist in analyzing it.

Upon a motion made by Dwight Russell, seconded by Robert Meacher, and unanimously carried, the Forum approves the Annual Report for fiscal year 2006-07, subject to inclusion of the final project reports and any technical revisions by the Technical Advisory Committee. If the Technical Advisory Committee determines a need for any substantive changes, the report will be brought back to the Forum for review and approval.

6. Plumas Watershed Forum Program Review

Mr. Morris reports a request for proposals to conduct the program review of the Watershed Forum was originally advertised in July, but the only technically acceptable proposal was submitted by Ecosystem Sciences Foundation. There was concern among the Technical Advisory Committee about retaining Ecosystem Sciences, since that was the organization that originally prepared the Feather River Watershed

Management Strategy for the Forum. The TAC decided to readvertise the RFP and try to obtain additional technically qualified proposals to consider, and the closing date for the readvertised RFP is November 16.

7. Lake Davis Water Treatment Plant

The Forum is in receipt of a letter from Bill Powers requesting that the Forum consider using the $100,000 in unallocated Majority/A funds to supplement the funding that the Forum has already provided for construction of a new water treatment plant at Lake Davis. Mr. Okita notes that the Lake Davis project is not a restoration project and is not consistent with the Feather River Watershed Management Strategy and states that he is concerned about using additional Majority/A funds to support the project. Mr. Meacher suggests that the Forum provide the $100,000 in Majority/A funding as an advance against the receipt of future Minority/B funds. Following discussion, upon a motion made by Dwight Russell, seconded by Bill Powers, and unanimously carried, the Forum approves an additional $100,000 in Majority/A funds for the Lake Davis water treatment plant subject to the conditions that: (1) approval will sunset in three months if the project is not under contract within that timeframe; (2) the project sponsors will continue to seek other funding and return money to the Majority/A fund if additional funding is obtained; and (3) the Majority/A fund will be reimbursed fully upon the future receipt of additional Minority/B funds.

8. Integrated Regional Water Management

Mr. Morris provides an overview of IRWM activities as set forth in the IRWM section of the Annual Report.

9. Scheduling

The next meeting is scheduled for May 28, 2008, at 9:00 a.m. with a tour scheduled for May 27.

10. Adjournment

The Forum adjourns at 12:10 p.m. to meet again on May 28, 2008.

BOARD OF SUPERVISORS
William Powers, Vice Chair, 1st District
Robert A. Meacher, 2nd District
Sharon Thrall, 3rd District
Rose Comstock, Chair, 4th District
Ole Olsen, 5th District

AGENDA FOR MEETING OF APRIL 08, 2008 TO BE HELD AT 10:00 A.M. IN THE BOARD OF SUPERVISORS ROOM 308, COURTHOUSE, QUINCY, CALIFORNIA

9:00 – 10:00 A.M. – COMMUNITY DEVELOPMENT COMMISSION

www.countyofplumas.com

AGENDA

[...]

3. 10:40 **PLUMAS WATERSHED FORUM**
   Approve request from the Feather River Coordinated Resource Management Group to reallocate $22,023 from Little Last Chance Creek project to Dixie Creek and Ferris Fields projects.

[...]

Note: This was a special meeting of the Plumas Watershed Forum that was scheduled during a regular meeting of the Plumas County Board of Supervisors

PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
PLUMAS WATERSHED FORUM
COUNTY OF PLUMAS, STATE OF CALIFORNIA

MEETING OF THE PLUMAS WATERSHED FORUM
HELD IN QUINCY ON APRIL 8, 2008

Approved 5/28/08; Revised 10/28/08

The Plumas County Board of Supervisors adjourns from its meeting to convene the Plumas County Flood Control and Water Conservation District and join the California Department of Water Resources and State Water Project Contractors in a teleconference meeting of the Plumas Watershed Forum.

Members from the Department of Water Resources include Dwight Russell. Members from the State Water Contractors include David Okita and Tom Hurlbutt. Forum members' staff attending the meeting or participating via teleconference included:

Plumas County Flood Control District: Brian Morris
Department of Water Resources: Todd Hillaire, Nancy Quan
State Water Contractors: Allison Dvorak

1. Feather River CRM Request to Reallocate Project Funding

Brian Morris, General Manager of the Plumas County Flood Control District, presents a letter from Feather River Coordinate Resource Management requesting the following reallocation of project funding:

	Approved Budget	Requested Budget	Change
Little Last Chance	$115,000	$92,977	($22,023)
Ferris Fields	$86,000	$107,011	$21,011
Dixie Creek	$56,000	$56,704	$704
Proj. Development	$50,000	$50,308	$308

Mr. Morris states that the Core TAC has discussed the justification for the reallocation of funds and forwarded the request to the Forum for approval.

The Forum members have also received a letter from Dwight Russell of the Department of Water Resources noting that the proposed reallocation of project funds is based upon extraordinary circumstances and does not establish any precedent for the future reallocation of any project funds.

Following discussion, motion by Mr. Russell, second by Supervisor Bill Powers and carried to approve the request from Feather River Coordinated Resource Management to reallocate $22,023 from Little Last Chance Creek project to the Dixie Creek, Ferris Fields, and Project Development projects as requested.

2. Adjournment
The Forum adjourns to meet again on May 28, 2008.

PLUMAS WATERSHED FORUM

PLUMAS COUNTY FLOOD CONTROL
& WATER CONSERVATION DISTRICT

AGENDA FOR
TOUR OF MAY 27, 2008
MEETING OF MAY 28, 2008

ROBERT MEACHER, CHAIR

www.countyofplumas.com

May 27, 2008 - 10:00 A.M. - Public Works Department, 1834 E. Main Street, Quincy
Note: All members of the Board of Directors have been invited to attend the tour.

Tentative Itinerary

10:00 A.M. – Depart Quincy (Plumas County Public Works)

Genesee Valley (drive-by) – Forum-sponsored restoration project on Hosselkus Creek completed in October 2006 and future IRWM/Prop. 50 restoration and water conservation projects.

Antelope Lake – Visit State Water Project facility following 2007 Moonlight and Antelope Complex fires; Herger-Feinstein Quincy Library Group pilot project fuel treatment effects.

Last Chance Creek (drive-by) – Various restoration projects with multiple sponsors, including Forum projects and future IRWM/Prop. 50 project.

Red Clover Valley – Return to large pond and plug project sponsored by CalFED watershed program (observed under construction on October 2006 tour).

Freeman Project – Recently completed and ongoing fuel treatment and stream restoration projects undertaken as part of the Herger-Feinstein Quincy Library Group pilot project.

5:00 P.M. – Arrive back in Quincy.

May 28, 2008 - 9:00 A.M. – Board of Supervisors Chambers, 520 Main Street, Quincy

1. 9:00 A.M. **Introductions**

2. **Public Comment Opportunity**
   Any member of the public may address the Forum on matters which are within the jurisdiction of the Forum. If you are addressing the Forum regarding a matter listed on the agenda, you are requested to hold your comments until the Forum takes up that matter. Please limit your comments to three (3) minutes or less.

3. **Approval of Minutes**
   A. October 23, 2007
   B. April 8, 2008

4. **California Watershed Program**
   Update on the development of the Department of Conservation's statewide watershed program.

5. **Watershed Tour**
   Overview and discussion of tour held on May 27.

6. **Monterey Plus EIR**
   Report from Department of Water Resources on status of Monterey Plus EIR.

7. **Plumas Watershed Forum Program Review**
   A. Presentation of Plumas Watershed Forum Program Review and recommendations from Jones & Stokes.
   B. Discussion of recommendations from Jones & Stokes and future of Plumas Watershed Forum pending resolution of Monterey Plus EIR. Possible action and/or direction to staff.

8. **Budget for 2008-09**
   A. Review of ongoing Forum-funded projects and brief reports from project sponsors.
   B. Discussion and direction to staff regarding budget for 2008-09 and use of unallocated funds.

9. **Next Meeting**
   Schedule annual meeting for October 28, 2008.

ADJOURNMENT

REASONABLE ACCOMMODATIONS: In compliance with the Americans with Disabilities Act, if you need special assistance to participate in this meeting please contact the Clerk of the Board at (530) 283-6170. Notification 72 hours prior to the meeting will enable the County to make reasonable arrangements to ensure accessibility to this meeting

PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
PLUMAS WATERSHED FORUM
COUNTY OF PLUMAS, STATE OF CALIFORNIA

MEETING OF THE PLUMAS WATERSHED FORUM
HELD IN QUINCY ON MAY 28, 2008

1. Introductions

The Plumas Watershed Forum meeting convenes at 9:00 a.m. with Plumas County Flood Control and Water Conservation District board members Robert Meacher and Bill Powers. Members from the Department of Water Resources include Dwight Russell. Members from the State Water Contractors include David Okita and Tom Hurlbutt. Forum members' staff attending the meeting or participating via teleconference included:

Plumas County Flood Control District: Brian Morris
Department of Water Resources: Todd Hillaire, Fraser Sime, Nancy Quan, Katie Spanos
State Water Contractors: Allison Dvorak

2. Public Comment

Phil Noya, a member of the Feather River Resource Conservation District, addressed the Forum regarding the previous day's tour. Mr. Noya stated that he would have liked to have shown Forum members some of the projects that the Feather River RCD had completed with the support of Forum funding. Brian Morris stated that the Feather River RCD projects had been included in information provided to tour participants and that projects had been pointed out during the driving tour.

3. Approval of Minutes

Upon a motion made by Dwight Russell, seconded by Bill Powers, and unanimously approved, the minutes from the Forum meetings of October 23, 2007, and April 8, 2008, were approved as presented.

4. California Watershed Program

Robert Meacher reported that he and Martha Davis were co-chairing an advisory board created by the Secretary of the Resources Agency to develop a statewide watershed program that would go beyond the scope of the Cal-Fed watershed program. Public meetings were conducted around the state, and hundreds of comments had been received and were being compiled into a report. The most common comment was to support expanding the scope of the Cal-Fed program. A program proposal will be presented to the Resources Secretary, following by more public vetting and state agency input, with the goal of moving legislation to authorize the program before the end of the Legislature's session.

Mr. Russell asked whether the watershed initiative had produced any pearls of wisdom that the Forum should review. Mr. Meacher stated that the Forum was the pearl and was the example of the direction the state should go in the future.

5. Watershed Tour

Mr. Morris reviewed the itinerary of the previous day's tour. The tour included driving by projects in Genesee Valley carried out by the Feather River CRM and Feather River RCD; a Forest Service presentation at the State Water Project's Antelope Lake in the aftermath of the severe forest fires in 2007; a return visit to Red Clover Valley to view a large Cal-Fed pond-and-plug project that had been completed by the Feather River CRM since the last tour; and a stop at the State Water Project's Lake Davis to view preventative forest fuels management projects. The tour outline is attached to these minutes as Exhibit A.

Mr. Okita stated that he appreciated the forest perspective that had been included in the tour.

6. Monterey Plus EIR

Katie Spanos reported that the comment period on the draft EIR closed in January and that between 20 and 30 letters and about 1,000 comments had been received. Ms. Spanos stated that DWR was working on responses to the comments and that an administrative draft should be done in mid-July. The draft will then go to the EIR committee for review to provide an opportunity for any dispute issues to be referred to the mediatory. If there are no complications or issues for the mediatory, the final EIR could be issued in late September.

Mr. Russell asked about the timing of any legal challenges that may be brought against the new EIR. Ms. Spanos stated that the deadline to file a lawsuit was 30 days after the notice of determination was filed, so it should be known by the end of the year whether there will be further litigation.

7. Plumas Watershed Forum Program Review

Ken Casaday from Jones & Stokes presented the final Program Review to the Forum. The recommendations from Jones & Stokes are attached to these minutes as Exhibit B, and the full report is posted on the Forum's website.

Mr. Russell asked a question about the proportion of funds used for various activities. Mr. Casaday stated that the breakdown was a reasonable balance of direct intervention and research. The one project that was an anomaly was the Lake Davis water treatment plant, which did not directly support the goals of the settlement agreement or the Feather River Watershed Management Strategy. Mr. Casady reviewed the funding allocations that had been recommended by Jones & Stokes, including an increased emphasis on upland areas.

Angie Dillingham from the Plumas National Forest asked whether the review included any long-term analysis of operation and maintenance costs. Mr. Casaday stated that the risk to stream and meadow restoration projects was that a large storm event would blow out the project and require repair. Mr. Casaday stated that the pond and plug projects had been very stable and successful compared to some earlier in-channel restoration projects that had been blown out by high flows.

John Sheen from Plumas Corporation stated that upland and forest management projects did have a long-term need for period maintenance.

Mr. Russell stated that the report was a shining example of what was needed to assess the program, which was an unbiased assessment of the program and an independent assessment.

Mr. Casaday said that Jones & Stokes appreciated the independence they were given to conduct the assessment.

Mr. Okita stated that the report presented two levels of recommendations. The nuts and bolts recommendation should be referred to staff, and the policy level recommendations needed to be discussed. Mr. Okita stated that the water supply analysis needed to be refined and carried further to determine whether the water actually gets to the contractors after it reaches Oroville. That analysis needed to be done before asking for more than the $8 million provided in the settlement agreement, and when the second series of payments commences some of that funding could be used to answer the questions. There should be a statistical analysis of the 80-year history of operations to determine what water is deliverable depending on wet or dry water year conditions, timing of flows, and Delta conditions.

Mr. Meacher stated that stable funding was needed to support the upper watershed program, such as a voluntary $1-per-month check-off on water bills. In 1995, it was calculated that a charge of 25 cents per acre foot would support an upper watershed program.

Mr. Okita stated that in response to AB32 DWR was working on a paper to meet the Governor's direction on climate change, and he requested that Mr. Russell go back to DWR for information about watershed work and carbon.

Mr. Okita suggested that a subcommittee be formed to look at the research that would be required to justify the water contractors' continued support of the Forum. In addition to reviewing the 80-year operations history and considering climate change issues, the economic analysis from Jones & Stokes should be refined.

Mr. Morris suggested that the Forum staff review the Jones & Stokes recommendations regarding administration and operation of the Forum and return to the Forum with any proposals that would update or augment existing policies and procedures. Mr. Morris agreed with the subcommittee proposed by Mr. Okita, which would work on a long-term analysis to develop information that would support continuation of the Forum program beyond the settlement.

Mr. Russell stated that a subcommittee's work would apply both to a short-term decision by DWR and the contactors to voluntarily resume funding under the settlement agreement and to any long-term decision on supporting the Forum.

Mr. Okita and Mr. Hurlbutt had spoken with the other contractors, and they reported there was not much interest in deviating from the requirements of the settlement agreement unless the benefits could be demonstrated.

8. Budget for 2008-09

Mr. Morris presented the budget report as of May 28. Based on estimated expenditures for the remainder of 2007-08, Mr. Morris stated that there was $50,000 that the Forum has set aside for program administration in 2008-09, $246,112 in Majority/A funds that had been committed to projects but not yet expended, and a balance of $42,658 in uncommitted Majority/A funds.

Upon a motion made by Mr. Russell, seconded by Mr. Powers, and unanimously approved, the Forum agreed that any uncommitted Forum funds could be used to further refine the Jones & Stokes analysis and answer questions regarding water supply deliveries as determined by the subcommittee noted above.

9. Next Meeting

The next meeting is scheduled for October 28, 2008.

10. Adjournment

The Forum adjourns at 11:50 p.m. to meet again on October 28, 2008.

Plumas Watershed Forum Tour

May 27, 2008

Outline

10:00 a.m. - Depart Plumas County Public Works – 1834 E. Main Street, Quincy

10:45 - Genesee Valley

- Feather River CRM – Hosselkus Creek (Forum Project A-5) and Ward Creek Restoration Projects
- Feather River Land Trust – Heart K Ranch
- Feather River Resource Conservation District – Capacity Building (Forum Project B-6)

11:30 - Antelope Lake

- State Water Project Facility
- Antelope Complex/Wheeler Fire – July 2007 – 23,000 acres
- Moonlight Fire – September 2007 – 65,000 acres

Lunch – Boulder Creek Amphitheatre

2:00 - Red Clover Valley

- Feather River CRM - Cal-Fed Restoration Project
- Plumas Geohydrology Monitoring Project (Forum Project A-10)

3:30 - Lake Davis

- State Water Project Facility
- Herger-Feinstein Quincy Library Group Pilot Project - Freeman Project

4:00 – Depart Lake Davis

5:00 p.m. - Arrive in Quincy

Genesee Valley Projects

Hosselkus Creek Restoration Project (Forum Project A-5)

In 2002, a pond and plug project on Hosselkus Creek restored 1,500 feet of gully, including 25 acres of meadow and remnant channel, and improved meadow flood drainage with multiple culverts. Proposition 204 provided $170,000 in funding, and the major partners were Plumas County, Neff Ranch, Plumas National Forest, and the Regional Water Quality Control Board. A second phase of restoration was completed in 2006, continuing efforts immediately upstream of the first phase along 1,600 feet of gullied channel. The Plumas Watershed Forum provided $80,000 in funding for the second phase of the project.

Feather River Land Trust – Heart K Ranch

The 884-acre Heart K Ranch and 80-acre Taylor Lake are recently protected lands in the Feather River watershed. The Nature Conservancy and Feather River Land Trust joined forces to protect this very special property that contains alluvial bottomlands and surrounding uplands that include black oak woodland, aquatic, riparian and wet meadow habitats. These habitats support a rich assemblage of rare wildlife and plant species, including four threatened or endangered species and twenty-two species of special concern. The Heart K Ranch also contains spectacular scenery, provides important wintering and breeding habitat for the Sloat mule deer herd, and provides a migratory corridor for numerous other wildlife. Taylor Lake, one of three sacred Maidu Indian lakes, is one of the few natural lakes in this area of the northern Sierra Nevadas.

One component of the Prop. 50 IRWM grant awarded for the Upper Feather region is to implement stream restoration, grazing management, and infrastructure repairs on the Heart K ranch. The project will install 25,000 feet of permanent riparian fencing, creating a 1/3-mile wide, 2.5-mile long riparian buffer strip between irrigated pasture and Indian Creek to accelerate the development of riparian vegetative stream cover. The buffer strip will reduce erosion and water temperatures. Also, a badly leaking 16,000-foot diversion ditch will be replaced with pipeline, and 200 acre-feet-annually of conserved water will be dedicated to instream flow in Indian

Creek. Prop. 50 will provide $555,000 for this project, with another $1 million from the Feather River Land Trust.

Feather River Resource Conservation District (Forum Project B-6)

The Feather River Resource Conservation District has worked with private landowners in many locations in Indian Valley and Genesee Valley to install riparian fencing and carry out fuel reduction projects. Forum funding has supported the RCD in these efforts, as well as with its ongoing education and outreach programs.

Ward Creek Restoration Project

Ward Creek is a tributary to Indian Creek in Genesee Valley. The objective of the project was to re-water the meadow adjacent to the downcut creek channel using the pond and plug technique. A 4,000 foot new channel was constructed at meadow elevation, and the gully was obliterated. The project was completed in 1999 with funding from Proposition 204.

USDA Forest Service Herger-Feinstein Quincy Library Group Pilot Project Implementation

April 2007

- ✓ The Lassen and Plumas National Forests and the Sierraville Ranger District of the Tahoe National Forest are implementing the Herger-Feinstein Quincy Library Group (HFQLG) Forest Recovery Act across approximately 1.53 million acres in the northern Sierra.

- ✓ In 1993, the Quincy Library Group, a grassroots citizen group interested in collaborative management of national forest lands, developed the "Community Stability Proposal," eventually lobbying for passage of the Forest Recovery Act in October 1998 directing the implementation of a Pilot Project in the northern Sierra.

- ✓ The primary purpose of the Pilot Project is to implement and demonstrate the effectiveness of resource management activities proposed by the Quincy Library Group to promote local economic stability; create healthy, fire-resilient forests that maintain ecological integrity; and construct a strategic network of fuelbreaks (Defensible Fuel Profile Zones or DFPZs) that provides for safe and effective fire suppression.

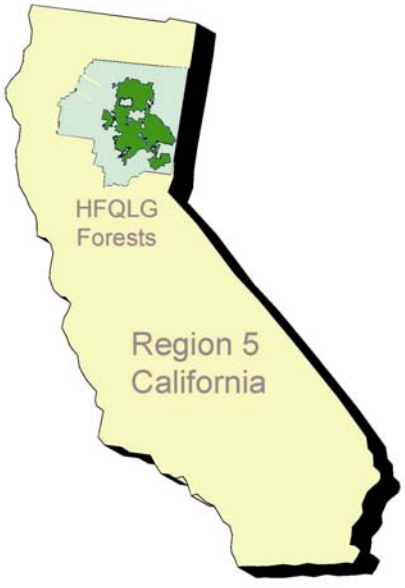
- ✓ Numerous documents and forest plan amendments were developed to facilitate implementing the Act across the Pilot Project. A combination of litigation and limitations in the documents delayed full implementation. The Act was extended an additional 5 years in 2003 and is scheduled to conclude in September 2009.

- ✓ About 50 percent of the DFPZ network is in place.

- ✓ More than 700 forest employees serve the three forests in the Pilot Project area, working for the overall health and sustainability of the forests in the northern Sierra. This includes providing assistance, technical programs and support to individuals, state agencies and other partners to continue improving forest health.

- ✓ The Pacific Southwest Research Station is studying the effects of HFQLG treatments on wildlife populations, watershed health and wildland fire threat reduction as part of an Administrative Study. The project is committed to sharing the results of this innovative research.

- ✓ The HFQLG Pilot Project forests are committed to supporting local communities, not only through project implementation, but also through volunteering for community projects and encouraging employees to personally make a difference in their community.



Contact Information:
HFQLG Implementation Team
P.O. Box 11500
159 Lawrence Street
Quincy, CA 95971
Phone: (530) 283-2050

Photos, from left: California spotted owl; Aspen restoration project on Eagle Lake Ranger District, Lassen National Forest; Firefighter on a prescribed burn on Mt. Hough Ranger District, Plumas National Forest; Logging truck on U.S. Highway 70 near Quincy.

Interesting HFQLG Pilot Project Facts:

The Quincy Library Group (QLG), established in 1992, is a pioneering grassroots citizen organization committed to enforcing responsible management of the National Forests.

Members of the Quincy Library Group before a meeting.

A DFPZ is a ¼ to ½ mile wide fuel break utilizing thinning and other vegetation management methods. Over 156,356 acres of DFPZs are complete.

Signal DFPZ on the Eagle Lake Ranger District of the Lassen National Forest.

Water is a critical resource in the West. As part of this, riparian restoration is restoring stream channels, improving watershed health and helping retain water for release downstream later in the summer. More than 3,999 acres of riparian restoration are completed.

Knuthson Meadow Riparian Restoration project on the Sierraville Ranger District of the Tahoe National Forest.

A Group Selection is an area between ½ and 2 acres that is cleared of trees up to a maximum diameter. These areas create an opening for increasing ecological diversity and improve community stability. More than 6,830 acres of Group Selection are in place.

Meadow Valley Group Selection Unit on the Mt. Hough Ranger District of the Plumas National Forest.

Individual Tree Selection (ITS) is a method used to thin the canopy. Typically smaller diameter trees and thick areas of brush are removed to help open the forest floor. Desirable trees with potential are selected to remain and given room to grow into strong, fire-resilient trees. Across the Pilot Project more than 4,318 acres have been treated using ITS.

Unit 43 after treatment on the Hat Creek Ranger District of the Lassen National Forest.

Budget Information

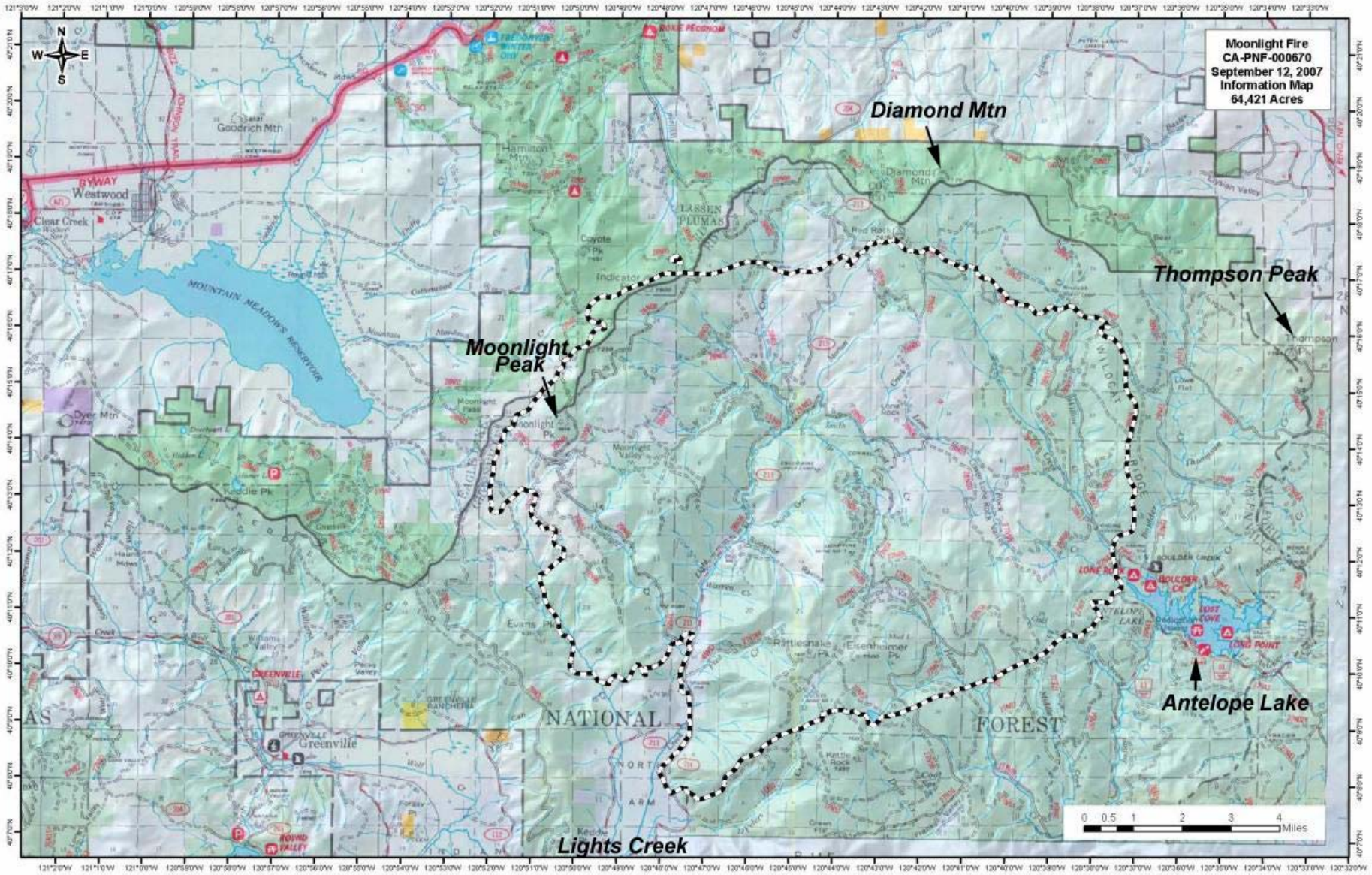
Fiscal Year 2006: *$26.2 million*
Fiscal Year 2005: *$31 million*
Fiscal Year 2004: *$30.8 million*

HFQLG Pilot Project Fast Facts:

Ranger Districts Involved: *Lassen – Almanor, Eagle Lake & Hat Creek; Plumas – Beckwourth, Feather River & Mt. Hough; Tahoe - Sierraville*
Total Acres Accomplished: *171,503 acres*
Total Sawlog Volume: *577,605 CCF*
Total Biomass Volume: *640,818 CCF*
Projects Completed: *221*

**Note: Data is through September 30, 2006.*

Moonlight Fire – 2007



Red Clover Valley Restoration

Starting in 1985, the Feather River CRM's first project in Red Clover Valley constructed four rock check dams on a highly eroded section of Red Clover Creek, which flows into Indian Creek. The dams created ponds and raised the water table on privately owned land used for cattle grazing. Willows and grasses were planted in areas affected by construction. Monitoring information has shown a 657% increase in waterfowl in the area, with nesting and usage indicators up for all indicator species.

In 2006, 3.3 miles of gullied stream channel immediately downstream of the 1985 project was eliminated. Stream flows were returned to remnant channels at original meadow/channel elevations utilizing the "pond and plug" technique, restoring the functionality of 400 acres of effected floodplain within Red Clover Valley, along Red Clover and McReynolds Creeks on both private and public lands. The primary project goal was to improve the water and sediment retention functions of the watershed, with objectives focusing on reduced bank erosion, improved water quality, improved fish and wildlife habitat, reduced flood flows, and increased base flows. Post-project monitoring completed in 2007 documented sediment retention, increases in vegetative and waterfowl production, and groundwater levels, and decreases in water temperatures. Project monitoring will continue in 2008. Primary funding ($1,101,000) was provided through the State Water Resources Control Board Proposition 13 CALFED Watershed Program, with contributions from the Department of Water Resources, Natural Resources Conservation Service, U.S. Forest Service-Plumas National Forest, the landowner, and volunteers.

Red Clover Monitoring Project (Forum Project A-10)

In conjunction with the 2006 restoration project, the Forum funded a monitoring project to assess baseflow augmentation related to the restoration work. Following project construction, beaver dams prevented data collection in 2007 until the month of December, but further efforts will be made to collect useful data during the summer of 2008.

Exhibit B

Recommendations from Jones & Stokes

Note: The Recommendations from Jones & Stokes are presented in Section III of the Annual Report

Part VI

Project Reports

Watershed Forum Completed Projects

Forest Canopy Interception Study
Sponsor: Plumas Geo-Hydrology
Approved Funding: $21,000 (B funds)
Expended By 6/30/08: $20,978

The purpose of this study was to assess the impact of tree canopy interception in a pine forest on moisture reaching the forest floor. Field experiments were conducted in the winter of 2005-2006 on private land near Blairsden, in eastern Plumas County, California. The objectives of this study were:

1. To examine the effect of forest canopy on the amount of throughfall.
2. To examine to what extent reduced canopy density can increase the amount of moisture reaching the forest floor.
3. To examine the feasibility of using isotope tracers to assess the impact of tree canopy interception on base flow.

The final report was submitted in July 2008 and is included here as Appendix A. Observations and projections of the report included the following:

- After eight storms, the average throughfall depth in the forest stations was 57 cm, compared to 75 cm total storm depth in the comparison meadow. The amount of precipitation evaporated due to canopy interception was 24%.
- Canopy interception increased with storm depth.
- Data suggests that isotope composition in throughfall is affected by canopy interception, and the hypothesized cause is the partial evaporation of intercepted precipitation before it is released from the canopy as throughfall.
- If forest canopy closure was reduced to 40%, throughfall could increase by more than 20% in high density forest stands.
- Under a 40% forest canopy reduction scenario, the isotope signature would be large enough to be detected under current lab analysis resolution.
- Comparison of throughfall data with data collected simultaneously from a nearby seasonal stream, a spring, and a well, suggest that isotope changes under reduced forest canopy density may be detected in ground water and baseflow.

The report concludes that (1) forest management practices that result in reduced forest canopy closure have the potential to increase ground water recharge and thereby increase baseflow and (2) overstocked forests may have significant adverse impacts on the water balance.

The report recommends additional research, including the following:

1. The sheer volume and complexity of the data deserves further analysis, if not further field data collection. Data should be collected in an area of the watershed that has recently

been logged for fire safety thinning, including continuous stream and ground water isotope monitoring.

2. Investigate the utility of using isotope signatures from moisture in woody tree tissue to characterize soil moisture.
3. Verify the impact of reduced forest canopy in extensive forest thinning or burn areas by systematic collection of stream and spring isotope data.

Revised Project Budgets

On April 8, 2008, the Forum approved a request from the Feather River Coordinated Resource Management group to reallocated funding between four previously approved projects. The completed project reports for Ferris Fields, Dixie Creek, and Project Development and Monitoring were presented in the 2007 Annual Report.

	Original Budget	Revised Budget	Change
Little Last Chance	$115,000	$92,977	($22,023)
Ferris Fields	$86,000	$107,011	$21,011
Dixie Creek	$56,000	$56,704	$704
Proj. Development	$50,000	$50,308	$308

The Little Last Chance Creek restoration project involved construction of rock riffles to reduce erosion, stabilize streambanks, and raise the level of the channel. Construction began in November 2007 and was completed within six weeks. Forum funding was matched by $467,000 from a Prop. 40 Non-Point Source Pollution grant and upstream work was completed using $153,000 in Title II funds from the Secure Rural Schools and Community Self Determination Act. A total of five miles of stream channel along Little Last Chance Creek was restored.

The primary work on Little Last Chance Creek was completed with a balance of $26,823 remaining on the Forum's project funding agreement. The Feather River CRM requested that $22,023 be reallocated to other projects where the costs had exceeded the amounts provided by the Forum. The remaining $4,800 for the Little Last Chance Creek project is being used for post-project monitoring and to complete a final report.

Funding from the Little Last Chance project was reallocated to the Ferris Fields and Dixie Creek restoration projects and the CRM's work on Project Development and Monitoring (Four Creeks). These three projects had exceeded the funding originally provided by the Forum because of higher fuel costs, needs for additional project equipment during construction, and project construction training of staff.

Watershed Forum Ongoing Projects

Hosselkus II Restoration Project
Sponsor: Feather River CRM
Approved Funding: $80,000 (A funds)
Expended By 6/30/08: $79,603

This pond-and-plug creek restoration project was constructed in October 2006, with initial re-vegetation work immediately following construction.

Activity continued in the 2007 work season with further re-vegetation work by volunteers, planting drier plug sites with pine saplings donated by the Forest Service, installing temperature loggers above and below the confluence of Hosselkus Creek and Indian Creek, and monitoring groundwater levels.

Monitoring of the project continues with monthly collection of data on water temperature and groundwater levels.

Feather River College Riparian Protection Project
Sponsor: Feather River College
Approved Funding: $92,453 (A funds)
Expended By 6/30/08: $92,420

This project was designed to improve the native pasture and wetlands on the Feather River College campus and better manage livestock with the goals of improving water quality in Spanish Creek and its riparian habitat and to offer educational opportunities to students and the community.

Primary work on this project was completed in the summer of 2005 with fencing to exclude livestock from riparian areas and the installation of heated and unheated off-stream water sources. The college also expanded and began the use of new dry-lots. The Natural Resource Conservation Service completed a pasture condition report in May of 2006 and water quality monitoring continued. The college also began using the new livestock facilities in conjunction with three new agriculture courses to demonstrate wetlands management, livestock management, and grazing practices.

The monitoring of water and wildlife will be an ongoing, permanent practice, including specific monitoring through 2010 that was included in the Forum funding agreement.

Sierra Valley Aquifer Testing
Sponsor: Sierra Valley Groundwater Management District
Approved Funding: $30,000 (A funds)
Expended By 6/30/08: $10,724

This project consisted of three aquifer tests in the southwestern part of Sierra Valley near Sattley, east of Beckwourth, and north of Loyalton. The three aquifer tests, along with about ten additional aquifer tests performed at different times since 1982, were to be used to determine aquifer characteristics and predict the effects of continued groundwater pumping on groundwater levels in certain areas. Where well interference is a significant problem, possible mitigating measures include development of well spacing criteria for new wells.

Ken Schmidt, the contract geohydrologist for the Sierra Valley Groundwater Management District, prepared an initial report which was included as Appendix C in the 2007 Annual Report.

Additional aquifer testing is proposed in the area of Sierraville to provide additional geographic coverage of the Sierra Valley area. Ken Schmidt has requested that any further testing be conducted in coordination with the Upper Middle Fork modeling work that will be performed by U.C. Davis/California Hydrologic Research Laboratory under a Prop. 50 IRWM grant.

Red Clover Monitoring Project
Sponsor: Plumas Geo-Hydrology
Approved Funding: $28,000 (A funds)
Expended By 6/30/08: $24,565

This is a monitoring project with the objective of assessing baseflow augmentation due to stream restoration in a meadow that is affected by an adjacent ground water discharge area. The project focuses on Red Clover Valley, which has been the site of a number of past restoration projects, including an expansive Cal-FED funded project that was completed in the fall of 2006.

Data collection was scheduled to end in September 2007, but the appearance of beaver dams delayed the return of steady stream flow below the project until December 2007. Data collection continued through the summer of 2008 to enable a comparison of pre- and post-project conditions.

Clark's Creek Aspen Enhancement and Ecosystem Restoration Project
Sponsor: Plumas National Forest
Approved Funding: $84,500 (A funds)
Expended By 6/30/08: $57,088

The Forum provided funding for the Plumas National Forest to perform the resource surveys and NEPA preparation that is required as a prerequisite to the Clark's Creek aspen enhancement and ecosystem restoration project. The project will enhance the local ecosystem by contributing to water quality, water yield, and water retention.

This project will restore the functioning condition of aspen stands within the Clarks Creek watershed, a tributary to Last Chance Creek. The project focuses on the release and regeneration of aspen communities from conifer suppression and encroachment. Conifers to be removed are within the existing aspen stand and include those trees actively suppressing aspen community productivity and function on 331 acres of land. Coniferous trees bordering aspen stands will also be removed to encourage the extension of the aspen community and improve the health of the existing stand. Timber removal activities will be accomplished through a combination of mechanical and manual thinning methods.

An additional focus of this project is to protect sprouts from excessive browsing. To limit extensive browsing of sprouts, Forest Service specialists and the allotment permittee will design and implement strategic grazing plans. Under these adaptive plans, existing levels of grazing within the project area could continue, but season or duration of use may be altered. When season or duration of use is inflexible, where intensive use has been previously documented, or where retaining any induced sprouting is absolutely critical, temporary exclusion fencing would be constructed. Traditional fencing (such as wire, or log fence) will be utilized when essential protection is required. Nontraditional fencing (strategic jackstraw barriers or guardian log placement) will be used when traditional fence construction is impractical or when high maintenance cost is anticipated.

Initial wildlife, botany, and archeology work was performed in the summer of 2006, with continued NEPA preparation and sale planning during the summer of 2007. The public notice for comment on the draft Environmental Assessment was issued in September 2008, and a final decision on the project is expected in November 2008.

Meadow Valley – Silver Creek Restoration Project
Sponsor: Feather River CRM
Approved Funding: $51,000 (A funds)
Expended By 6/30/08: $10,304
Expended by 10/1/08: $28,049

This project is the result of a Forum-funded project development grant. The project was intended to restore Silver Creek in Meadow Valley, a major tributary of Spanish Creek. The entire Meadow Valley stream system has degraded, including that portion of Silver Creek located in the valley. The projects includes affecting 250 feet of stream channel upstream of the main treatment section with three large, log jams designed to capture bedload; treating 50 feet of channel bank with boulder vanes, sloped bank and transplanted vegetation at the one bridge within the project reach; treating 60 feet of stream length with a fourth log jam within the actively eroding channel section to capture bedload and maintain channel grade; stabilizing 170 feet of channel bank with boulders placed under exposed tree roots and with transplanted vegetation; treating 320 feet of meander bend streambank with reshaped bank, boulder vanes and transplanted vegetation; treating 550 feet of stream channel with raised riffles and improved scour holes to reconnect the inset channel with a mid-terrace (floodplain) and dissipate energy; and sloping back 110 feet of channel bank and vegetation with transplanted material.

Resources surveys were conducted in the summer of 2007 to meet CEQA requirements, and construction began in the summer of 2008. The project is scheduled to be completed this year.

Log Jam Constructed on Silver Creek

Meadow Valley – Spanish Creek Restoration Project
Sponsor: Feather River CRM
Approved Funding: $147,000 (A funds)
Expended By 6/30/08: $17,125
Expended By 10/1/08: $50,404

Boulder Vanes Constructed on Spanish Creek

This project is the result of a Forum-funded project development grant. The project is intended to restore Spanish Creek in Meadow Valley at Spanish Ranch. Spanish Creek in Meadow Valley has been historically manipulated and channelized, and it subsequently degraded. Spanish Ranch Road (County Road 413) forces Spanish Creek to flow under a 43-foot wide bridge, which reduces the stream channel-floodplain width by 90 percent. The constriction is an effective barrier to high flows, causing it to slow and a large backwater area to form. Bedload material quickly deposits within this backwater area, creating large gravel bars that force flows against the opposite, eroding channel banks. The long-term result is the loss of property and a migration of the stream channel around the bridge. The restoration treatments include inserting 12 culverts into the south approach to the bridge to alleviate pressure on the bridge, spread flood flows out onto 100 feet of floodplain, alleviate the backwater effect, and reduce upstream bank erosion and the potential for the stream to end-run the bridge. The project treats 200 feet of eroding outcurve channel bank with boulder vanes, sloped bank, and transplanted vegetation. It also removes 1,200 cubic yards of gravel berms used to further constrict and direct stream flows within a

2,300-foot long section of channel-floodplain upstream of the bridge, opening the section up for improved overbank flows and reducing concentration of flows against the entrenchment banks.

Environmental surveys and reports required for the project were conducted in the summer of 2007, and construction began in the summer of 2008. Construction will be completed this year.

Little Last Chance Restoration Project
Sponsor: Feather River CRM
Approved Funding: $92,977 (A funds)
Expended By 6/30/08: $91,837

As reported above in the explanation of revised project budgets, the Little Last Chance Creek restoration project involved construction of rock riffles to reduce erosion, stabilize streambanks, and raise the level of the channels. Construction began in November 2007 and was completed within six weeks. Forum funding was matched by $467,000 from a Prop. 40 Non-Point Source Pollution grant and upstream work was completed using $153,000 in Title II funds from the Secure Rural Schools and Community Self Determination Act. A total of five miles of stream channel along Little Last Chance Creek was restored.

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Pre-Project Conditions on Little Last Chance Creek

The restoration concept was riffle augmentation. The stream channels had been highly manipulated because of the fan location and intensive livestock and hay production. Rather than a network of often changing, shallow channels across the valley, flow has been restricted into two main channels. A combination of concentration of flow, highway culverts, loss of sediment supply, and intensive agricultural use contributed to the development of the degradation of the channels to an existing depth of three to nine feet. Irrigation diversion ditches and a grade control dam helped reduce the rate of down-cutting, but the depth of the gully captured enough flood flows to thwart most in-gully attempts at control. Two diversion structures were no longer operable, and most of the rest were at risk of failure. Because the channel bottom had not yet reached a resistant layer, without treatment, incision cycles were expected to continue moving upstream, resulting in a deeper and wider gully, making irrigation structure maintenance more difficult and expensive. Riffle augmentation was proposed for over 100 locations to cause flows slightly over 200 cfs in each channel to spill onto the floodplain.

Little Last Chance Creek After Construction

NEPA review and pre-project monitoring were completed in the summer of 2007, and construction was completed late in the 2007 season. With financial assistance from other sources, the project was completed without using all of the funding allocated by the Forum, and the Forum approved a request from the Feather River CRM to reallocate funds to other projects that were completed over budget. The remaining funding for the Little Last Chance Creek project will be used for post-project monitoring and to complete a final report.

Lake Davis Water Treatment Plant
Sponsor: U.S. Army Corps of Engineers
Approved Funding: $588,260 (A funds)
Expended By 6/30/08: $588,260

This project involves the construction of a new 1.5 million-gallon-per-day water treatment plant at Lake Davis to serve the City of Portola and the Grizzly Lake Resort Improvement District. The original water treatment plant was taken out of service in 1997 when the Department of Fish and Game poisoned Lake Davis in an attempt to eradicate northern pike. Once the lake was recertified as a municipal water source and the City of Portola agreed to return to the lake as its water supply, it was determined that the old water treatment plant was obsolete and needed to be completely replaced.

The U.S. Army Corps of Engineers is the lead agency for the project, and the prime contract was awarded to Engineering and Remediation Resources Group of Concord, California. Construction began in June of 2008, and the water treatment plant is expected to be in operation by July of 2009.

In late 2007, the Department of Fish and Game undertook a second attempt to eradicate northern pike from Lake Davis. Following an extensive water quality testing program, the California Department of Public Health recertified Lake Davis as a municipal water supply in May of 2008, after all chemicals used to treat the lake had reached non-detect levels. Monitoring of the fish population continues, but no pike had been encountered as of the end of the 2008 fishing season.

Feather River Watershed Public Awareness Campaign
Sponsor: Feather River CRM
Approved Funding: $33,668 (B funds)
Expended By 6/30/08: $23,493

The *Feather River Watershed Public Awareness Campaign* is a concerted effort to bring water quality and watershed-related information into the homes and minds of residents of the Feather River watershed. By engaging landowners, educators, students and community members in multiple formats for learning about watershed issues, improved understanding and increased participation in stewardship activities will result over time.

Other outreach and education activities have included completing a sediment and erosion control brochure for small-scale construction sites; sponsoring a storm drain stenciling watershed stewardship event in Quincy to celebrate Watershed Awareness Month; publishing a watershed awareness opinion article in the Plumas County newspapers; and producing a map of the Feather River Watershed showing the relationship of the Feather River to the Sacramento River watershed and the rest of California.

Work that remains to be done on this project includes implementing a system to sell the watershed map at various locations in the Feather River region and completing a brochure for landowners.

As part of the public awareness campaign, the Feather River CRM conducted a contest to create a logo to accompany the tagline "Feather River Watershed: Clean Water Starts Here." In the picture at right from the *Feather River Bulletin*, the three finalists display their entries. The final logo, below, is based on the entry from Dale Keefer of Chester, but it was simplified by a graphic artist to facilitate reproduction.

CLEAN WATER

UPPER FEATHER RIVER WATERSHED

STARTS HERE

Appendix A

Canopy Interception in a Coniferous Forest

Plumas Geo-Hydrology
LAND AND WATER RESOURCES
P.O. Box 1922, Portola, CA 96122
tel. (530) 836-2208, fax (530) 836-0959

Canopy interception in a coniferous forest in eastern Plumas County, California

Final Technical Summary Report

July 28, 2008

Prepared for

Brian Morris, Plumas County Flood Control and Water Conservation District

By

Burkhard Bohm, Geologist/Hydrologist

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Table of Contents

Executive summary

Purpose and scope

The purpose of this study is to assess the impact of tree canopy interception in a pine forest on moisture reaching forest floor. Field experiments were conducted in the winter of 2005/06 on private land near Blairsden, in eastern Plumas County, California. In specific the objectives of this study were:

1. To examine effect of forest canopy on the amount of throughfall.
2. To examine to what extent reduced canopy density can increase the amount of moisture reaching the forest floor.
3. To examine the feasibility of using isotope tracers to assess impact of tree canopy interception on base flow.

Data collection

1. Field data collection was conducted at twenty stations in a partially overstocked forest, with fifteen stations on a north facing slope and five on a south facing slope. A control station was established on an open meadow between the stations. Data were collected from December 2005 to March 2006.
2. Data collection included:
    a. Forest canopy density (closure) measurements with a wide angle lens mounted on a digital camera. For comparison canopy density was also measured with a spherical mirror densiometer.
    b. Throughfall depth.
    c. Throughfall samples for analysis of the stable isotopes deuterium and oxygen-18 in water.

Results:

1. For the purpose of this study the wide angle lens canopy data were used, however, since the current forest management is based on densiometer canopy closure data, a comparison was conducted between the data sets. Despite the data scatter wide angle lens and densiometer canopy densities show some correlation, however densiometer values are on average 20% higher.
2. After 8 storms the average throughfall depth in the forest stations was 57 cm, compared to the 75 cm total storm depth in the meadow. Thereby the amount of precipitin evaporated due to canopy interception was 24%.
3. Canopy interception increased with storm depth.
4. These data suggest that isotope composition in throughfall is affected by canopy interception:
    a. The hypothesized process is partial evaporation of intercepted precipitation, before it is released from the canopy as throughfall.
    b. The correlation of isotope shift on the one side and throughfall depth and canopy density on the other side is not very clear, suggesting that the underlying process is more complex than initially thought.
5. The data were examined to determine by how much throughfall would increase if forest canopy closure was reduced to 40%.
    a. Based on wide angle photo canopy density data throughfall could increase by as much as 9%.
    b. Since canopy closure measured with a spherical densiometer is significantly greater the throughfall increase could exceed 20% in high density forest stands (excluding clearings).
6. Also under a forest canopy reduction to 40% scenario:

a. The isotope signature would be large enough to be detected under current lab analysis resolution.

b. Comparison of throughfall data with simultaneously collected data from a nearby seasonal stream, a spring and a well, suggest that isotope changes under reduced forest canopy density maybe detected in ground water and baseflow.

7. The implications of these results are;

a. Impacts of forest management practices that result in reduced forest canopy closure have the potential to increase ground water recharge and thereby increase baseflow.

b. More so these results suggest that overstocked forests may have significant adverse impacts on the water balance.

Recommendations

The most important recommendations made at the end of this report are highlighted:

1. The sheer volume and complexity of the data deserves further analysis, if not further field data collection. Data should be collected in an area of this watershed that has recently been logged for fire safety thinning, including continuous stream and ground water isotope monitoring.
2. Investigate the utility of using isotope signatures from moisture in woody tree tissue to characterize soil moisture.
3. Verify the impact of reduced forest canopy in extensive forest thinning or burn areas by systematic collection of stream and spring isotope data.
4. Conduct a literature search.

Introduction

A number of field measurements were conducted to assess the impact of tree canopy interception on moisture reaching a forest floor in a pine forest. Field experiments were conducted in the winter of 2005/06 at a forested lot near Blairsden, in eastern Plumas County, California at an elevation of about 4640 ft. A wealth of data has been collected from precipitation, stream and ground waters. This report is a summary of observations and conclusions. Being the result of several iterations of data analysis, in the opinion of the author the sheer volume and complexity of the data does deserve further comprehensive analysis, if not further field data collection.

It is common knowledge that when one gets caught in a rainstorm, to avoid getting wet, is to find shelter under a large tree. Also, in the pine forests of the Sierra Nevada it is typical to find less snow on the ground under large trees and in dense forests, when compared to meadows and clearings. This study investigates methods to quantify the effect of forest canopy interception on baseflow. Numerous field studies have provided convincing data that support the notion that vegetation can affect baseflow, which is based in accepted hydrologic concepts.

The objective of this study is twofold:

1. To continue what was initiated in a pilot study conducted in 1996/97 (Bohm, 1997) by collecting new throughfall data, and re-test the hypothesis that reduced canopy density increases the amount of moisture reaching the forest floor, and thereby may increase baseflow.
2. To examine the feasibility of using isotope tracers to assess impact of tree canopy interception on soil infiltration, ground water recharge and stream base flow.

The interest in understanding the connection between forest canopy density and stream flow evolved from an ongoing debate between the author and several other hydrologists involved in stream and watershed restoration projects in the Plumas NF and private land. The key observation is that the geomorphic features of many ephemeral streams and their riparian surroundings seem to hint that at one time these were populated by beavers, implying that these were once perennial streams. Why would the flow regime have changed in these streams? Several factors could contribute to this, including changing climate and land use. While the impact of climate change on small stream flow regime is still being verified, the impact of fire suppression on forest vegetation density is apparently well established. For example increased spring flow after wildfires seem to be a common observation (reference). A connection between stream flow regime and vegetation is founded in commonly accepted hydrologic concepts (e.g. Bosch & Hewlett, 1982).

If the conclusions based on the above mentioned geomorphic observations are realistic, then it is reasonable to ask how forest thinning, if not catastrophic wildfires, will affect a watershed's water balance. Since impact of evapotranspiration and hence vegetation on water balance is a well accepted concept, the logical next step is to ask to what extent does reduction of vegetation density increase baseflow, if not the overall water yield from a watershed. To be clear, this study is not to advocate aggressive vegetation management for the purpose of increasing water yield, but to enhance a balanced discussion about local watershed management concerns.

The focus of this study is on only one aspect of evapotranspiration, i.e. evaporation from the forest canopy.

Background

A preliminary study conducted in 1995/96 indicated that evaporation of rain and snow intercepted in high density forest canopies can be substantial (Bohm, 1997). For the sake of watershed restoration estimating the impact of interception on streamflow is in the opinion of the author an essential component of watershed management. However, there are reasons to believe that the precision of stream flow measurements is insufficient to detect the effect of increasing or decreasing forest canopy density. To help circumvent these difficulties it was proposed to apply naturally occurring oxygen-18 and deuterium isotope tracer techniques. The objective is to develop methods that can help provide a seasonal and aerial averaged measure of canopy interception impact on ground water recharge and stream flow.

In specific this project entails:

a. Examining evaporation loss during forest canopy interception and infiltration through forest litter and soil measuring the naturally occurring environmental isotopes deuterium and oxygen-

18 in throughfall and soil moisture.

b. Comparison of this study with the 1995/96 preliminary throughfall field study results.

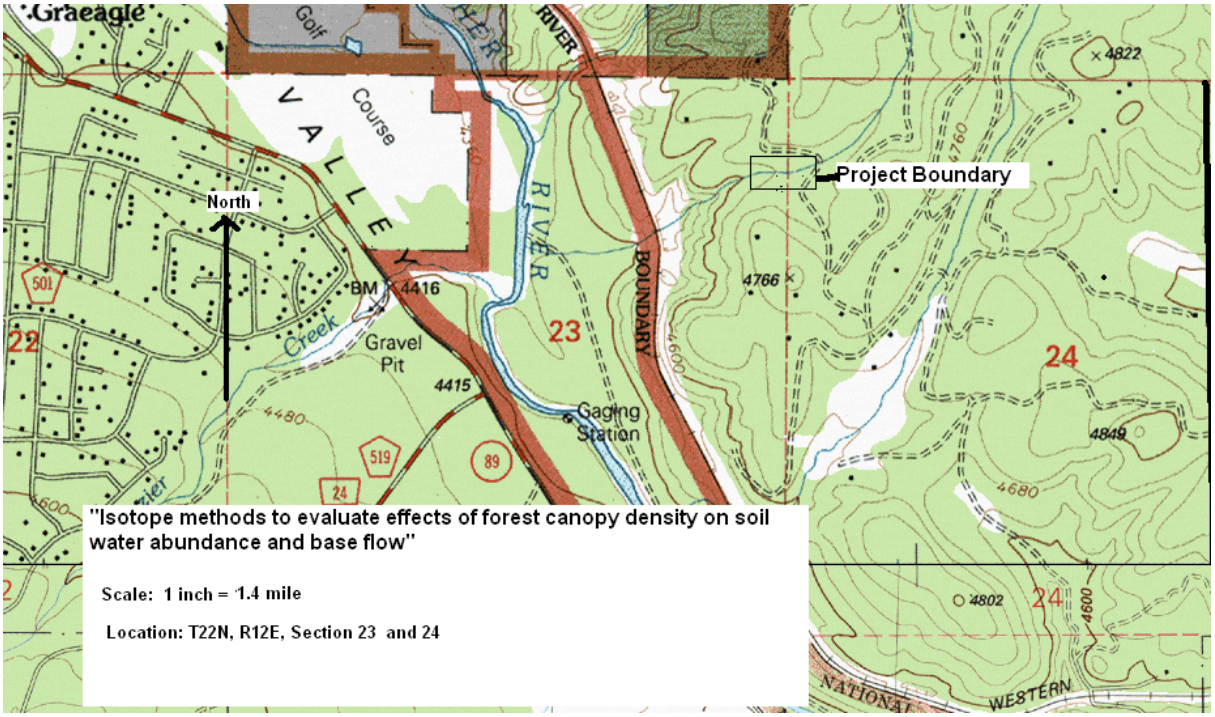
c. Examining to what extent the isotope signatures induced by evaporation in the forest canopy and in soil waters can be recognized in ground water and base flow.

d. Examine if the effect of forest canopy thinning can be noticed in ground water and baseflow.

The intent is to identify means whereby one can estimate the impact of forest canopy interception by comparing pre- and post-project isotope signatures in precipitation, soil moisture, springs and stream water samples.

Project location

This project is located in the Middle Fork Feather River (MFFR) watershed at one specific location, a 13 acre forested parcel about 1 mile north of the town of Clio in eastern Plumas County (see location map), at an elevation of 4600+ ft. Given the intensity of field data collection necessary during the winter the project focused on a limited area, near the author's residence.



Working hypothesis

To start, it is important to establish the working hypothesis.

1. The term "throughfall" implies the amount of precipitation penetrating the canopy and reaching the forest floor.
2. The term interception is the fraction of precipitation which ends up on branches and leaves of tree canopies. Some of this is returned to the atmosphere by evaporation, while some is eventually shaken off by wind, thereby becoming throughfall.
3. The denser the forest canopy, the less throughfall reaches the forest floor.
4. Partial evaporation of temporarily intercepted throughfall results in isotope enrichment. Part of the remaining fraction (partially evaporated) eventually falls to the forest floor, carrying an isotope enrichment signature. In other words the degree of isotope enrichment in throughfall samples is expected to correlate with canopy density and throughfall depth.
5. Isotope enrichment in soil moisture, correspondingly, is expected to correlate with isotope enrichment in throughfall.

6. Correspondingly isotope signatures in base flow and ground water are expected to reflect the integrated effect of average tree canopy density in a forested watershed.

Acknowledgments

A number of individuals have been instrumental in helping to conceptualize the queries leading to this study proposal. First, credit is due to the Plumas Watershed Forum who authorized and funded this study. David Decker and Jim Thomas of the Desert Research Institute gave valuable advice in field data collection methodology. They also provided valuable report review comments. This study ha also benefited from many helpful suggestions from Terry Benoit and Jim Wilcox of the FR-CRM. Credit is also due to John Sheehan of the FR-CRM for his continuing support since inception of the 1997 study.

Experimental Setup

Throughfall stations

A total of 20 stations were randomly established at approximately 25 ft intervals along two east-west transects in a forested parcel, spaced about 150 ft apart. Each station was marked with a wooden stake, with an alphabetic letter assigned to each station.

7. The first transect located on a north facing slope, had ten stations on an east-west line (stations A-G, M-O), and five stations in a north-south line (stations H-L).
8. The second transect with five stations is arranged on an east-west line on a south facing slope (stations P-T).
9. At each station an open 5 quart plastic bucket (top opening diameter 20.3 cm) was placed on the forest floor to capture precipitation under the given local conditions.
10. A control station was established in a meadow about half way between the two transects, with an open 5 gallon plastic bucket (top opening diameter 27.1 cm).

Vegetation

The parcel is covered with a pine dominated conifer forest, including mostly Jeffrey Pines and to lesser extent red cedars. The parcel is visibly overstocked with small diameter trees, scattered among larger trees with DBH's (diameter at breast height) up to 24 inches, or more. The southern transect is mostly in an overstocked forest, and the northern transect forest has been thinned substantially in 1995.

The stations can therefore be categorized into two groups:

11. Stations A through O: dense forest, not thinned, with variable canopy coverage on a 15% north facing slope. Tree stem diameters range from about 2 inches up to 24 inches or more.
12. Stations P through T: mostly trees taller than 30 ft, though usually less than 24 inches in diameter. This area has been thinned and partially logged in 1995, selectively taking out small diameter trees, and a select number of large diameter trees.

Field Data

Forest canopy measured from wide angle lens photos

Forest canopy density was measured in percentages of sky area, using a Canon A70 digital camera with a wide angle lens. This is a very convenient and time saving method. Percentages of blue sky pixels were estimated with the Photoshop Elements software. These measurements were made in the spring of 2006. For the duration of the experiment it is assumed that the canopy density has not changed.

Forest canopy measured with a densiometer

Forest management practices are typically based on forest canopy closure data collected with a densiometer, not with a camera. For that reason it was deemed prudent to also measure canopy density with a spherical densiometer. This is an instrument with a concave mirror, used for measuring forest overstory density. These measurements were made in the spring of 2008. It is deemed safe to assume that since the collection of throughfall data in 2005/2006 the canopy density had not changed significantly. A comparison between wide angle lens and densiometer canopy data is presented in attachment D.

Canopy density distribution

The frequency distribution of canopy density for both types of data is shown in Figure 1, and the canopy densities are summarized as follows. Among the 21 stations:

13. The densiometer data are consistently larger than the wide angle lens data, on average by 20 percent (79% versus 59%).
14. While the wide angle lens data cover the entire range from 10% (meadow station) to 90%, densiometer data range from 30% to more than 90%.
15. Among the densiometer data 62% of the station have closures greater than 70%, while among the wide angle lens data only 29% have densities greater than 70%, clearly the densiometer data are skewed towards the higher densities. In fact 43% have densities greater than 90%.

The canopy data are presented in Attachment D. For the purpose of this study wide angle lens canopy density data were used, though a brief comparison of using densiometer data was included.

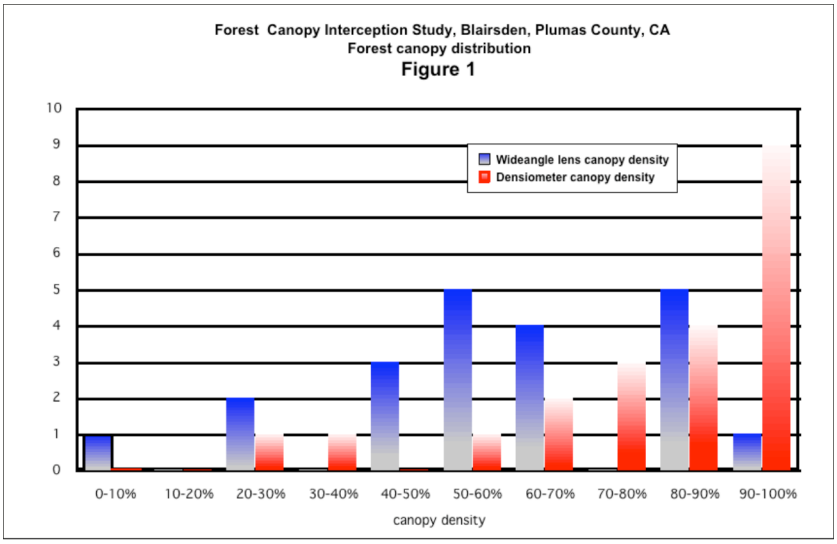
Precipitation measurements

Eight storms were monitored, beginning in the third week of December 2005 and ending in the last week of March 2006. During each storm, at each station depth of throughfall was captured in five-quart plastic buckets with 20 cm diameter top openings, placed on the forest floor.

Precipitation captured in each bucket was measured with a specially designed four inch diameter cylinder, within 24 hours past the end of the storm. Smaller volumes were measured with a glass graduated cylinder.

The depth of throughfall (precipitation) at each station was calculated from the volume of water captured and the top inside diameter of the 1 gallon bucket. Actual storm depth was approximated by measuring precipitation depth in a 5 gallon bucket placed amidst the meadow. However, these storm depth data are most likely too low, since its location violated the minimum distance-to-tree rule for a standard precipitation gage (30 degrees angle of elevation to nearest tree), and the canopy density measured here was 10%. In the absence of a better location the actual storm depths need to be compared with data collected at the nearby Mohawk Ranger Station.

Mohawk Ranger Station is located about five miles to the northwest, west of the town of Blairsden.



Isotope sample collection

More than 240 water samples were collected. Due to budget constraint no more than 170 were analyzed for the stable isotopes O-18 and deuterium. A breakdown by water source type is tabulated below.

Throughfall samples were collected after each storm from each station. Ground water samples were collected from a low discharge spring and a residential well. Stream water samples were collected from a seasonal stream at one location in the meadow. Several samples were also collected at one single location from forest floor runoff.

Water samples were collected in 40 ml glass vials with Teflon lined caps. Samples were shipped to UC Davis Isotope Lab for analysis of the environmental isotopes in water, deuterium and oxygen-18. Due to budget limitations samples from only four storms (out of eight) were submitted to the lab.

Soil core samples were collected from ten selected throughfall data collection stations at the end of the major precipitation season. Five cores are from the north and five from the south facing slope. Cores were collected from depths between 24 and 30 inches below surface in six-inch long, 1 _ inch diameter brass tubes. The tubes were sealed with plastic caps and electric tape and kept frozen until submitted to the lab.

Soil samples were processed at a special lab at Desert Research Institute (DRI) in Reno, NV, to extract soil moisture. Soil moisture extract samples were then sent to University of Nevada Isotope Lab for analysis of deuterium and oxygen-18.

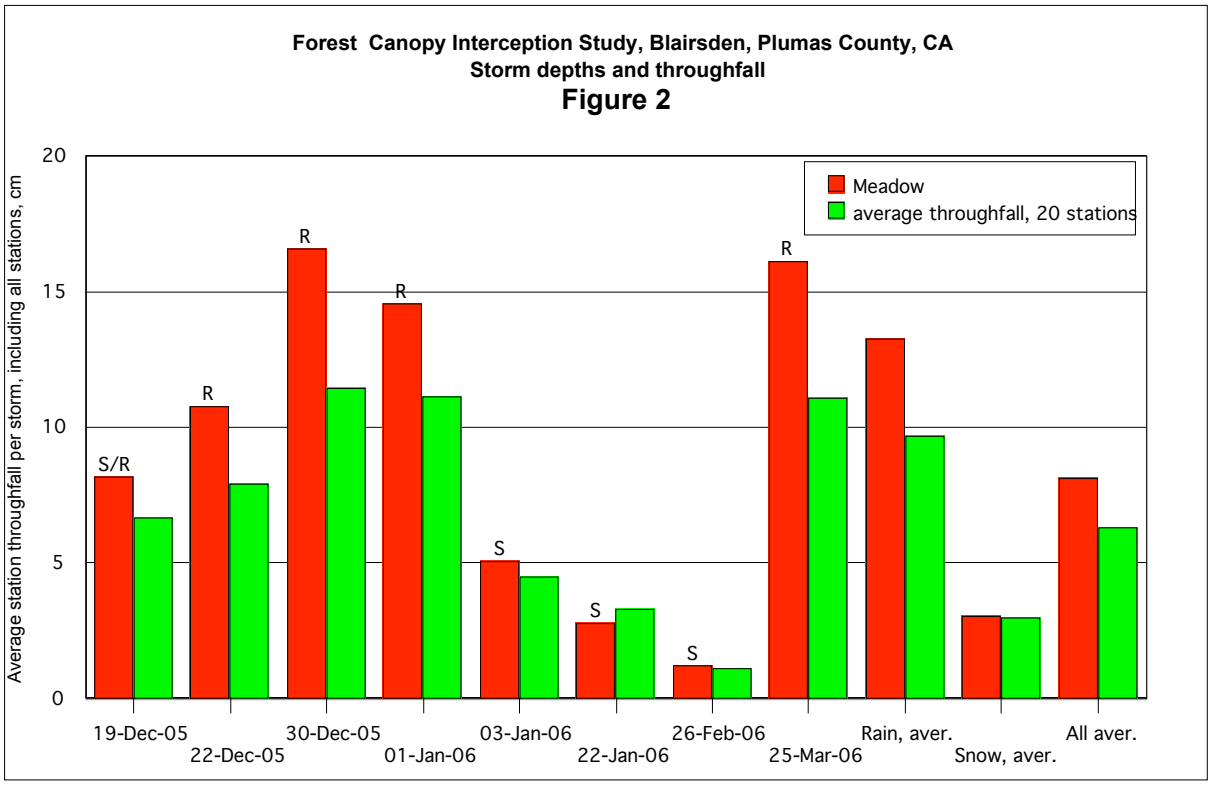
Table 1: Number of samples submitted for isotope lab analysis

throughfall & precipitation	101
ground water	16
stream flow & runoff	35
soil moisture	12
total	164
Total samples collected	244

Throughfall depth observations

Canopy density and depth of throughfall

Figure 2, - Storm depths and throughfall



1. This bar diagram compares each storm depth measured in the meadow (red) with the corresponding 20 station average forest throughfall depth (green).
2. The storms are plotted in the order of date at which they occurred, with the letters 'R' and 'S' denoting rain or snow.
    a. Four of these storms were predominantly rain storms, if not entirely rain. The other four storms are snow storms.
    b. Snow storm depth is significantly less than rain storm depth. Of the total 75.4 cm meadow precipitation, 77% are attributed to rain and 23% to snow. A similar pattern was observed in the 1995/96 study.
    c. Average throughfall depth is typically significantly less than storm depth due to canopy interception.
    d. The difference between meadow precipitation depth and average throughfall is significantly less in the snowstorms. In one storm throughfall depth was even greater than in the meadow. This is due to the nature of throughfall in snow storms (discussion below).

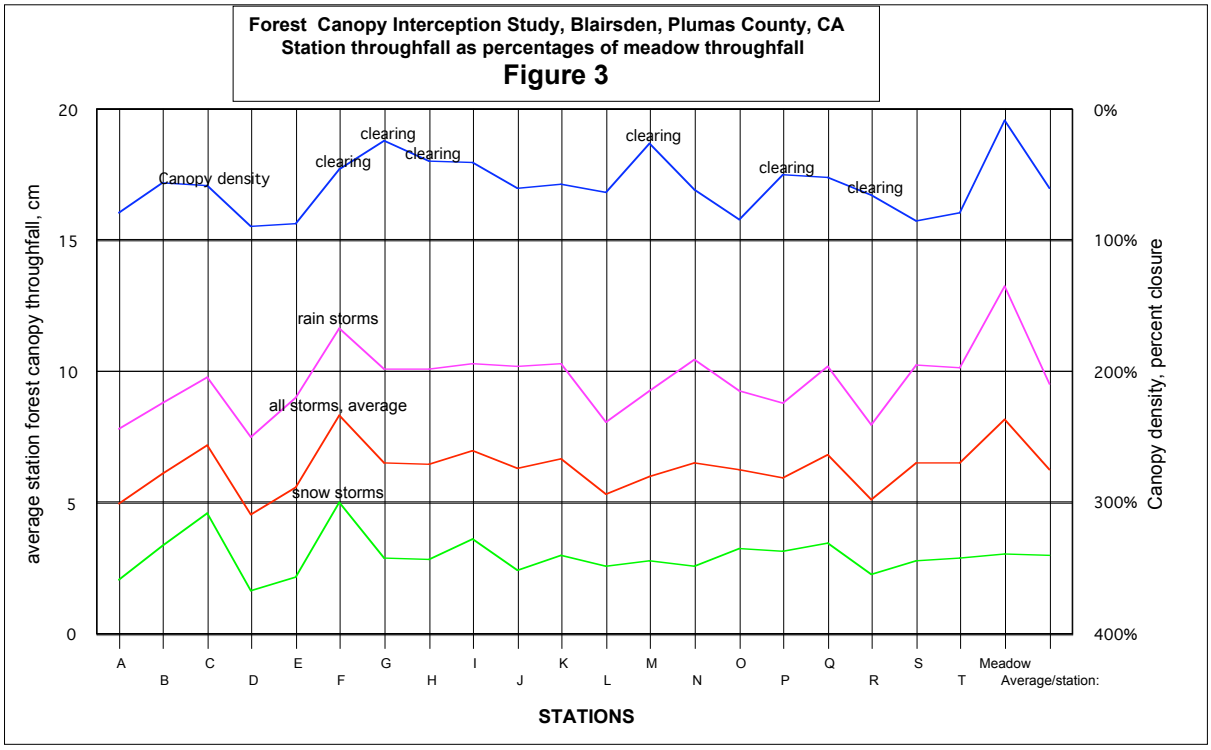
It should be noted that wet tree stems were observed only during very windy storm conditions, when wind was blowing the rain against the trunk for a long period of time. More importantly, when examining a typical pine tree, it can be seen that its branches are not particularly suited for inviting water to run from the branches towards the trunk ("stem"). This is different than in a typical deciduous tree. In pine trees excess water most likely drips off the branches before it can reach the trunk. This maybe one explanation for the observation made by Bosch and Hewlett (1982), stating that the impact of vegetation on the water budget is most significant in watersheds dominated by pine forests.

Evidently the amount of canopy interception is significant. The entire profile's mean station throughfall for

8 storms is 57.2 cm, which is 76% of the 75.4 cm measured in the meadow. In other words 24% of the total precipitation was returned to the atmosphere via evaporation from forest canopy.

Station throughfall compared to meadow throughfall

Figure 3, Station throughfall as percentages of meadow throughfall



1. In this figure average throughfall depth at each station is compared to tree canopy density. To facilitate an easier visual comparison, the canopy density axis is inverted on the right.
    a. The throughfall station averages are shown as percentages of open meadow precipitation.
    b. The stations are arranged roughly as in the order in the forest. Three data sets are compared:
        i. Green - averages of snow storms.
        ii. Purple - averages of rain storms.
        iii. Blue - percent canopy density
2. The throughfall data profiles of both storm types mimic the canopy profile to about more than 75%. However, the rain storm profile mimics the canopy profile far better than the snow storm profile.
    a. The rain storm station averages are greater than the snow storm percentages.
    b. In about 25% of the stations snow storm throughfall depth exceeds open meadow precipitation.
    c. Since the rain storm profile in these data correlates far better with the canopy profile, apparently the effect of canopy interception increases with storm depth.
3. Some stations however, consistently deviate from the patterns;
    a. Stations associated with forest clearings (G, H, M, P, R) received less throughfall than would be expected under given canopy density.
    b. Station F, on the other hand was affected by stem flow, moisture dropping from a branch, as observed in-situ.
    c. Evidently stations associated with forest clearings constitute a sub population of data.

Discussion

Correlation between throughfall depth and percent open sky is convincing for some stations, and less convincing, if not absent in others. It is possible that these correlations will improve when canopy aspect is brought into play, or a wider canopy perimeter is included.

Variation in average throughfall is significant. Compared to meadow precipitation, snow storms range from 65% to 157% and rain storms range from 54% to 84%. Canopy density ranges from 10% to more than 90%. Evidently in the rain storms the correlation between throughfall and canopy density is much better than in snow storms.

When looking at individual storms, the relations are by far not as convincing, although the effect of canopy interception remains evident in each storm. To make things more complicated, the data scatter significantly from storm to storm, although the variance of throughfall does not increase with storm depth. This is to be expected, and the various factors that may give rise to this variance are discussed later in this report.

When looking at all stations correlation between canopy density and throughfall is very poor in both storm types. However the correlation constants (R-square) for the total throughfall values improve significantly when only stations from high density forest stands are included, without clearings. Though still not very good, the correlation is best when comparing throughfall with densiometer canopy densities, instead of wide angle lens densities (Attachment D).

One important further step would be non-parametric testing of correlation (Spearman's rank correlation) to verify increasing canopy interception with storm depth. In other words a good linear relationship can not be established probably due to other confounding factors (aspect, tree sizes, species, storm direction, wind strength, etc.)

General observations about canopy interception

Canopy interception is hypothesized as precipitation retained in the canopy and at least partially evaporated before dripping to the ground. Since the rain storm profile mimics the open sky profile reasonably well this model seems to apply to rainstorms. However, this is far less so in snow storms. Why this is so can only be speculated on at this time.

One likely possibility is that snow is better retained in the tree canopy. When the air temperature remains at or below freezing the only way moisture can return to the atmosphere is by sublimation. This does not result in isotope enrichment. If on the other hand air temperature increases after a snow storm snow struts melting, partially evaporates, and then drips to the ground.

On the other hand when the amount of snow in parts of the canopy is excessive it may slide off in large chunks, depending on tree type and size. It can be envisioned that the amount of throughfall released under such conditions can be much larger than the steady throughfall seen in rain storms.

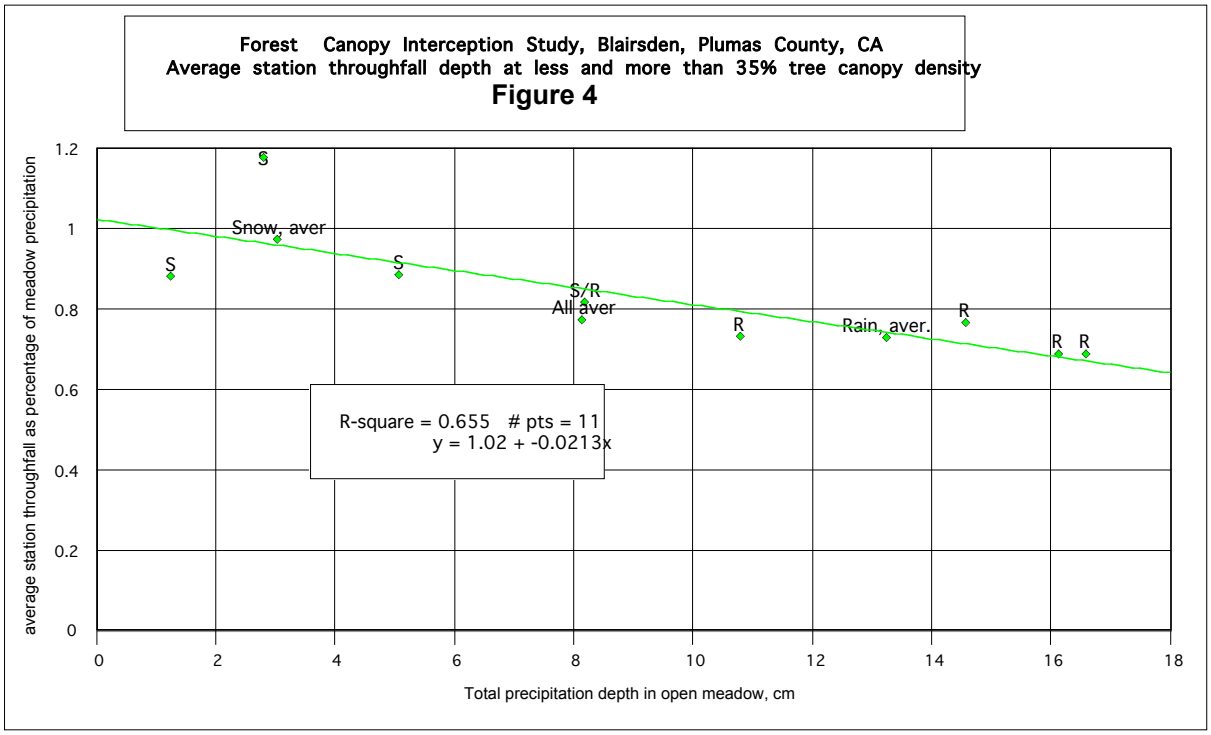
Another possibility is air turbulence affected by localized tree/canopy arrangements (aerodynamic effect). Snow flakes are much more susceptible to turbulence than rain drops. These possibilities can be further examined visually by watching the process in the forest.

These factors can serve as a possible explanation why the effect of canopy interception is minimal during small storms, but it increases during large storms.

The December 22 storm throughfall samples do not display the elongated patterns seen in the other storms. This is probably due to the samples being collected too early, before canopy evaporation and simultaneous drip-through could come into effect.

Evidently, it can be seen that these confounding factors make for poor correlations between canopy density and throughfall depth. On the other hand correlation may improve with larger data populations, if not larger diameter canopy densities.

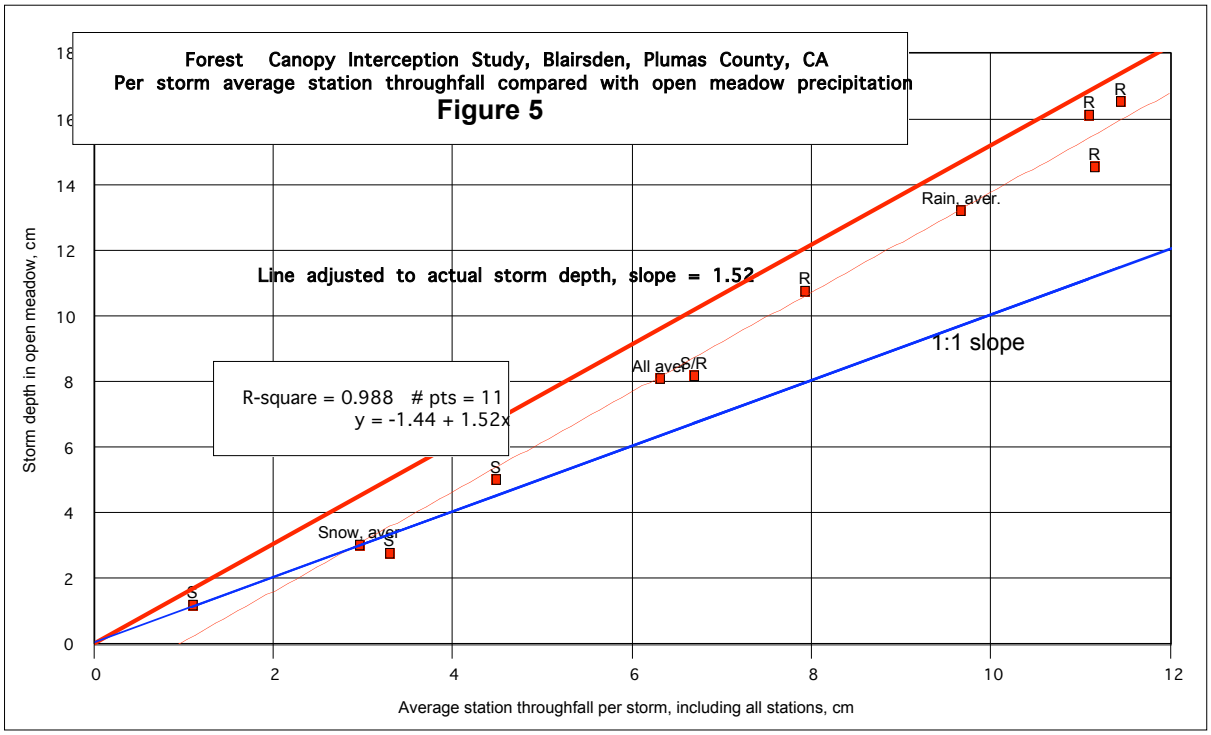
Figure 4, Dependency of average station throughfall percentage on storm depth



1. This diagram compares average station throughfall (percent of open meadow) with meadow storm depth.
   a. Total precipitation measured per storm in the open meadow is plotted on the horizontal axis (x-axis).
   b. Average station throughfall per storm (green) expressed as percentage of open meadow precipitation is plotted on the left vertical axis (y-axis). Rain (R) and snow (S) storm types are indicated next to each plotting position
2. Average station throughfall per storm (green) expressed as percentage of open meadow precipitation is a measure of canopy interception representing an approximate 'areal average':
   a. Average station throughfall is almost 100% below 3 cm total storm depth. On the other hand, it decreases down to about 65% at a storm depth of 17 cm.
   b. In other words, according to these data, the effect of canopy interception is minimal during small storms, but it increases during large storms (which seems counterintuitive).
   c. The degree to which canopy interception becomes effective is specific for this forest section and can be quantified by the slope of the green line. Although the correlation coefficient is only 0.65, looking at this diagram the correlation is convincing.

Average station throughfall dependent on storm depth

Figure 5, Average station throughfall compared with open meadow precipitation



1. Actual storm depth in the meadow is compared to average station throughfall depth, measured in cm. Storm types are indicated together with storm date (end of storm).
    a. The linear correlation is remarkably good as indicated in the correlation coefficient R-square of 0.988. The regression equation is not affected by including snow, rain and all storm averages, as indicated.
    b. The slope of the line is 1.52 (greater than a 1:1 slope). In other words, compared to open meadow precipitation, the forest canopy interception effect diminishes the original storm depth on the average by 34% (1 - 1/1.52 = 34%).
2. The line's y-intercept is negative (-1.44), suggesting that at zero cm storm depth throughfall depth is still about 1 cm. This is of course contradictory, since throughfall should be zero at zero storm depth. The reason is that the meadow precipitation depth data are slightly diminished by canopy interception.
    a. The meadow station canopy density is not zero, but 10% (305 densiometer value).
    b. The meadow station does not qualify as a rain gauging station since obstacles (trees) are reaching above the 30 degree angle of elevation line. .
3. A preliminary comparison of the meadow precipitation data with rain gauge data collected at the Mohawk Ranger Station led to conclude that actual storm depth were higher than actually measured in the meadow. Consequently the line was redrawn by shifting it upwards by the interval 1.44. Thereby the meadow values (vertical axis) increase, reflecting actual storm depth as it would be measured in a precipitation gauge.

Discussion

The slope of the line in Figure 5 is expected to increase above 1:1 the greater the average canopy contrast between the two groups. In this case average canopy density of the 20 stations is 62%. It is worth examining the relation between total throughfall depth per season and average station canopy density.

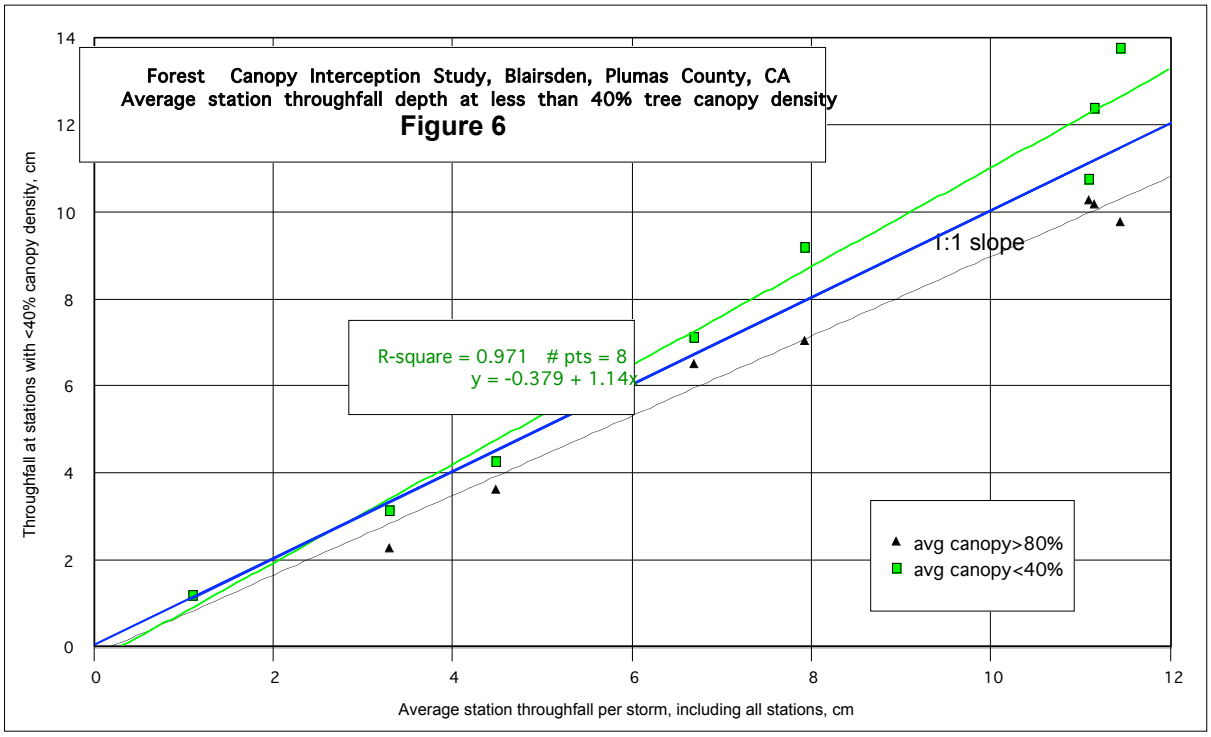
Compared to open meadow precipitation, the forest canopy interception effect is significant, reducing the original storm depth on the average by more than 30%. For example in a 15 cm storm, canopy throughfall

is reduced to 10 cm. This is comparable to what is reported in the literature.

To be clear, the purpose of this discussion is not to advocate the utility of complete forest removal for water resources management. The hydrologic benefit of watershed management is best measured in terms of long term self-sustaining ecological health of a watershed. Nevertheless, this explains the observation made by some researchers why spring flow often increases after a major fire (references?). It also suggest the plausibility of forest canopy thinning increasing the water balance.

It should also be kept in mind that during winter when most ground water recharge occurs, water loss from dormant vegetation is probably minimal. Nevertheless it should be clarified to what extent forest vegetation can survive in the uplands where depth to ground water exceeds rooting depth, only on soil moisture left after infiltration.

Figure 6, Average station throughfall at less and more than 35% tree canopy density



1. This diagram examines a hypothetical scenario, assuming a reduction of canopy thickness to less-or-equal-to 40% (forest thinning scenario). Data are plotted for the 8 storms only.
   a. Average station throughfall per storm including all 21 stations is plotted on the x-axis. This represents average throughfall in the forest under current conditions. In this case the average canopy density is 62%, ranging from 10% to 91%.
   b. On the y-axis are plotted station average throughfall per storm (blue) only for those stations with canopy density less than 40%. This includes only four stations with an average canopy thickness of 29%. All four stations are also included in the group plotted on the x-axis.
   c. As expected, under these conditions the linear regression line slope is greater than 1, i.e. 1.14, with a very high correlation coefficient R-square = 0.98.
2. With an R-square value of 0.98 the linear correlation is convincing:
   a. Since the slope is greater than 1.0, again the effect of canopy interception is evident.
   b. The line intercepts the y-axis at -0.38, although it is expected to be zero. Compared to the -1.44 cm value in Figure 5, this discrepancy is negligible, maybe since the lower section of the line is unduly affected by the snow storms, where the effect of canopy interception appears to be less than in rainstorms.
3. With the regression line y-axis intercept at zero, in the stations with canopy density less than 40% canopy density, throughfall is increased by 14%, compared to the totality of stations in this data set. When the regression line is forced through the origin the slope is diminished to 1.11. In other words by thinning a forest canopy interception can be reduced significantly. For example in a 10 cm storm, canopy throughfall can be increased by about 1 to 1.5 cm.
4. For comparison data are also plotted for stations with canopy density greater than 80% (black). Average canopy density for these five stations is 87%.
   a. Average station throughfall for the >80% canopy density group is significantly less compared to the average of all stations. For example for an all inclusive station average of 11 cm, for a greater than 80% canopy density station average is only 10 cm.
   b. Under these conditions the linear correlation line slope is only 0.92 (less than 1.00), with a very high correlation coefficient R-square = 0.99.

Discussion

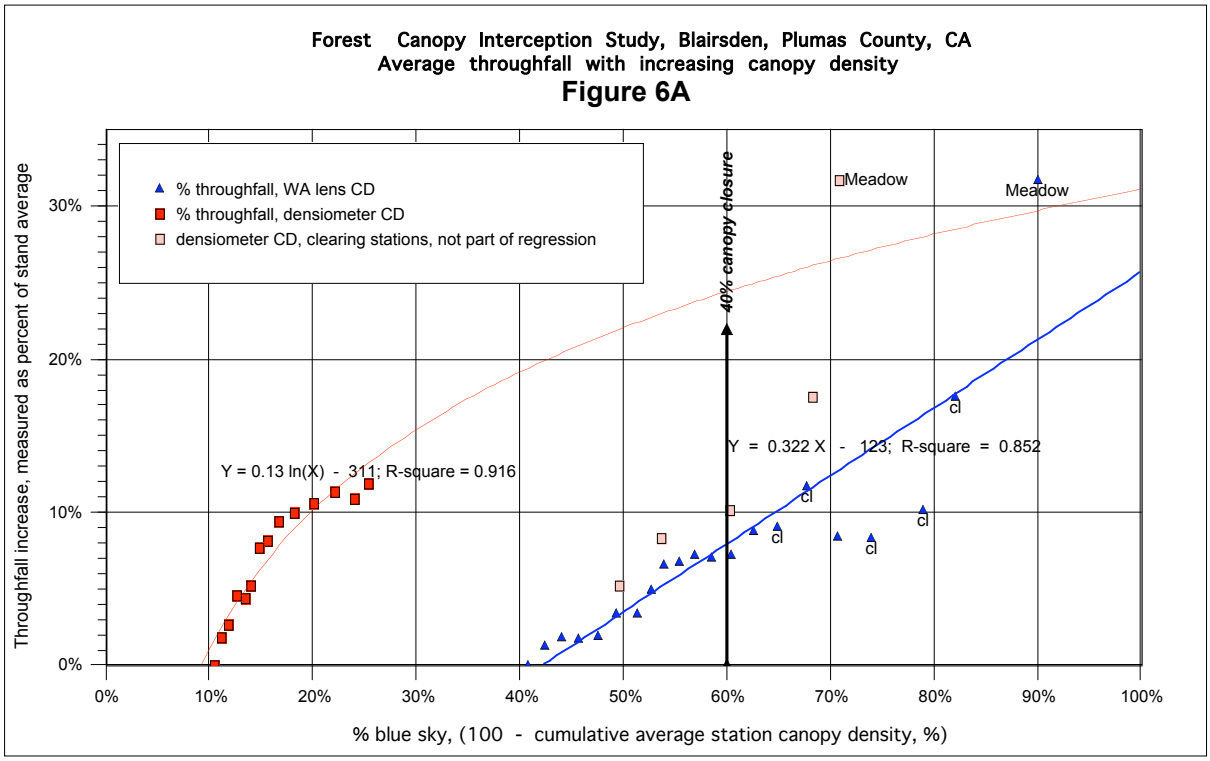
Again, this line is representative for the stations selected herein. Contrasted here are an average canopy density of 29% (thinned) with 62% (not thinned) to explore possible methods to collect and study larger data sets, sets that are statistically more representative.

Cumulative average throughfall estimates

In the preceding section it was demonstrated that reduced canopy closure in a forest stand can significantly increase the amount throughfall reaching the soil. In this case it was assumed all stations' canopy density was reduced to less than one particular threshold, i.e. less-equal than 40%.

The same concept can be expanded by estimating the amount of throughfall increase when the average canopy closure decreases. This will establish a continuous curve that relates closure to throughfall. Nevertheless, it would be interesting to see the impact of an entire range of possible canopy reduction scenarios. For that purpose the stations were rearranged in the order decreasing canopy density. Throughfall and canopy closure was then calculated as an average of stations, including more and more stations while the average canopy density decreases. Correspondingly throughfall is expected to increase.

In Figure 6A the results were plotted in blue for the wide angle lens canopy densities. To ease the regression instead of canopy density the canopy opening percentage was plotted on the x-axis. The blue data suggests a linear trend and the regression equation is given. However a few stations deviate significantly often suggesting they receive less throughfall than expected from the trend of the bulk of the remaining stations. Again, this supports the previously made observation that the stations in forest clearings are a different data population.



Although the remaining data analysis discussed in this report is based on the wide angle lens canopy closure data, it deemed prudent to conduct a similar comparison based on canopy closure data measured with a densiometer - plotted in red. Different than done previously, the stations located in or adjacent to clearings were not included in the regression analysis. The best fit suggests a logarithmic relation, and the regression coefficient R2 of 0.916 is even better than in the wide angle lens data.

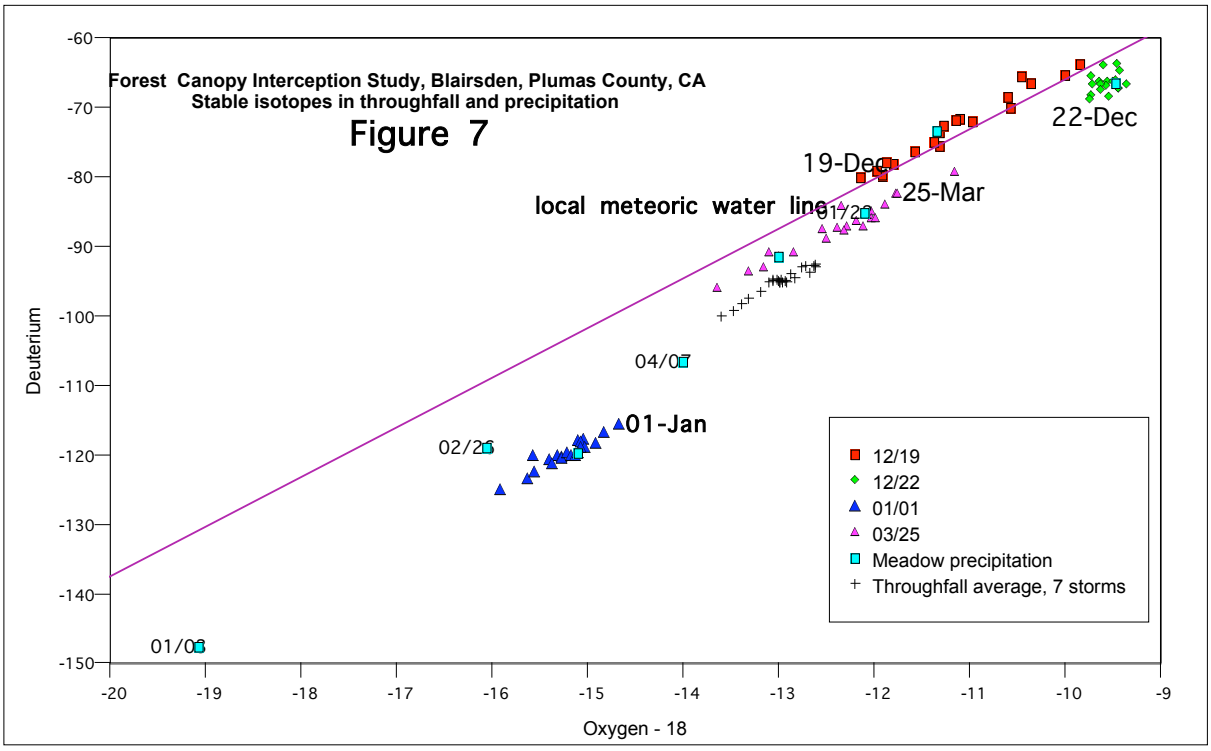
The two curves derived from the regression can be used to estimate the increase if the average canopy

closure was decreased to 40% (60% canopy opening, blue sky). Based on the wide angle lens data the increase would be about 8%. Estimating the increase based on the densiometer data may be somewhat tenuous without data that cover that range. Nevertheless, it is encouraging to see that the projection of the regression equation is bracketed by the meadow data. Most likely then under canopy density reduction to 40% the throughfall increase could be more than 20%.

Stable isotopes deuterium and O-18 in throughfall

Storm isotope signatures

Figure 7, stable isotopes in throughfall by storm



1. This is a standard plot depicting the isotopes of oxygen-18 (x-axis) and deuterium (y-axis). The local meteoric water line (LMWL) serves as a reference line. It is a regression of snow isotope data collected in American Valley, Last Chance watershed and elsewhere in the region.
2. The plot includes the major 8 storms for which station data were collected, plus a number of minor storms. Isotope composition varied considerably from storm to storm, probably depending on the storm path preceding arrival at this site.
    a. Station throughfall data were plotted, for the four storms for which samples were submitted for lab analysis. These storms comprise 66% of the total precipitation depth collected for this project.
    b. Meadow precipitation for the remaining storms is plotted in light blue, comprising the remaining 36% of the total precipitation of that season.
    c. Average station throughfall for the measured storms (plotted as black '+') was calculated like a mixture, weighted by each station's throughfall depth:

        Cmix = (C1xT1 + C2xT2 + ... + CixTi)/(T1 + T2 + ... + Ti), were 'C' and 'T' are isotope composition and throughfall depth for each storm, and 'i' is the number of storms.
3. Effect of canopy interception:
    a. With one exception, as expected all storms display elongated patterns, suggesting the effect of canopy evaporation. Evaporation results in the O-18 and deuterium composition shifting to the upper right.
    b. The O-18 and deuterium shifts of up to 2.5 and 16 per mil are parallel to the LMWL s expected for evaporation under cold conditions.
    c. The December 22 storm throughfall samples do not display the elongated patterns seen in the other storms. This is probably due to the samples being collected too early, before

canopy evaporation and simultaneous drip-through could come into effect. This will be further discussed later in this report.

d. Unexpectedly meadow precipitation samples (blue) never plot at the lower left of each respective group. This could be due to several reasons (see further discussion below).

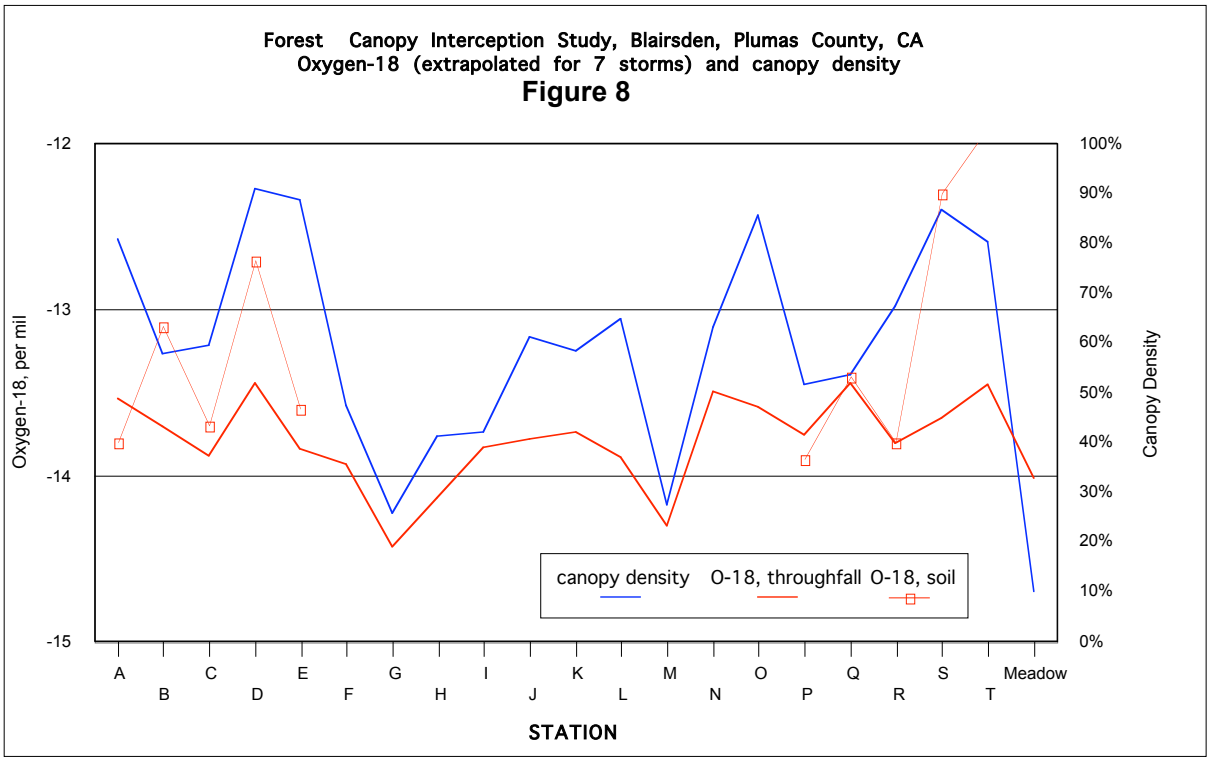
e. Also plotted are the per station mixtures. (Black crosses - '+'). The values were calculated by weighing each isotope value by their respective station throughfall depth for each storm.

Discussion

The meadow samples do not plot in the lower left end of each storm group. Since the meadow has the lowest canopy density one would expect the least amount of evaporation and hence the least enrichment. The reason for this contradiction maybe found in one or several factors, such as aspect, too small canopy perimeter measured aerodynamics in clearings, etc.

Isotopes in throughfall correlating with canopy density

Figure 8, O-18 and canopy density



1. Shown in Figure 8 and Figure 9 are oxygen-18 and deuterium of throughfall and soils, compared with canopy density. The stations are arranged roughly in the order as they are arranged spatially in the forest.
   a. The plotted isotope values are the extrapolated station averages for seven storms (see discussion below).
   b. The storm of 22-Dec was not included since in it no correlation between isotope values and canopy density can be recognized (probably due to sampling too early after storm ended).
2. The throughfall isotope "profiles" closely mimic the canopy density profile, which is a strong indication that throughfall isotope composition is affected by canopy interception. The isotope values increase upwards in response to evaporation (enrichment).
3. Also shown are isotope values measured in soil cores collected at ten selected stations.

a. Soil oxygen-18 profiles mimic the throughfall isotope profiles reasonably well, suggesting that throughfall measured indeed is representative of ground water recharge.

b. On the other hand, significant deviations in the deuterium data maybe due to evaporation of soil moisture, since the cores were taken too late in the season July 2006).

c. Deviations may also be related to problems with sampling technique (stations S and T).

Discussion

The apparent correlation between canopy and isotope enrichment is not always as expected. For example, unexpectedly, the meadow station which has the lowest canopy density does not have the lowest O-18 and deuterium. Correspondingly the highest O-18 and deuterium values do not match up with the largest canopy density value. One reason could be that the effective canopy perimeter determining throughfall characteristics in some stations may be much larger than what was measured.

The soil moisture isotope values are deemed the most dependable indicator of throughfall isotope composition. Soil values mimic the throughfall values consistently, but they are higher in most stations. This is probably not due to sampling error, since great care was exercised while handling the cores in the field. Possible reasons could be:

a. At the time (May 2006) when the cores were taken at some stations soil moisture was at field capacity and affected by evaporation in the unsaturated zone (i.e. Sampled too late in the year).

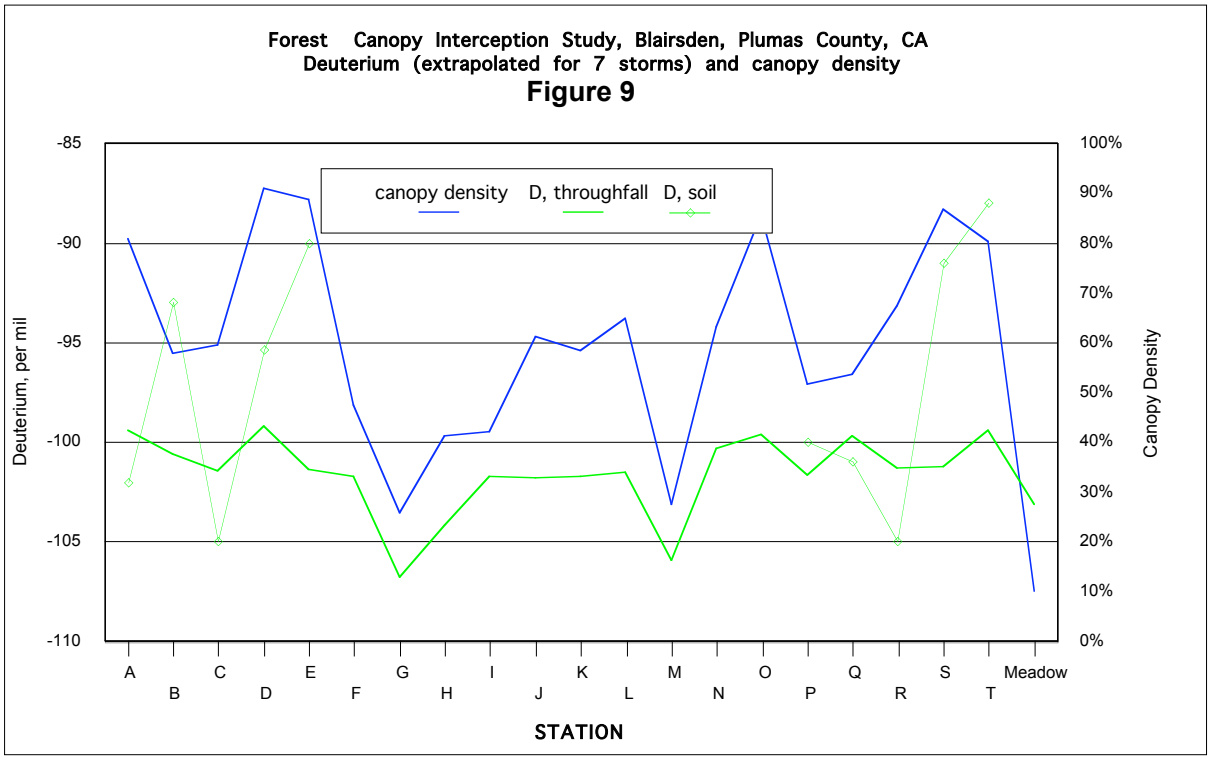
b. Some stations soil moisture was affected by lateral moisture migration, following soil stratification downhill.

c. The estimated throughfall station averages are significantly off since at least the December 22 storm data could not be included.

Since soil moisture is still deemed the most reliable indicator of throughfall isotope composition alternative ways are needed. For that purpose in February 2007 one pint plastic cups filled with clean sand and _ inch PVC access sampling tubes were installed at stations A through D. So far no soil moisture samples have been recovered from these.

Another solution could be sampling woody tissue in nearby trees.

Figure 9, Deuterium and canopy density



Evaluating effects of forest canopy changes on isotope signature

In the following the seasonal average isotope signature is estimated as it is a combination of individual storm depth and individual station isotope signal. Essentially the estimate constitutes a mixing calculation.

Effects on individual storm throughfall depth

The linear relationships identified in Figure 5 and Figure 6 are very useful to test to what extent a reduced canopy density may increase the amount of moisture reaching the forest floor. As noted earlier, canopy interception (reduction of throughfall) increases with storm depth. Hence any such estimates need to take the long term seasonal storm depth distribution into account.

Thereby, knowing storm depth, one can estimate the amount of throughfall, using the linear equation Y = aX + b in Figure 5. The estimated throughfall depth can then be plugged into the linear equation derived from Figure 6, assuming the forest canopy has been thinned to less-than-or-equal-to 40%.

The methodology is demonstrated in Table 2. Using the measured average throughfall values for each storm, the throughfall under reduced canopy density was estimated, using the equation

$$Y = 1.14\ X\ -\ 0.38,$$

Where X is the all-station average throughfall depth for a particular storm and Y is the estimated throughfall average for only those stations with less than 40% canopy density (average canopy density for the 4 stations included is 29%). Based on this approach the estimated throughfall would have increased from 57.2 cm to 61.8 cm. This is an increase of 9%.

Probably this estimate is conservatively low, since the line implied in the above equation should pass through the origin (at zero storm depth throughfall depth is nil). Although thereby the slope ‘a’ may diminish somewhat the constant ‘b’ should be zero which increases the estimate.

It should be noted that this approach implies two caveats:

1. The constants ‘a’ and ‘b’ in the aforementioned linear equations apply to that particular set of stations used in this study, where ‘a’ is the slope and ‘b’ is the y-axis intercept. To come up with a data set that is applicable for an entire area proposed for thinning, one may have to apply more sophisticated canopy data collection and analysis (for example geostatistics, Kriging, remote sensing).
2. The estimated increase in throughfall applies to the storm pattern observed in this data set. For a more comprehensive analysis one would have to estimate the same effect for the typical long term storm depth distribution for this location or nearby areas. This can be accomplished by using precipitation data from the nearest precipitation gauging station (in this case Mohawk Ranger Station).

Admittedly this analysis applies to a limited data set, but it characterizes the nature of throughfall data and points to methods that can be applied to more comprehensive and larger data sets.

Average station throughfall isotope composition

The isotope data as measured for throughfall at each station are tabulated in attachment B. A summary of the data is given in Table 3 below. Station average isotope values are given for three storms, i.e. those for which complete suites of station samples were analyzed. Calculation procedures are explained in Attachment C.

As expected, the station averages vary significantly. The data were evaluated in a fashion similar to the throughfall depth data, by comparing the average of all stations with the average of those stations with less than 40% canopy density. The December 22 storm was not included since its samples show virtually no impact from canopy interception due to timing of sampling (see discussion above).

As can be seen in the table, the shift in isotope composition is noticeable (row 7 & 8, Table 3). As expected, the shift is towards less enrichment (less evaporation). However the shift is inconsistent, between storms, though it is tempting to correlate the magnitude of the shifts with storm depth. The inconsistencies probably need to be attributed to the fact that snow and rain storms are put together here.

The average isotope composition for each station was then derived by weighing each station’s isotope value by its respective throughfall depth for each storm. Thereby a seasonal average was derived for

each station, which is actually a quasi-seasonal mixing value for each station after 3 storms.

Average station throughfall was calculated like a mixture, weighted by each station's throughfall depth:

Cmix = (C1xT1 + C2xT2 + ... + CixTi)/(T1 + T2 + ... + Ti),

Were 'C' and 'T' are isotope composition and throughfall depth for each storm, and 'i' is the number of storms. The signature for the entire season's storms was then recalculated by adjusting the values with the remaining meadow isotope values (weighted by storm depth).

Table 2. Estimated throughfall depth per storm under reduced canopy density

(canopy densities measured from wide angle lens photos)

	avg canopy density	19-Dec 2005	22-Dec 2005	30-Dec 2005	01-Jan 2006	03-Jan 2006	22-Jan 2006	26-Feb 2006	25-Mar 2006	Rain, aver.	Snow, aver.	All aver.	Total Throughfall
Storm type		S/R	Rain	Rain	Rain	Snow	Snow	Snow	Rain				
All station aver. Throughfall, cm	62%	6.7	7.9	11.4	11.2	4.5	3.3	1.1	11.1	9.7	3.0	6.3	57.2
Estimated throughfall increase under reduced canopy density, cm:													
			Assumed station canopy density is less-or-equal 41%										
	equation y = ax + b, see Figure 6							a = 1.14		b = -0.38			
All station avg., cm		7.26	8.65	12.66	12.34	4.73	3.39	0.87	12.27		Total, cm:		61.8
Increased by:		8%	9%	11%	11%	6%	2%	-21%	11%				40%
		Estimated throughfall increase for the season:											9%

Since the four storms include only 66% of the season's total precipitation depth, the preceding values are not necessarily representative of stream and ground water derived from this section of the forested watershed. For that reason the available additional 4 meadow isotope values and their respective storm depths were used to extrapolate a seasonal station mixture of isotope values. The 8th meadow sample, representing about 22% of the season's precipitation, was lost when the glass vial broke. Unfortunately this leaves an uncertainty in the extrapolation of the seasonal throughfall isotope signature.

Although these estimates are based on a limited data set they nevertheless suggest that using isotopes to measure the impact of forest canopy changes on baseflow is feasible. If indeed the average isotope shifts are significantly larger than the lab measurement precision (as indicated in the last two rows of Table 3), then a strategic sampling program of springs and baseflow may very well accomplish this.

A station average was also derived for the soil data (only 10 stations). Since each station's soil moisture composition is already a seasonal integrated signal, the aerial soil water signal is approximated by the soil water average. These values can be compared with local ground and stream waters to arrive at a determination to what extent these are determined by the forest canopy characteristics, and the changes imparted on the same.

For comparison, the data are plotted in Figure 10, together with ground and stream waters.

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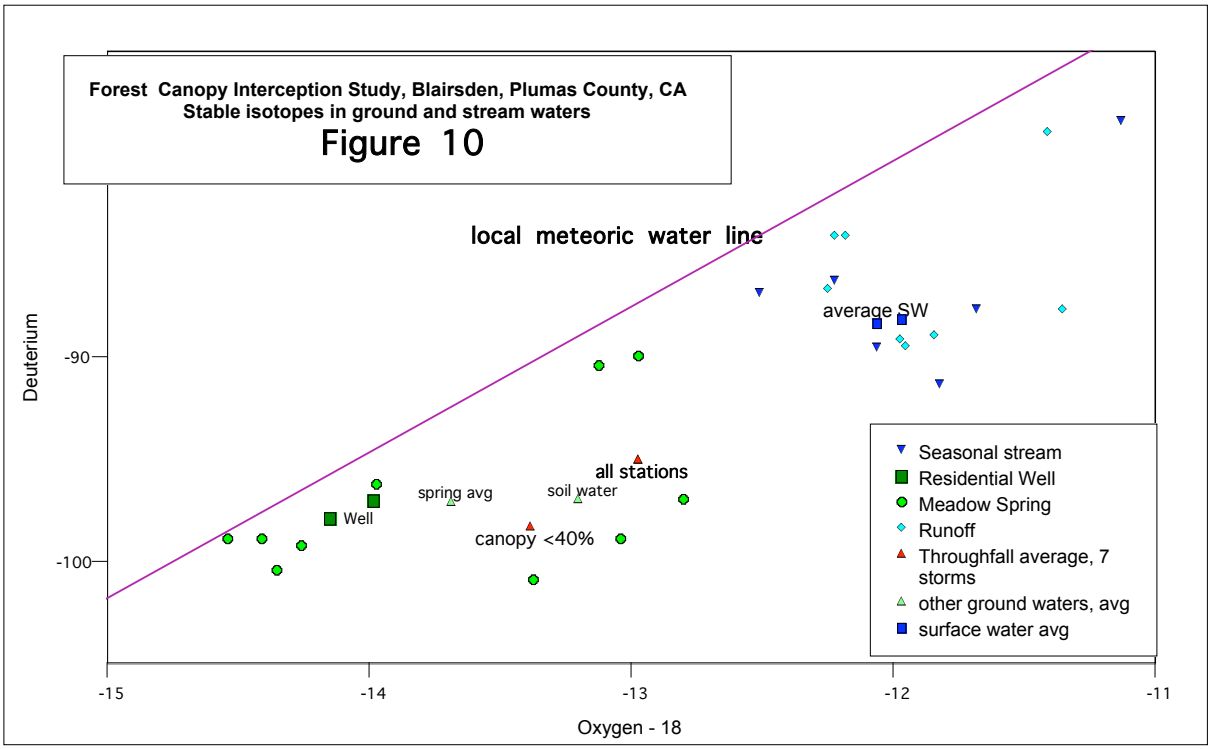
Table 3: Throughfall isotope data summary

Measured storms									
	19-Dec	01-Jan	25-Mar			19-Dec	01-Jan	25-Mar	
storm depth, cm	8.2	14.6	16.1			8.2	14.6	16.1	
Storm type - % of total:	Snow	Rain	Rain			11%	19%	21%	
	Oxygen-18, per mil:					**Deuterium, per mil:**			
average all stations	**-11.2**	**-15.2**	**-12.4**			**-73.0**	**-119.7**	**-87.4**	
Station avg CD<40%	**-11.6**	**-15.3**	**-13.2**			**-75.8**	**-121.0**	**-92.7**	
Isotope shift, per mil	0.39	0.13	0.76			2.79	1.23	5.30	
Station averages for entire season, weighted by storm depth:									
	Season average, 3 storms measured:			**Extrapolated, 7 storm average:**			**Soil water, 10 station average:**		
	O-18, per mil	D, per mil		O-18, per mil	D, per mil		O-18, per mil	D, per mil	
Storm dates included	19-Dec, 01-Jan, 25-Mar			19-Dec, 01-Jan, 25-Mar, 22-Dec, 03-Jan, 22-Jan, 26-Feb					
all station avg	**-13.2**	**-96.7**		**-13.0**	**-94.9**		**-13.2**	**-96.9**	
canopy <40% avg	**-13.6**	**-100.0**		**-13.4**	**-98.3**				
Isotope shift, per mil	0.4	3.4		0.4	3.4				
Lab measurement precision, per mil	+/- 0.05	+/- 1.0							

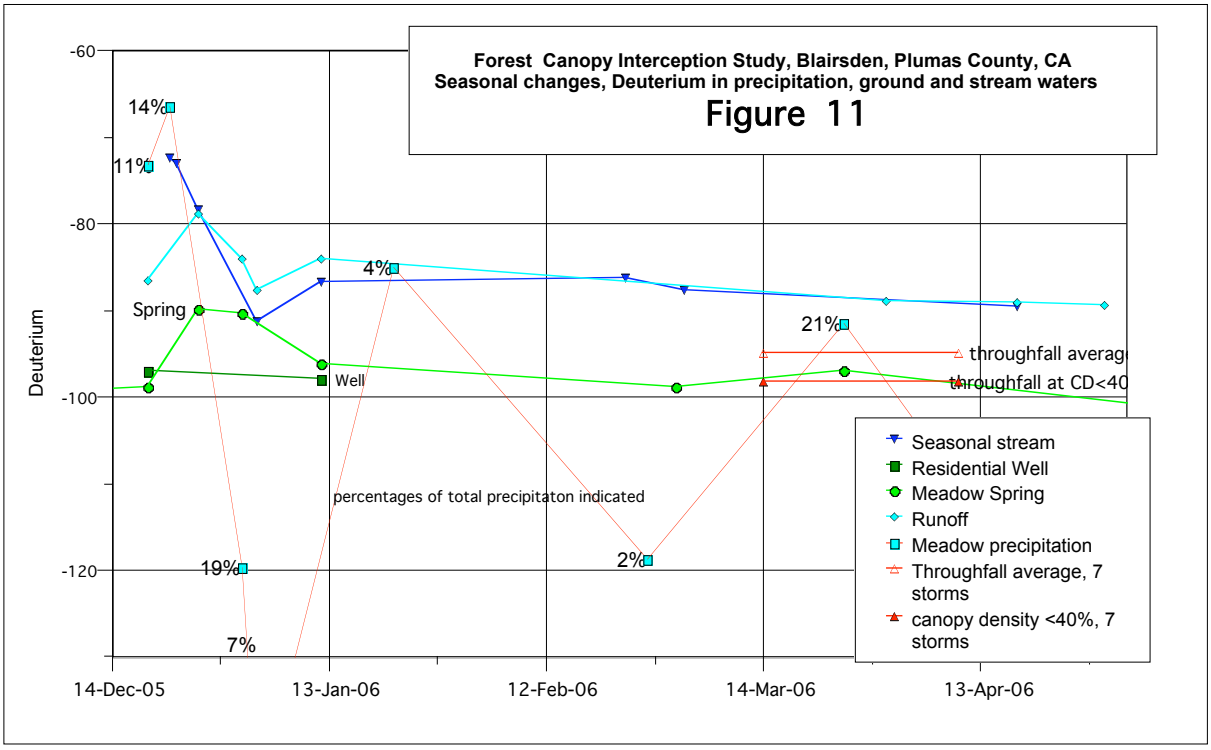
Isotope composition of stream and ground water

Figure 10, Stable isotopes in ground and stream waters



1. This is a standard isotope plot of ground water, runoff and average throughfall.
   a. Throughfall and precipitation data are plotted in red.
   b. Ground water data are plotted in green.
   c. Stream and runoff data are plotted in blue.
2. The ground waters and throughfall data plot in the same range, suggesting a link between throughfall and ground water recharge.
   a. The soil water average is almost the same as the three-storm station average, and differs from the seven storms extrapolated average.
3. Stream and ground waters make two distinct groups, each with a wide range. Although the significant scatter may suggest no systematic trends, nevertheless, as can be seen in the next diagram, the data are subject to systematic seasonal changes in response to precipitation,.

Figure 11 - Seasonal changes, deuterium in precipitation, ground and stream waters



1. This diagram shows the connection between precipitation events, throughfall, stream water and ground water. Shown here are the changes of deuterium over time.
2. Storm precipitation data collected in the meadow are plotted in red. Ground water data are plotted in green. Stream and runoff data are plotted in blue.
    a. Storm deuterium fluctuates most widely early in the season,. The fluctuations diminish later in the year. Each storm's depth is indicated in percentages of the total for all eight storms.
    b. Early in the season both ground and surface water changes mimic the storms, however, the response is significantly dampened. Over the long range stream and ground water composition remains much more stable.
    c. Runoff from the forest floor and the seasonal stream are almost identical, indicating the immediate influence of precipitation.
    d. Response by surface water bodies to precipitation would be expected to result in isotope fluctuations of a similar range as in the concurrent storms. But since stream water is also affected by ground water the impact of precipitation in a stream is only muted.
    e. More so, ground water responses are much more muted due to mixing in a larger reservoir (shallow aquifer). Nevertheless these data are a strong indication of how precipitation enters the stream channel: either as open meadow precipitation or throughfall into the soil, into ground water and then into the stream channel.

Discussion

The observations made in the previous two diagrams have useful implications for using isotopes to study stream response to forest canopy changes.

The long term average deuterium level in the spring is -99 per mil, and is the same as in the well. This increased up to -90 per mil after the first major storm, only to return to the long term average within 30 days. Presumably ground water composition is determined by the long term average recharge composition, in this case forest canopy throughfall.

The spring is perennial and is presumably fed by a larger aquifer system, probably the same as the well.

The long term average spring O-18 and deuterium is -13.82 and -99.16, which is significantly lower than the seasonal throughfall averages in Table 3. On the other hand, the stream and runoff averages are significantly higher. In other words:

1. The spring discharges a mixture of ambient ground water and new seasonal recharge. Given the large aquifer volume, the long term ground water composition is relatively stable (samples between March 2005 and June 2006), however, in the early storm season it is affected significantly by precipitation (infiltration).
2. Deuterium in the seasonal stream and runoff is for the most part also relatively constant around -89 per mil, except for the temporary increase early in the season. Presumably the stream channel is affected by ground water and due to its much smaller 'volume' its composition is much more susceptible to precipitation.

The estimated changed isotope composition for only those stations with less than 35% canopy density are plotted in Figure 10 and Figure 11. The observed 3 storm station average is indicated as a horizontal red line in Figure 11 (far left). As expected it fairly closely coincides with the average ground water composition. The observed deuterium from the stations less than 35% is shown as a purple horizontal line. To identify the effect canopy thinning to ground and stream water isotope signature would encompass to convincingly demonstrate a change of that magnitude in a spring, well or stream.

To accomplish this one would have to collect at least one years' worth of ground water and baseflow data before and after treatment. Since the estimated isotope shift is well outside the lab measurement error in Table 3, it is conceivable that the shift can be detected. In larger watersheds it may require more than one year's worth of post-thinning data due to greater subsurface water travel times. Hopefully, this can be demonstrated in ongoing thinning projects, if not areas affected by wildfires.

Recommendations for further research

While the data analysis conducted so far is adequate for the interim a number of further steps are beneficial:

1. Further data analysis:
    a. Storm depth data measured in the meadow are probably too low, and should be corrected via double-mass-plot using precipitation gauge data collected at the Mohawk Ranger Station.
    b. One important further step will be non-parametric statistical testing of correlation (Spearman's or Kendall's rank correlation) to verify increasing significance of canopy interception with storm depth.
    c. Lab analysis of the remaining four storm's throughfall samples is recommended since it may shed considerable light on the evaporation process during interception of snow.
    d. Sample and analyze tree tissue. Water in tree tissue is derived form the unsaturated zone that the tree's root tap into. In other words by obtaining isotope signatures from tree tissue at each station it is expected that thereby one can determine a long-term seasonal average for each station.
2. Further field data:
    a. Part of this watershed has been logged as part of fire safety thinning operation. It would be interesting to continue stream and ground water isotope data for pre- and post-logging comparison.
    b. Correspondingly an effort should be expended on collecting isotope data from stream and springs with capture zones under extensive thinning or burn areas. Considering that isotope data are comparatively cheap, most expenditure would be associated with traveling. On the other hand, automated samplers may significantly ease access problems during the winter.
    c. Identify improved means of determining canopy densities. Though the connection between canopy densities, throughfall depth and isotope enrichment has been established the confounding factors are not understood at this point.
3. Conduct a literature search. So far this work is in its entirety a field study. But the results need to be tied into other researchers' work by means of literature search.
4. The findings made in this study should be tested in other areas, preferably in areas slated for thinning projects, if not areas affected by wildfires.

Bibliography

Bohm, B., 1997: Precipitation Loss due to Tree Canopy Interception and Evaporation in a Pine Forest, Eastern Plumas County, California. Field Measurements and Data Analysis. Technical Summary Report prepared by Burkhard Bohm, Plumas Geo-Hydrology. July 26, 1997.

J.M. Bosch and J.D. Hewlett, 1982, a review of catchment experiments to determine the effect of vegetation changes on water yield and evapotranspiration. Journal of Hydrology, 55 (1982) 3-23, 3.

Attachment A: Measured throughfall depths

Canopy interception in a coniferous forest in eastern Plumas County, California

Throughfall data. Table entries are depths given in cm.

Date, sampling		19-Dec-05	22-Dec-05	30-Dec-05	01-Jan-06	03-Jan-06	22-Jan-06	26-Feb-06	25-Mar-06	Rain, aver.	Snow, aver	Total Throughfall	% meadow precip
	time	13:45	22:00	16:25	10:30	14:15	11:30	15:30	09:30				
Storm type:		S/R	R	R	R	S	S	S	R				
isotope data?		yes	yes	no	yes	no	no	no	yes				
	Can. density	TF, cm	TF, cm	TF, cm	TF, cm	TF, cm	TF, cm	TF, cm	TF, cm	TF, cm	TF, cm	TF, cm	
Storm depth of total		11%	14%	22%	19%	7%	4%	2%	21%	77%	23%	100%	
Meadow	10%	8.2	10.8	16.6	14.6	5.1	2.8	1.2	16.1	13.3	3.0	**75.4**	100%
G	26%	7.4	9.5	13.9	12.7	3.8	3.8	1.1	6.9	10.1	2.9	59.2	78%
M	27%	6.8	7.9	11.7	11.0	3.9	2.7	1.7	8.7	9.2	2.8	54.5	72%
H	41%	6.1	8.6	13.0	11.3	4.3	3.4	0.8	11.4	10.1	2.8	58.8	78%
I	42%	6.9	7.4	12.6	12.1	5.2	4.7	0.9	12.5	10.3	3.6	62.4	83%
F	47%	9.7	9.2	13.8	13.5	6.5	6.9	1.7	12.1	11.6	5.0	73.3	97%
P	52%	6.6	6.7	*9.0*	9.7	4.2	3.3	1.9	11.7	8.8	3.2	53.2	71%
Q	53%	5.9	8.7	*13.1*	11.0	5.2	4.3	0.8	12.1	10.2	3.4	61.2	81%
B	58%	5.0	7.6	10.1	10.3	3.9	5.4	0.7	11.1	8.8	3.4	54.1	72%
K	58%	5.9	8.8	13.0	11.9	4.8	3.9	0.3	11.9	10.3	3.0	60.5	80%
C	59%	8.6	***7.4***	10.1	12.4	9.4	2.8	1.6	10.4	9.8	4.6	62.6	83%
J	61%	7.0	8.8	12.5	11.9	4.1	2.4	0.7	10.8	10.2	2.4	58.2	77%
N	63%	7.2	9.6	12.0	12.1	4.7	2.4	0.6	11.3	10.4	2.6	59.8	79%
L	65%	4.9	6.2	9.3	8.2	3.2	3.6	0.8	11.6	8.0	2.5	47.8	63%
R	67%	6.1	6.0	8.4	8.4	3.4	2.1	1.2	10.9	8.0	2.2	46.6	62%
T	80%	5.8	8.0	*12.4*	12.2	4.2	3.4	1.0	12.1	10.1	2.9	59.2	78%
A	81%	5.9	6.1	8.2	8.9	2.9	1.7	1.5	10.0	7.8	2.0	45.2	60%
O	86%	6.7	7.9	10.4	10.9	3.8	4.5	1.5	10.3	9.3	3.3	56.1	74%
S	87%	5.8	8.2	12.4	11.6	4.4	3.6	0.2	13.2	10.2	2.8	59.5	79%
E	89%	7.7	7.3	10.1	10.2	3.8	1.0	1.6	9.7	9.0	2.2	51.5	68%
D	91%	6.4	5.7	7.9	9.3	3.1	0.6	1.1	8.2	7.5	1.6	42.3	56%
Average/station:	**62%**	6.7	7.9	11.4	11.2	4.5	3.3	1.1	11.1	9.7	3.0	57.2	
TF Range per storm, cm		4.8	3.9	6.0	5.3	6.4	6.3	1.7	6.4	4.2	3.4	33.1	
station avg/Meadow, %		82%	73%	69%	77%	88%	118%	88%	69%	73%	97%	76%	
										total in meadow	75.4	cm	
										total average throughfall in stations	56.3	cm	
										meadow versus forest	134%		

Attachment B: measured stable isotope data from throughfall stations.

Forest Canopy Interception Study, Blairsden, Plumas County, CA

Isotopes in water data, Oxygen-18 and Deuterium.

					total:				
Storm depth, cm	8.2	10.8	14.6	16.1	49.7				
% of all 8 storms	11%	14%	19%	21%	66%				
Date sampled	19-Dec	22-Dec	01-Jan	25-Mar		19-Dec	22-Dec	01-Jan	25-Mar
storm type	S	R	R	R		S	R	R	R
Station	O-18	O-18	O-18	O-18		D	D	D	D
Meadow	-11.34	-9.47	-15.1	-13		-73.2	-66.4	-119.6	-91.4
G	-11.57	-9.43	-15.3	-13.63		-76.3	-67.1	-120	-95.8
M	-11.79	-9.54	-15.62	-12.83		-78	-68.4	-123.3	-90.8
H	-11.3	-9.73	-15.02	-13.3		-73.5	-68.8	-118.9	-93.5
I	-11.27	-9.71	-15.26	-12.38		-72.5	-66.5	-120.3	-87.2
F	-11.96	-9.45	-15.07	-12.54		-79	-63.6	-118	-87.4
P	-11.87	-9.59	-15.36	-12.11		-77.7	-63.8	-121.3	-87.1
Q	-10.45	-9.62	-15.12	-11.98		-65.5	-67.4	-120.1	-85.8
B	-10	-9.64	-14.66	-13.09		-65.3	-66.2	-115.6	-90.7
K	-10.35	-9.44	-15.21	-12.49		-66.4	-67.2	-119.7	-88.8
C	-11.9	-9.53	-15.56	-11.77		-79.7	-65.4	-120.1	-82.3
J	-11.1	-9.55	-15.26	-12.28		-71.5	-66.1	-120.5	-87.1
N	-10.96	-9.62	-14.9	-12.02		-71.9	-66.6	-118.2	-85.8
L	-11.14	-9.56	-14.82	-13.15		-71.7	-66.8	-116.6	-92.9
R	-11.37	-9.49	-15.91	-12.18		-74.9	-66.1	-124.9	-86.3
T	-10.6	-9.35	-15.07	-11.75		-68.3	-66.6	-118.9	-82.4
A	-11.3	-9.72	-15.1	-12.02		-75.4	-68.1	-117.8	-84.8
O	-10.57	-9.46	-15.16	-12.33		-69.9	-66	-120	-84.1
S	-9.84	-9.47	-15.55	-12.31		-63.6	-66.4	-122.4	-87.6
E	-12.13	-9.72	-15.39	-11.88		-80	-65.4	-120.6	-83.8
D	-11.9	-9.42	-15.04	-11.15		-79.6	-64.6	-117.6	-79.1
average per station	-11.17	-9.55	-15.22	-12.36		-73.04	-66.36	-119.74	-87.17
avg CD<40%	-11.6	-9.5	-15.3	-13.2		-75.8	-67.3	-121.0	-92.7
avg CD>40%	-11.1	-9.6	-15.2	-12.3		-72.6	-66.2	-119.5	-86.5
>40%/<40%	96%	101%	99%	93%		96%	98%	99%	93%

Attachment C: Canopy measurements

Canopy density measurements

Canopies were photographed with a wide angle lens on a digital camera, looking up. The camera was placed stationary and horizontal facing up to zenith, using a small contractor's level, arranged such that the top of the image faces north, and the right side to the west (!), etc.

Images were downloaded and processed with the Adobe Photoshop Elements 2.0 software. Total image size was 307200 pixels. The purpose of processing was to estimate canopy density for each station. This was accomplished by using the 'Magic Wand Tool', clicking either on the sky portion or on the canopy portion of each image. Pixels were counted using the 'image- histogram' feature. Tolerance levels were as a rule set to 10% when estimating percent blue sky, and 100% when relying on the dark color of canopy, branches, trunk, etc. However, tolerance levels had to be raised for the sky pixel counts when partial cloud cover occurred.

The pixel counts were entered into a spreadsheet to calculate the canopy densities for each station.

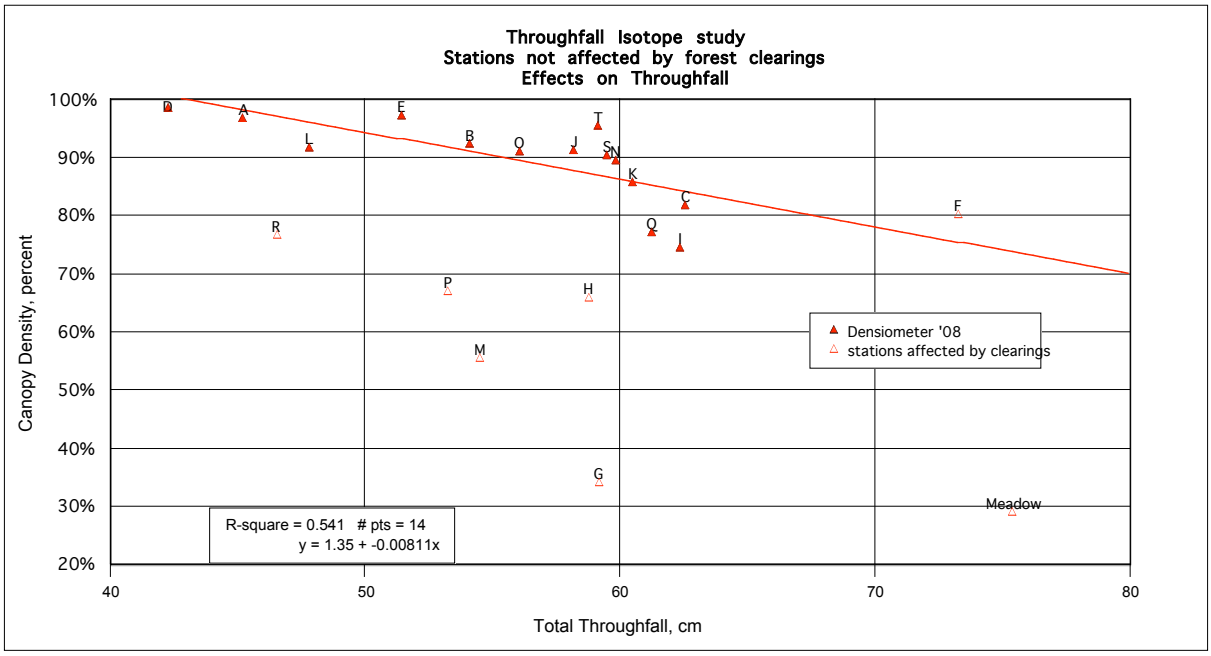
Attachment D: Canopy data

Canopy interception in a coniferous forest in eastern Plumas County, California

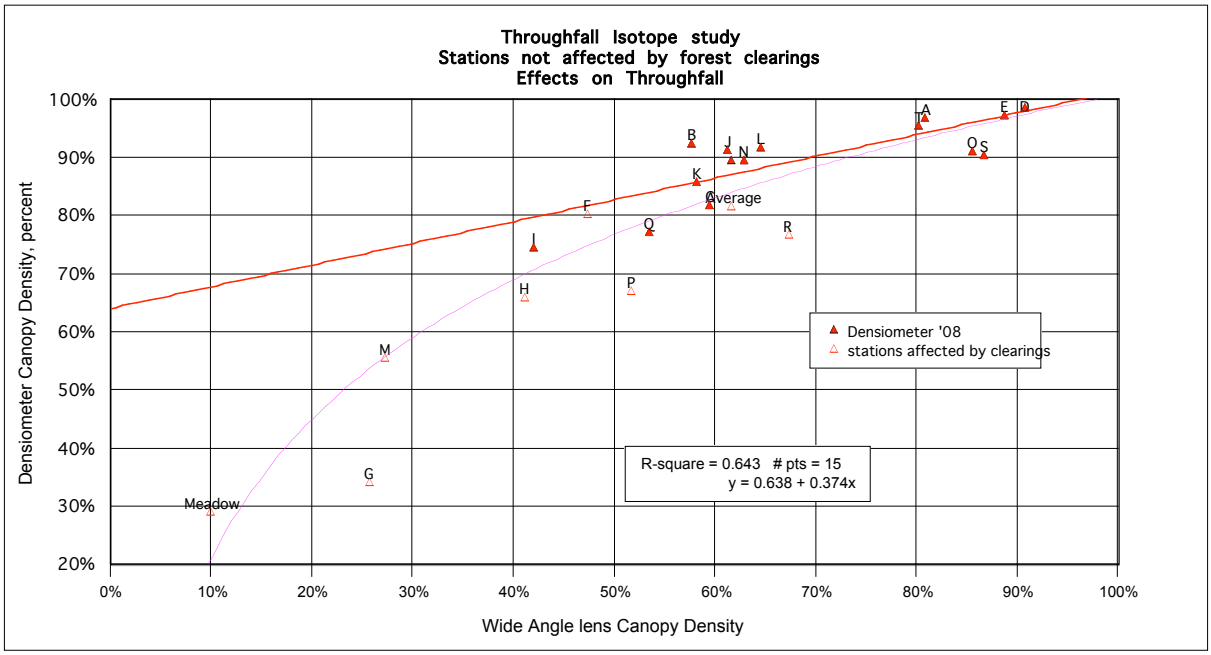
Canopy data

	Canopy densities										
Station	**regular lens**	**Wide-angle lens**	**Densiometer '08**	**aspect**	**clearing?**	**Rain, aver., cm**	**Snow, aver., cm**	**All aver., cm**	**Total Throughfall, cm**	**O-18, avg.**	**Deuterium, avg.**
Meadow	5%	10%	29%		yes	13.3	3.0	8.1	75.4	-12.23	-87.7
G	3%	26%	34%	N	yes	10.1	2.9	6.5	59.2	-12.48	-89.8
M	15%	27%	56%	N	yes	9.2	2.8	6.0	54.5	-12.45	-90.1
H	34%	41%	66%	N	yes	10.1	2.8	6.5	58.8	-12.34	-88.7
I	31%	42%	75%	N	no	10.3	3.6	7.0	62.4	-12.16	-86.6
F	44%	47%	80%	N	yes	11.6	5.0	8.3	73.3	-12.26	-87.0
P	40%	52%	67%	S	yes	8.8	3.2	6.0	53.2	-12.23	-87.5
Q	54%	53%	77%	S	no	10.2	3.4	6.8	61.2	-11.79	-84.7
B	71%	58%	92%	N	no	8.8	3.4	6.1	54.1	-11.85	-84.5
K	58%	58%	86%	N	no	10.3	3.0	6.7	60.5	-11.87	-85.5
C	50%	59%	82%	N	no	9.8	4.6	7.2	62.6	-12.19	-86.9
J	52%	61%	91%	N	no	10.2	2.4	6.3	58.2	-12.05	-86.3
N	57%	63%	89%	N	no	10.4	2.6	6.5	59.8	-11.88	-85.6
L	69%	65%	92%	N	no	8.0	2.5	5.3	47.8	-12.17	-87.0
R	55%	67%	77%	S	yes	8.0	2.2	5.1	46.6	-12.24	-88.1
T	68%	80%	95%	S	no	10.1	2.9	6.5	59.2	-11.69	-84.1
A	84%	81%	97%	N	no	7.8	2.0	4.9	45.2	-12.04	-86.5
O	71%	86%	91%	N	no	9.3	3.3	6.3	56.1	-11.88	-85.0
S	77%	87%	90%	S	no	10.2	2.8	6.5	59.5	-11.79	-85.0
E	76%	89%	97%	N	no	9.0	2.2	5.6	51.5	-12.28	-87.5
D	77%	91%	99%	N	no	7.5	1.6	4.5	42.3	-11.88	-85.2
Average	54%	62%	82%								
excl. meadow											

plot

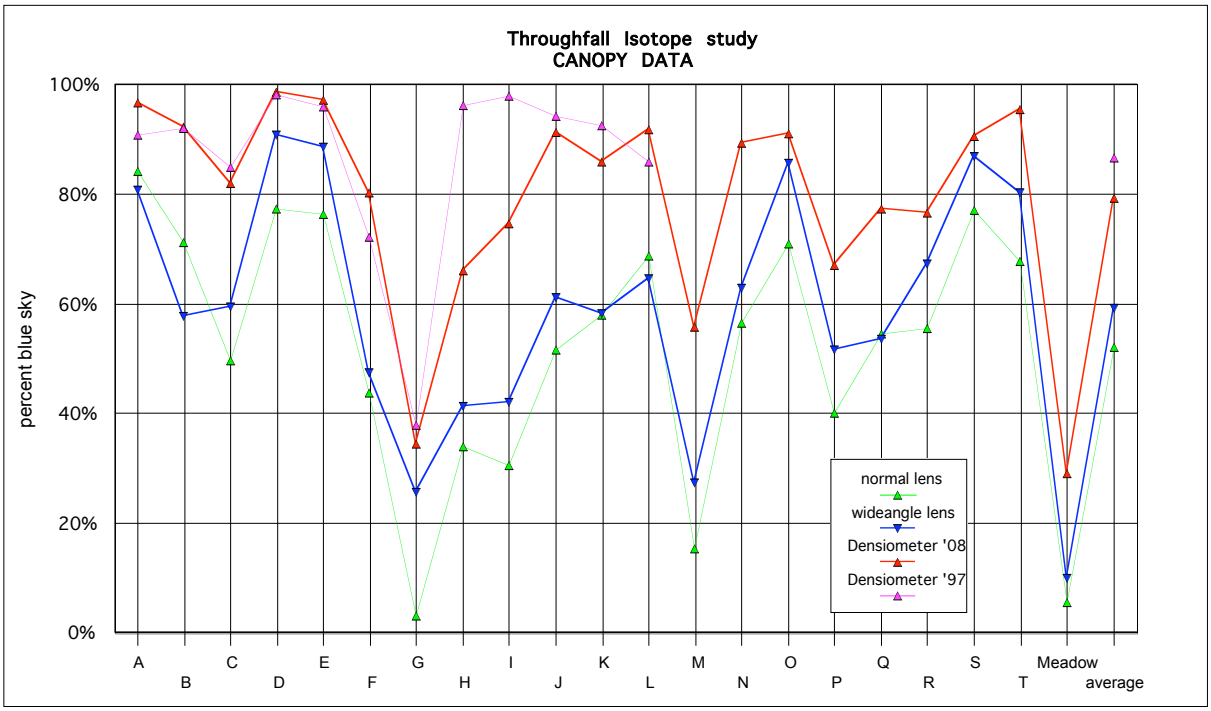

Throughfall Isotope study
Stations not affected by forest clearings
Effects on Throughfall
Canopy Density, percent
Total Throughfall, cm
100%
90%
80%
70%
60%
50%
40%
30%
20%
40
50
60
70
80
Densiometer '08
stations affected by clearings
R-square = 0.541 # pts = 14
y = 1.35 + -0.00811x
Meadow

Plot

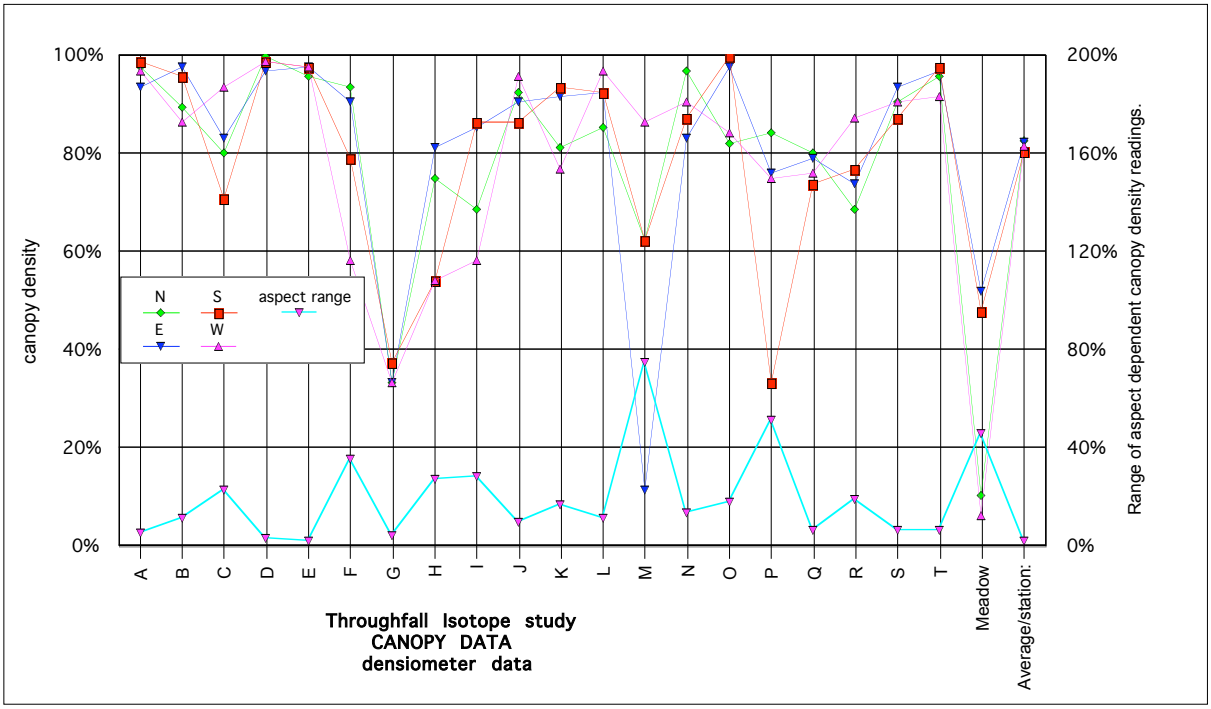

Throughfall Isotope study
Stations not affected by forest clearings
Effects on Throughfall
Densiometer Canopy Density, percent
Wide Angle lens Canopy Density
100%
90%
80%
70%
60%
50%
40%
30%
20%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Densiometer '08
stations affected by clearings
R-square = 0.643 # pts = 15
y = 0.638 + 0.374x
Meadow

P

P


Throughfall Isotope study
CANOPY DATA
100%
80%
60%
40%
20%
0%
percent blue sky
normal lens
wideangle lens
Densiometer '08
Densiometer '97
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
Meadow
average

P


100%
80%
60%
40%
20%
0%
canopy density
N
S
aspect range
E
W
200%
160%
120%
80%
40%
0%
Range of aspect dependent canopy density readings.
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
Meadow
Average/station:
Throughfall Isotope study
CANOPY DATA
densiometer data