STREAM NOTES

To Aid In Securing Favorable Conditions of Water Flows

Rocky Mountain Research Station **April 2003**

USGS National Flood Frequency Computer Program

Estimates of the magnitude and frequency of flood peak discharges and flood hydrographs are used for a variety of purposes, such as the design of bridges and culverts, fish crossing structures, channel restoration, and floodplain management. Flood frequency estimates are often needed by forest hydrologists at ungaged sites. One method commonly used for estimating the magnitude and frequency of flood peak discharges at ungaged sites is to use regression equations developed by the U.S. Geological Survey (USGS). These equations are now readily available in a user-friendly Windows based computer program developed by the USGS that allows easy computation using any desktop PC.

The USGS has been involved in the development of flood regionalization procedures for over 50 years. These regionalization procedures are used to transfer flood characteristics, such as the 100-year flood-peak discharge, from gaged to ungaged sites. The USGS has traditionally used regionalization procedures that relate flood characteristics to watershed and climatic characteristics through the use of correlation or regression techniques. Because flood characteristics vary substantially between regions due to differences in climate, topography, and geology, tests of regional homogeneity of a group of stations is an integral part of regionlization procedures.

The evolution of flood peak discharge estimation has followed a progression of procedures including (1) the index-flood procedure used in the late 1940s to the 1960s, (2) the ordinary least squares regression procedure used in the 1970s and 1980s, (3) the weighted and (4) generalized least squares procedures, first used in the late 1980s and still used today, and (5) the more recent region-of-influence procedure that is still somewhat experimental.

The regression equations have been shown to be unbiased, reproducible, and easy to apply. By 1993, reports that contained regression equations for estimating flood discharges for rural, unregulated watersheds had been published by the USGS, at least once, for every State.

In 1994, the USGS released a computer program titled the National Flood Frequency Program (NFF), which compiled all the USGS available regression equations for estimating the magnitude and frequency of floods in the United States and Puerto Rico. The

STREAM NOTES *is produced quarterly by the Stream Systems Technology Center, Rocky Mountain Research Station, Fort Collins, Colorado. Larry Schmidt, Program Manager*

The PRIMARY AIM *is to exchange technical ideas and transfer technology among scientists working with wildland stream systems.*

CONTRIBUTIONS *are voluntary and will be accepted at any time. They should be typewritten, single-spaced, and limited to two pages. Graphics and tables are encouraged. E-Mail: jpotyondy@ fs.fed.us*

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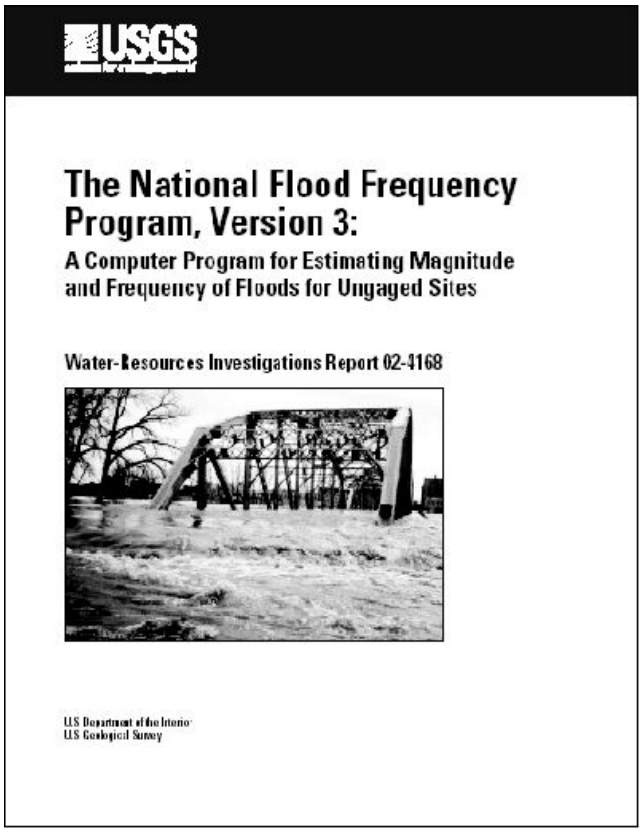
USGS

The National Flood Frequency Program, Version 3:

A Computer Program for Estimating Magnitude and Frequency of Floods for Ungaged Sites

Water-Resources Investigations Report 02-4168

U.S. Department of the Interior
U.S. Geological Survey

original NFF program was a MS-DOS computer program that provided engineers and hydrologists with a practical tool for computing estimates of flood peak discharges at selected recurrence intervals.

Since the initial release of NFF, the USGS has produced new equations for many areas of the Nation. A new, user-friendly Microsoft Windows version of NFF has been developed that incorporates these new equations and provides additional functionality and ease of use. NFF version 3.1 provides regression-equation estimates of flood-peak discharges for unregulated rural and urban watersheds, flood-frequency plots, and plots of typical flood hydrographs for selected recurrence intervals. The Program also provides weighting techniques to improve estimates of flood-peak discharges for gaging stations and ungaged sites.

USGS Water-Resources Investigations Report 02-4168, ***The National Flood Frequency Program, Version 3: A Computer Program for Estimating Magnitude and Frequency of Floods at Ungaged Sites***, describes the flood-regionalization techniques used in NFF. The report provides an overview of flood regionalization techniques, summarizes the characteristics of the estimation techniques, and describes their applicability and limitations. The report also describes how to obtain information needed to solve the regression equations for individual States.

NFF Software and Documentation

The NFF software and the documentation for the regression equations included in NFF are available from a USGS Web page at http://water.usgs.gov/software/nff.html. The documentation includes a digital copy of Water-Resources Investigations Report 02-4168 and information for each State that contains the applicable regression equations and much of the reference information needed to solve them. Information is provided through Web links to fact sheets, online reports, and pages from the original NFF report. In addition, the page provides direct links to flood frequency regression equation papers published in all of the States. As new equations are developed each year, the NFF software and documentation will be updated and potential users are encouraged to check the Web site often for updates.

NFF Program Features

The NFF program and its supporting database can be downloaded from the Web page and installed like many other Windows applications and an NFF icon can be created to easily launch the NFF program from the PC desktop.

The program has four main components:

1. A user interface,
2. A calculation routine,
3. A Microsoft Access database named StreamDB, and
4. A help facility.

The NFF user interface allows users to control the operation of the software and presents results (Figure 1). As many as seven multiple regression equations (2-, 5-, 10-, 25-, 50-, 100-, and 500-year) are defined for each of more than 280 flood regions. The user simply selects the State of interest, enters the appropriate watershed and climatic data, and the program computes and displays the results.

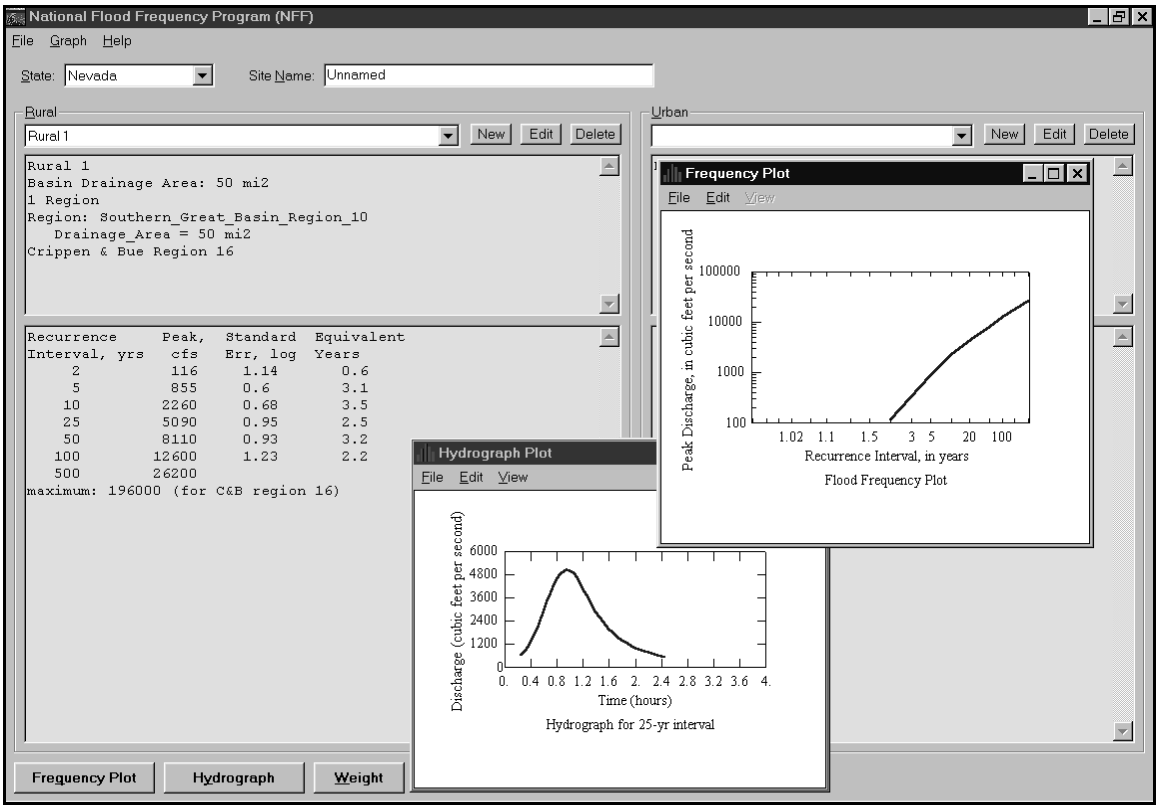

Figure 1. The main window of the National Flood Frequency Program showing results of a rural computation for an example site in Nevada. The graphs superimposed over the main window are also generated automatically by the program. The graph in the upper right shows a flood frequency plot and the graph in the middle shows an average hydrograph for the 25-year peak discharge.

The top box in Figure 1 shows input parameters used to solve the regression equations for the selected rural scenario for the selected State. The bottom box shows the outputs, including the recurrence intervals, the estimated peak flows, the standard error of estimate or prediction, and the equivalent years of record for the estimates. If both rural and urban estimates are available, the rural input and output appears in the left box and the urban values are displayed in the right box.

Buttons are available for (1) plotting flood frequency curves, (2) estimating a typical flood hydrograph for a selected T-year peak discharge, and (3) weighting flood peak estimates obtained from regression equations for stream gaging stations and ungaged sites.

The Microsoft Access database file, StreamstatsDB, contains the regression coefficients, standard errors, etc., for about 2,050 multiple regression equations for the various States. This database is shared by another computer program and contains additional data used by that program. The StreamstatsDB file will be updated frequently as new equations become available.

Finally, the NFF program has a self-contained Help menu that includes the Manual and information on how to access the Web Site. This built-in feature provides everything anyone might need to successfully use the program.

You can access the USGS Web page directly at http: //water.usgs.gov/software/nff.html or link to it via the STREAM Web Page, http://stream.fs.fed.us, and click on “Publications & Products” submenu “Software.”

The Importance of Hydrochory (Water Dispersal of Seeds) in Free-Flowing and Regulated Rivers

by David M. Merritt and Ellen E. Wohl

Rivers are important corridors for the movement, migration, and dispersal of aquatic organisms as well as for the dispersal of the seeds and vegetative propagules of riparian plants. Because large rivers and their tributaries traverse broad gradients of latitude and elevation, frequently dissecting multiple ecosystems, they invariably collect large numbers of wind and gravity dispersed seeds from surrounding landscapes and transport them to points downstream. Hydrochory, or the dispersal of seeds by water, has long been recognized for the important role it plays in structuring plant communities along streams and river systems.

Water dispersal by river networks can enable new plant populations to become established at great distances from parent populations and may facilitate genetic continuity between otherwise spatially separated populations. By providing a supply of seeds to sites from elsewhere, sometimes from great distances upstream, hydrochory also plays an important role in the maintenance of high riparian plant community diversity.

Despite its central role in maintaining longitudinal connectivity between plant populations along river margins and its influence on patterns of species richness along streams, few studies have experimentally examined the process of hydrochory to develop an understanding of the relationships among dispersal phenology, hydrologic regime, and stream channel morphology.

Although many investigations have labeled the hydrologic regime as the most important extrinsic factor determining hydrochoric seed dispersal patterns, the final location of water-dispersed seeds along riparian corridors is a function of at least three interacting factors:

1. The hydrologic regime during seed release and transport, which is defined by the timing and magnitude of peak flow and the rate and direction of change in discharge.

2. Channel morphology and hydraulics.

3. The phenology of seed release as it relates to hydrologic regime.

Alteration in natural flow regimes, an inevitable consequence of water development, influences both the temporal availability and suitability of streamside habitat and the dynamics of seed delivery to sites suitable for establishment. Managed flows that deviate from historical regimes may serve to decouple the synchrony between availability of establishment sites and the timing of dispersal of seeds to such sites.

The purpose of our investigation was to develop an understanding of the patterns and mechanisms of seed transport under “natural” and “modified” hydrologic regimes. Marked seeds were introduced over different time segments of a gradually descending snowmelt hydrograph and over segments of two managed hydrologic regimes typical downstream of hydroelectric and agricultural storage reservoirs.

Experiments were designed to address the following questions:

1. Are natural snowmelt hydrologic regimes more effective than modified hydrologic regimes in delivering and depositing riparian plant seeds to riparian sites?

2. Is the assumption of ubiquitous seed dispersal along river margins acceptable or are seeds deposited in a clumped, nonrandom, and perhaps predictable fashion along river margins?

3. Does the timing of seed release in relation to attributes of hydrologic regime (rate and direction of change in discharge) result in distinctive patterns of seed deposition along river margins?

The Experiment and Methods

A channel with fluvial features representative of high-gradient, pool-riffle, and meandering streams was constructed in a 1.8 x 20 meter experimental flume located at the Engineering Research Center, Colorado

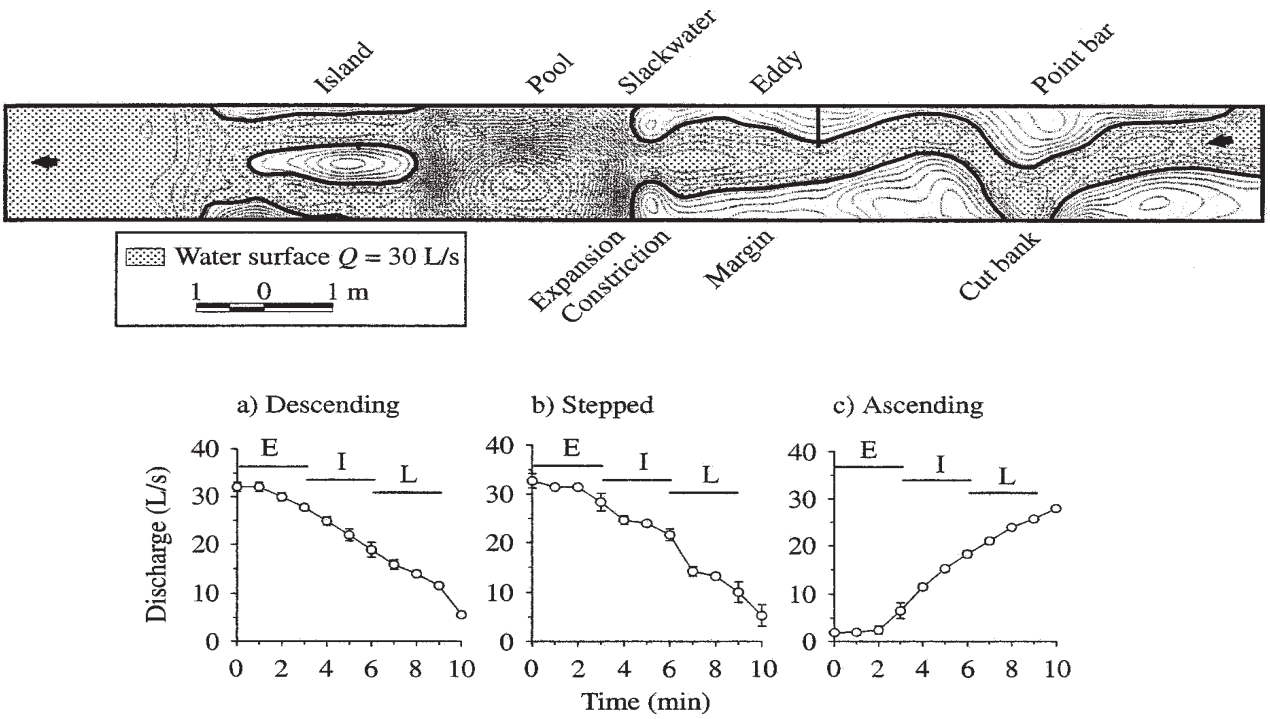

Figure 1. Design of flume experiment. The flume (top) with fluvial features indicated. Arrows indicate direction of flow. Hydrographs (bottom panels) of (a) descending, (b) stepped, and © ascending flow regimes. Black horizontal lines indicate the durations of early (E), Intermediate (I), and late (L) seed releases.

State University, in Fort Collins, CO. Fluvial features included straight channel margins, pool margins, constrictions, point bars and cutbank sequences, an eddy, an expansion, an island, and slackwater areas (Figure 1). Three hydrologic regimes were routed through the flume: one "natural" (descending) and two "modified" (stepped and ascending). Color-coded seeds were released at different time intervals to mimic early, intermediate, and late seed release scenarios.

Summary of Results

Hydrologic Regime: The majority of the seeds dispersed over all time periods were flushed completely through the flume under the ascending hydrologic regime. The characteristics of the recessional limbs of the descending hydrographs had a significant influence on the number of seeds deposited along shorelines with the more structurally stepped flow rates resulting in the deposition of more seeds on average than the smoother descending hydrologic regime. This suggests that ascending flows during seed release may have a significant negative effect on hydrochoric seed deposition.

The hypothesis that natural hydrologic regimes result in the deposition of higher concentrations of seeds than regulated flows was not entirely supported. Stepped and descending flows both captured significantly more seeds than ascending flows. In fact, the characteristics of the stepped flow provided the most effective conditions for detaining and depositing seeds. This suggests that even below reservoirs, flows may be managed systematically to facilitate or to hinder seed deposition at certain times and at certain elevations across the floodplain corresponding to river stages important for the management of selected species.

Channel Morphology: Significantly greater number of seeds were deposited in areas of slow flow velocity (eddies, flow expansions, point bars, pool margins, and slackwaters) relative to areas of high velocity (cut banks,

flow constrictions, islands, and straight channel margins). However, seeds were also recorded in the highest energy areas.

These results suggest that the hydraulic factors governing seed deposition act over two spatial scales: (1) macroscale hydraulics such as eddies and expansions which detain and recirculate seeds, and (2) microscale hydraulics such as small waves produced by bursting phenomena at higher flows and hydraulics regulated by channel microtopography, boundary roughness, and bed irregularities. Macroscale hydraulics dominate at higher discharges when most of the bed features are drowned. These macroscale features trap seeds by drawing them out of the main current and detaining them in eddies. At lower discharges, microscale features become exposed, generating turbulence, dissipating energy, and providing surfaces for seed adhesion, and therefore have a greater influence on where seeds are deposited under low flow conditions.

Dispersal Phenology: Although there is tremendous year-to-year variability in the timing of seed release in riparian species, many riparian species exhibit dispersal phenologies that correspond to environmental cues related to river hydrologic regime. Species with environmentally cued phenologies are particularly vulnerable to modifications in hydrologic regime, which may decouple the synchrony between the availability of seeds and presence of suitable habitat along river margins.

By varying hydrologic flow regimes, we were able to investigate relationships between seed dispersal and the flow regime. In general, early seed dispersers which are deposited high on the floodplain risk water stress and desiccation later in the year. Late dispersers on the other hand may have more favorable moisture availability but may suffer from high mortality due to scouring and submergence during subsequent high flows. The selective pressures of such trade-offs between dispersing early, thereby establishing above the scour zone, or dispersing late in the season and ensuring adequate moisture availability, but risking subsequent mechanical stresses, are particularly pronounced along rivers because habitat availability is transient but seasonally predictable. Thus the species with the most specific requirements for regeneration and establishment are most vulnerable to modifications in natural flow regimes. In contrast, generalists are quite resilient to shifts in hydrological regimes. Species specific information of this type provides insight into adjustments that could be made to specific hydrograph segments to benefit native species while inhibiting undesirable species.

Discussion

From a vegetation perspective it is important to consider the timing, magnitude, direction, and rate of change in discharge when designing flow release schedules below dams. The results of our work suggest that flows can be modified for a specific segment of the hydrograph to maximize seed delivery and deposition into optimal habitat patches. Adjusting flows to accommodate the natural regenerative process of a particular sensitive or key species could provide a greater return for the cost than other common forms of remediation such as manual planting of seedlings or broadcasting seeds. The incorporation of information concerning dispersal phenology of floodplain species into flow release schedules is an effective means of enhancing recruitment of entire suites of riparian species over large areas while leaving many of the societal and economic benefits of dams uncompromised.

Reference

Merritt, D.M, and E.E. Wohl, 2002. Processes governing hydrochory along rivers: Hydraulics, hydrology, and dispersal phenology. Ecological Applications 12(4):1071-1087.

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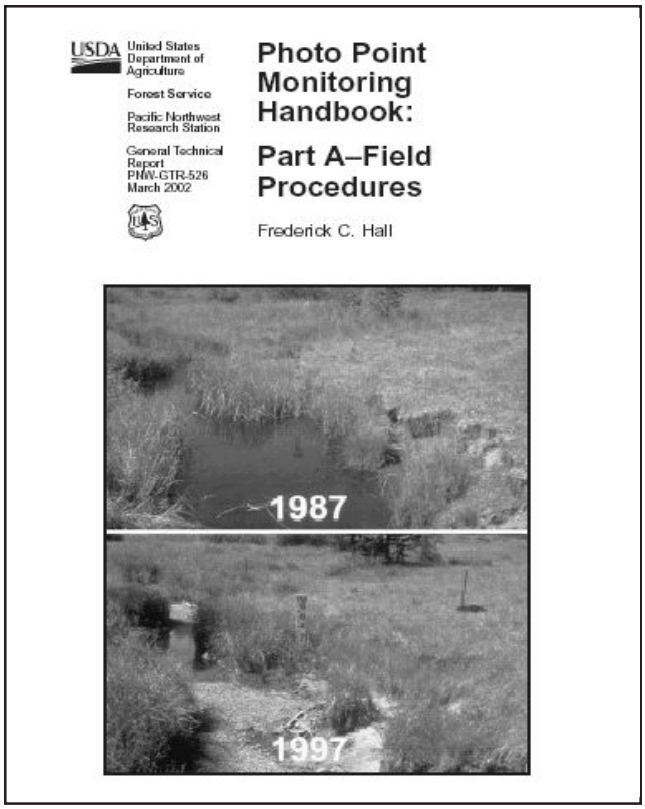
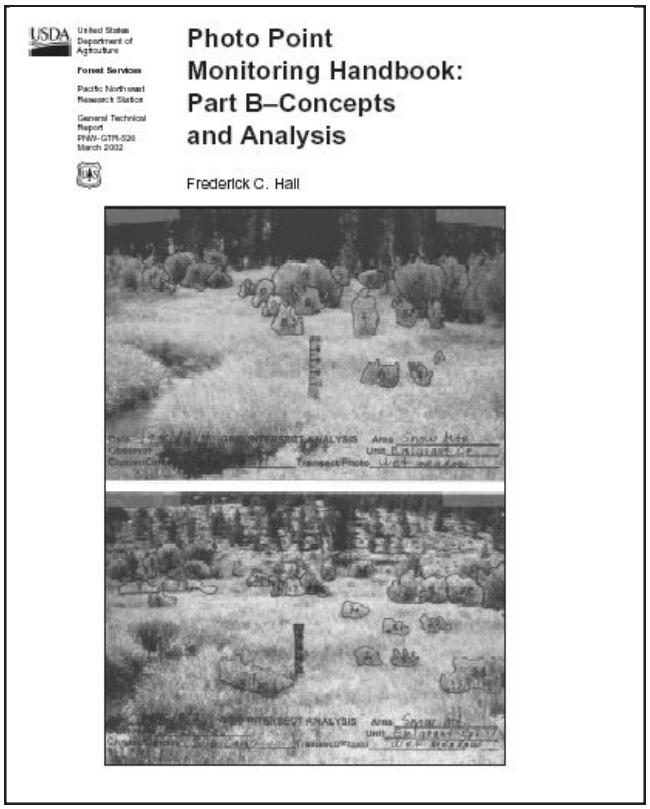
A Handbook for Photo Point Monitoring



General Technical Report PNW-GTR-526A



General Technical Report PNW-GTR-526B

Anyone interested in quick and effective documentation of change in vegetation through repeat photography will find the ***Photo Point Monitoring Handbook***, PNW-GTR-526A and B, useful. Illustrations cover such topics as streamside changes, riparian willow response to beavers, logging, livestock use, and mountain pine beetle kill of lodgepole pine. No special skill or training is required to apply the techniques other than some knowledge of cameras.

The handbook is based on 45 years of experience in repeat photography by the author, **Frederick C. Hall,** senior plant ecologist (now retired), USDA Forest Service, Pacific Northwest Region. Fred points out that during those years he discovered many nuances that he wishes to share so that new users can avoid the pitfalls he ran into.

Fred notes that there is one essential criteria if repeat photography is used to document change. Distance from camera to photo point must remain the same. For this reason, both the camera location and photo point require permanent markers.

The ***Photo Point Monitoring Handbook*** is published in two parts: Part A: Field Procedures, and Part B: Concepts and Analysis.

Part A discusses three critical elements: (1) maps to find the sampling location and maps of the photo monitoring layout; (2) documentation of purpose, camera and film, weather, season, sampling system, and equipment; and (3) precise replication in the repeat photography. Part B covers concepts and procedures required to use photography for analyzing change in photographs, monitoring equipment specifications, and forms for recording information and mounting photographs.

Copies of the handbook can be downloaded directly from the Web at http://www.fs.fed.us/pnw/pubs/gtr526/ or if you prefer, you can order hard copy version at http://www.fs.fed.us/pnw/pubs/order.htm.

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Editorial Policy

For a successful newsletter, we need voluntary contributions of relevant articles or items of general interest. YOU can help by taking the time to share innovative ideas or approaches to problem solving that you may have developed.

Feel free to contact John Potyondy to discuss ideas for contributions (970- 295-5986). Or if you like, submit typed, single-spaced contributions limited to 2 pages to John Potyondy at jpotyondy@fs.fed.us in electronic format. If possible, include graphics and photos that help explain ideas.

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