# Road Decommissioning Effectiveness Monitoring Techniques

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National forest road decommissioning techniques are a key tool in effective watershed restoration. Although land managers have been involved in road decommissioning over the past three decades, there is little consistency in road decommissioning monitoring. This document provides a framework for developing and implementing a monitoring plan that responds to the specific needs and unique ecological conditions of each forest.

Keywords: *road decommissioning, effectiveness monitoring, watershed restoration*

## Introduction

The Road Decommissioning Effectiveness Monitoring Techniques report presents a framework that an interdisciplinary team (IDT) can use to develop a road decommissioning monitoring program. Additional forms, references and examples of monitoring plans can be found by visiting the links at the end of this document.

As the group that needs this information most is the IDT, this report takes the form of instructions to the team. However, all other readers with interest in the subject will find the information useful.

Several national forests have developed road decommissioning monitoring plans and this report builds on their work. Rather than advocating one method for each monitoring project and budget, this document enables users to select a monitoring technique for each situation.

In the late 1970s, Redwood National Park (RNP) started to decommission unneeded roads. Park geologists tried to reduce the adverse environmental effects of roads and road crossings including erosion, mass wasting, and sedimentation. Techniques to decommission roads evolved from monitoring results. Treatments changed from hand tools and revegetation to dozers and excavators. The same kind of heavy equipment that created the road now decommissioned the road.

At the same time, national forests across the country began decommissioning roads. Flood events that occurred during the 1980s and 1990s also showed the vulnerability of the transportation system and the negative results of poorly designed and located roads.

M Furniss, C Clifton, and K Ronnenberg, eds., 2007. *Advancing the Fundamental Sciences: Proceedings of the Forest Service National Earth Sciences Conference, San Diego, CA, 18-22 October 2004*, PNW-GTR-689, Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Road decommissioning reduces chronic sediment delivery, restores hillslope hydrology and reduces impacts to aquatic, riparian, and terrestrial ecosystems of roads crossings. The Forest Service has different levels of decommissioning treatments to reduce road hazards. Forest Service personnel have learned which decommissioning treatments are effective for different climatic conditions, geology, and soil type. Forest IDTs develop monitoring plans for evaluating the effectiveness of decommissioning treatments.

## What is Road Decommissioning?

Road decommissioning is defined as: "Activities that result in the stabilization and restoration of unneeded roads to a more natural state." (36 CFR 212.1, Forest Service Manual 7705 - Transportation System [[USDA FS 2003]]). The Forest Service Manual (7712.11- Exhibit 01) identifies five levels of treatments for road decommissioning which can achieve the intent of the definition. These include the following:

1. Block entrance
2. Revegetation and waterbarring
3. Remove fills and culverts
4. Establish drainageways and remove unstable road shoulders
5. Full obliteration, recontouring and restoring natural slopes

These five treatments give the IDT a range of options for stabilizing and restoring unneeded roads. Watershed Analysis (WA) and Roads Analysis (RA) help determine what treatment level or combination of treatments is appropriate. In some situations blocking the entrance may meet restoration objectives. In other situations, restoring hillslope hydrology may require full obliteration recontouring. Local factors such as climate, geology,

topography, soil, and road design and construction also factor into the stabilization and restoration objectives.

## Components of a Monitoring Plan for Road Decommissioning

The following steps (adapted from Kershner 1997) will help the interdisciplinary team establish their monitoring plan:

***1. Obtain management and leadership support.*** Monitoring dollars will always be limited, as will available resources to conduct the monitoring. Link monitoring results to management decisionmaking and goals. Identify some linkages from scoping questions in NEPA analysis: What are the commonly asked questions that management has to answer about road decommissioning? Will the monitoring effort provide information that is critical for policy making and reporting to the public? Can the monitoring obtain results in a useful timeframe?

***2. Define the participants. Jointly develop the monitoring goals and objectives.*** Ensure that the team has the technical expertise to set protocols, collect the data, and analyze the data.

***3. Determine the overall goal or goals.*** Use findings in the RA and WA, Land and Resource Management Plan (LRMP) goals, and aquatic conservation strategies, as available and appropriate. The following are sample goal statements from the Aquatic Conservation Strategy for the Northwest Forest Plan (FEMAT 1993)

*Maintain and restore the physical integrity of the aquatic system including shorelines, banks and bottom configurations.*

*Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.*

*Maintain and restore the habitat to support well distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.*

These goal statements are broad and general. Although teams often want to further break down the goals, be patient during this step and look at the ecosystem from a broad perspective.

***4. Select objectives that fit the goal(s).***

A well-written objective statement clearly shows the expected outcome. Make it specific, concise, and most importantly, observable or measurable. Objectives can also be time-specific statements of measurable planned results, responding to pre-established goals that you can find in the WA, RA, or Land and Resource Management Plan (LRMP) for the forest. If specific, measurable objectives are not available, locate indicators of similar "healthy" systems and use these for objectives. Select monitoring objectives that best indicate change and measure them in the locations that are responsive to change. (Kershner 1997)

***5. Design monitoring to detect change to: (a) distinguish treatment effects from other variations, and (b) take replicate samples over space and time.*** Consider the geographic extent of the plan and minimize the variability from site to site, by selecting areas of similar size, geology, morphology, stream discharge, and other unique or important characteristics. Sample number and statistical significance of the monitoring should be included in the initial monitoring design. Use pretreatment inventory data as a benchmark of pre-restoration condition.

***6. Prioritize and schedule monitoring activities: identify what needs doing and prioritize it.*** For example, evaluate cover effectiveness the first year if a mulch or seed mix is a component of the treatment. Monitoring the type of cover for vegetation composition and species dominance may require sustained monitoring over several years. Evaluating the change in riparian vegetation community composition and spatial arrangement at a road decommissioning site may require less intensive monitoring but over a longer duration.

***7. Implement the road decommissioning treatment.*** The FSM 7712.11 identifies five treatment levels for road decommissioning. Depending on the site, a combination of treatments may be implemented.

***8. Analyze data and report results.*** Complete an annual report on the monitoring results and present the findings to the district and/or forest leadership team. Seek opportunities to share the team's findings during field trips with the forest leadership team or other interested groups.

***9. Use new information to adapt goals and objectives.*** "Whether monitoring demonstrates success or failure of outcome predictions, what is learned from monitoring will illuminate analysis and decisionmaking in the future." (USDA 1999)

### Monitoring Plan Development

The previous section provided a framework for organizing a road decommissioning monitoring program. Use information from the Watershed and Roads Analysis to identify watershed restoration goals and objectives. Identify restoration goals and objectives and select the appropriate treatments. The monitoring plan provides the feedback mechanism for answering questions on both implementation and effectiveness.

Seek guidance and feedback from forest Line Officer's on questions, activities, resources and schedules. The interdisciplinary team needs the staff for the design, analysis, interpretation and annual reporting of findings to managers and the public.

## Designing a Road Decommissioning Effectiveness Monitoring Plan

Designing a road decommissioning effectiveness monitoring plan can be difficult. This section is designed to provide a framework for a team to fully develop each component of a monitoring plan. The four most common monitoring methods currently being used for road decommissioning effectiveness are shared. Depending on the resources available for monitoring, a team can select different methods for different areas. The monitoring level of intensity may vary from year to year and the team may want the flexibility to capture more or less information in a given year.

Table 1 gives examples of goal and objective statements that a team can use as a starting point for items #3 and #4 of Components of a Monitoring Plan. Tables 2 and 3 illustrates a technique to link Watershed and Roads analysis findings to restoration objectives, treatments, and finally, measurable indicators for monitoring treatment effectiveness.

In researching current monitoring methods used by Forest Service, state, or private watershed groups, the following four monitoring methods were repeatedly cited as tools to monitor decommissioning effectiveness:

- Quantitative measurements of channel cross-sections, vegetation, and soil erosion rates.
- Qualitative measurements using Best Management Practices (BMPs).
- Photo-point monitoring using "before" and "after" photographs.
- Tracking spreadsheets that answer who, what, where, how much, and when.

*Table 1: Examples of goal and objective statements from forest LRMPs.*

| Generic Goal Statements | Measurable Objective Statements: |
|---|---|
| Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport. | Keep ground-covering litter, duff, and/or vegetation on at least 90% of non-rocky riparian areas. |
| | Roads occupy less than 3% of all near-stream areas within a sub-watershed. |
| Improve juvenile steelhead habitat to restore runs of summer steelhead. | Remove identified unneeded crossings to achieve < 2 crossings per mile of perennial stream. |
| Restore spawning and rearing habitat for summer steelhead in the subwatershed. | Increase Channel Bank Stability to obtain an upward trend in stability, with target of 85% stability for reaches. |
| Restore hillslope hydrology and improve infiltration on compacted road prisms. | Upward or stable trend in W/D measures, as compared to reference stream data, measured at flat water habitat types. |
| Restore watershed functions to improve water quality, fish and wildlife habitat, and scenic value | Increase structurally complex rearing habitat for juvenile steelhead as measured for deep pools and woody debris frequency in the current administrative policy. |
| Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species. | Increase the numbers of juvenile steelhead to meet downstream migrant numbers defined as optimal in state management plan. |
| Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands. | Decrease the percentage of fines in spawning gravel to less than 10% during spawning and incubation. |
| Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations. | Decrease near stream road density to 1 mi/sq mi in key watersheds. |
| Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. | Decrease soil compaction to less than 5% in near stream areas within a sub-watershed. |
| | Upward trend in bank angle, with target of 100° average for reaches. Maintain streambanks to ensure the protection of the aquatic systems to which species are uniquely adapted. |

*Table 2: An example of a table used to illustrate the linkages between watershed process, watershed analysis (WA), and restoration objectives to treatments and monitoring indicators.*

| Process or Attribute | WA findings and Results | Restoration Objectives | Restoration Treatment | Monitoring Indicator |
|---|---|---|---|---|
| Channel morphology (width to depth ratio) | Identify the appropriate goal based on findings from WA, RA, and previous inventory or monitoring records. | Identify the specific objective based on channel type classifications. | Link WA, objectives, to identify priority areas. Select decommissioning level that obtains objective | Channel cross sections |
| Sediment regime | Identify existing sources and change to temporal and spatial scale | Consider direct and indirect indices to include on site and off site effects. Link to regulatory agency direction. | On-site cover techniques including natural mulches and large woody debris | Change in contributing source areas; In stream pool fines; amount of material removed at stream crossing. |
| Channel and floodplain function | Identify change in channel type as a result of management inputs. | Determine restored channel classification | May include channel stabilization thru redesign | • channel cross sections • streambank erosion • amount of material removed at cross section. |
| Species composition and structural diversity | Locate PNV information to determine natural species composition. | Identify composition and time frames to achieve goal. | Identify seed and cutting sources for vegetation establishment. Consider risk associated with noxious weeds. | Vegetation monitoring (Releve plots, line or belt transects |
| Erosion and mass wasting processes | Identify existing sources, and change in frequency and magnitude. | Determine "natural triggers" and reduce management induced triggers. | Restore hillslope hydrology and vegetative recovery. | Change in contributing source areas; in stream pool fines; amount of material removed at cross section |

Regardless of which monitoring method or combination of methods is selected, the monitoring team must develop goals and objective statements for the monitoring. Table 1 provides sample goal and objective statements for a monitoring plan. Remember that goal statements are broad and can commonly be found in the LRMP. Objective statements are specific, concise, and measurable, and generally harder to pinpoint. Write objectives from the best data available.

## Indicators

Item #5 of the components of a monitoring plan requires that monitoring be designed to detect change. Indicators are the measure or record of change. Select indicators that can be observed and measured. The following are examples of indicators used for road decommissioning monitoring:

1. Channel adjustment both above and below a road crossing
2. Erosion rate changes including surface erosion (existing road prisms) to changes in mass wasting frequency and extent (landslides)
3. Sediment sources associated with roads (chronic vs. pulse)
4. Revegetation of hillslopes and riparian areas to desired species
5. Amount of material removed from crossing(s), and miles of road decommissioned

Some of these indicators are direct indicators of change while others are indirect. Select direct or indirect indicators depending on resource availability (personnel and funding), priority, and treatment type.

Table 2 provides a template for tracking WA findings, and linking restoration objectives to treatments and

indicators. The table focuses the monitoring team on determining which process or processes a road modifies. In the first example, the removal of a culvert, ford, or bridge modifies channel morphology at stream crossings. In addition, roads paralleling a stream channel can modify channel morphology by constricting the channel.

Other changes to processes occur with roads crossing meadows. In many cases channels have aggraded above culverts and degraded at the culvert outlet. In meadows, roads can affect channel and floodplain functions. It is not uncommon for channels to change from a Rosgen C Type to an incised gullied channel. The team faces the task of determining how to decommission the road and what type of channel stabilization is necessary. Monitoring treatment effectiveness may focus on recovery of the channel and floodplain. The team must determine the best indicators.

**Levels of Intensity of Effectiveness Monitoring**

With different intensity levels for conducting effectiveness monitoring, forests use a mixture based on the values at risk, project design, and availability of personnel and resources.

The four monitoring methods commonly used by forests are:

1. Quantitative measurements with repeat evaluation on excavated channel cross sections, vegetative recovery transects, and evaluation of erosion rates on site.
2. Use of BMP evaluation protocols to assess implementation and treatment effectiveness.
3. Photo comparisons of treatments, including key indicators of change in channel cross section and revegetation.
4. Tracking tools, quantifying amount of material removed, length of road decommissioned, and treatment type.

### Quantitative Measurements

Quantitative measurements refer to measurements taken in the field such as stream channel dimensions, amount of erosion, and revegetation.

The team and forest management may be implementing road decommissioning with the goal of improving juvenile steelhead (anadromous *Oncorhynchus mykiss*) habitat to restore runs of summer steelhead. However, the team may select as indicators, direct measures of channel cross section, erosion, and revegetation. If the road decommissioning treatment results in a stable stream channel, reduced erosion, and healthy revegetation, the conditions exist for an improved juvenile steelhead habitat.

Several forests use direct stream measurements to evaluate treatment effectiveness.

Common goals for this type of monitoring are to quantify the effectiveness of road decommissioning projects to reduce or eliminate sediment inputs. Additional goals include identifying both successful treatments' techniques and limiting factors. The team must know if treatments are effective for a particular site.

Teams conducting this level of monitoring divide the decommissioning work into three areas: 1. Road prism stabilization; 2. Stream channel excavations; 3. Revegetation and effective soil cover. Road prism stabilization may involve random transects across numerous segments of the treated prism. The team must ask: is there adequate cover to reduce erosion? What is the type and composition of the soil cover? Did the treatment improve infiltration? On a fully decommissioned road the team samples the re-contoured area from the toe of the fill slope to the top of the cut bank. Soil transects can be line-intercept transects or grid and measure bare soil, litter, plants, downed material, rilling, and compacted soil. (San Dimas Technology and Development Center Website, *http://fsweb.sdtdc.wo.fs.fed.us/programs/im/fy04/rdmt/*)

For monitoring stream channel excavations the team has several choices. Obtaining baseline inventory data of the volume of material in the crossing is valuable. Data may be found in the National Environmental Policy Act (NEPA) document or restoration contract. The monitoring questions at road crossings include the amount of horizontal and lateral adjustment of the stream channel, and surface erosion or mass wasting. A longitudinal channel profile and cross sections may be established.

Secondly, an "as-built" longitudinal channel profile and cross-section survey taken immediately after decommissioning and prior to storm events can serve as a benchmark. The design for the removal of the crossing should be based on reference stream channel characteristics. (Harrelson et al. 1994; Rosgen 1996)

Lastly, to expedite cross section measurements the team can use a simplified model of the excavated crossing. Many forests use this model in the inventory phase, modeling the cross section as parallelograms. The team calculates the total area of the cross section by subtracting the area of the two triangles on the sides from the parallelogram area. (San Dimas Technology and Development Center Website, *http://fsweb.sdtdc.wo.fs.fed.us/programs/im/fy04/rdmt/*).

The line intercept transect used on the road prism stabilization can measure surface erosion and effective soil cover. Mass wasting documentation is evaluated during the years after implementation, or if an event occurred that triggered some instability. Data collected for mass wasting

is an estimate of size (L x W x D) and amount of material moved. The team can determine how much of the material stayed on the hillslope and how much entered a stream.

Revegetation monitoring goes beyond measurement of effective soil cover to prevent surface erosion, and records the species composition and community types present. Monitoring protocols are available to determine the effectiveness of the treatment on revegetation.

Use protocols that best capture the type of vegetation the area is capable of producing. For example, the Greenline protocol is useful for monitoring meadow or riparian vegetation response to road decommissioning. (Winward 2000) In drier sites other protocols may better capture the species composition and community types present. In forested areas, the Forest Inventory Analysis (FIA) inventory protocols may be used to track changes in vegetation type.

### Strengths of the Actual Measurements

When measurement data is linked to specific monitoring questions and succinct objective statements, the effectiveness of the treatment can be assessed. However, with general objectives and poorly defined monitoring questions, the determination is difficult even with actual measurements.

Actual measurements can help separate out and categorize the sample pool by independent variables, such as: bedrock geology, soil type, hillslope position, hillslope gradient, size of excavation, time since implementation, and contract method. The team can more easily manipulate the data to keep independent variables from confounding the results.

The team can take actual measurements for erosion, stream channel adjustments, and vegetation with a variety of proven and effective protocols. Depending on the monitoring plan questions, more emphasis may be given to stream channel adjustments than to erosion from the decommissioned road prism.

### Limitations of Actual Measurement Monitoring

To ensure the accuracy of measurements and documentation, all monitoring protocols require training and spot-checking. Personnel need thorough training. To collect good data requires confidence in the use of equipment and a thorough understanding of the assumptions and questions underlying the monitoring plan.

Actual data collection takes more time than photo documentation, tracking, or BMP monitoring, because the crew will not be able to sample as many sites in the available time.

As with all monitoring, the team needs to design the method of data analysis before any data is collected. For actual measurement monitoring, a database may be necessary to expedite analysis of the data. Database development is not difficult, but the IDT must have the necessary skills or access to skills to ensure this step is taken prior to data collection.

## Best Management Practices

Best Management Practices (BMPs) are a set of practices, procedures and programs that comply with requirements of Sections 208 and 319 of the Federal Clean Water Act (PL92-500). Section 208 of the Clean Water Act states that the agencies responsible for implementing the State Water Quality Management Plan must be designated as a Water Quality Management Agency (WQMA). In California, the Forest Service has a Management Agency Agreement (MAA) with the State Water Resource Control Board designating the Forest Service as the WQMA for NFS lands in California. BMPs are identified for all land-disturbing projects. Each forest monitors the implementation and effectiveness of the BMPs for road decommissioning. (San Dimas Technology and Development Center Website, *http://fsweb.sdtdc.wo.fs.fed.us/programs/im/fy04/rdmt/*)

Each Forest Service region implements a BMP program. The monitoring reports vary from region to region, depending on what agencies are designated as responsible for implementing the State Water Quality Management Plan. Currently there is emphasis to develop a national BMP effectiveness program that is similar to the Forest Service Region 5 (Pacific Southwest Region) program.

Region 5 BMP Effectiveness Program (EP) monitoring includes the following:

- Annually develop a sample pool of all road decommissioning projects (old and new)
- Conduct an in-office review of NEPA documents, timber sale contracts, and restoration contracts to identify the water quality issues and objectives for the project.
- Conduct a field review comparing the planning document objectives to the on the ground results.
- Using the established protocols for ground cover and revegetation, rilling, compaction, slope failure, and traffic control, complete the data sheet.
- For effectiveness evaluations of stream crossings, use numeric indicators for channel adjustment, including downcutting and lateral channel adjustment. (Refer to attached R-5 BMP form and protocol link, San Dimas Technology and Development Center Website at *http://fsweb.r5.fs.fed.us/unit/ec/water/*

*final_bmpep_protocols/Final_BMPEP_Forms-Onsite_Evaluations_06_10_02.pdf*)

- Attach photographs to the data sheets at the time of field review.
- Conclude the effectiveness of the treatment with data entry into the BMP database (R5) analysis of the indicators.

**Strengths of BMP Monitoring**

The BMP format is useful for several reasons. First, review of water quality considerations in the decommissioning plan tells the reviewer what the planning team identified as the water quality values at risk. The office review may also highlight missing information about water quality objectives.

Second, the field review for implementation puts the reviewer at the site, during or shortly after the work is completed. Implementation monitoring can allow for mid-course corrections if the situation requires.

Finally, a second field review within two years after project implementation assesses treatment effectiveness.

**Limitations of BMP Monitoring**

Limitations to BMP monitoring are training, qualifications and timely evaluations.

The monitoring team should ensure that personnel resources are trained and available to conduct the BMP evaluation. Well-qualified and trained personnel reduce subjectivity and error.

BMP monitoring must occur within two years of implementation. However, if only mild weather conditions prevail during the first two years, they may not test the treatment fully. Consider the climatic factors and design storm the treatment was designed for when monitoring. Some types of problems with road decommissioning results become evident only after a large storm event.

BMP monitoring lumps dissimilar sites and treatments as one. Stratify BMP records by treatment types, geology, climatic regimes, and other variables when designing the monitoring plan.

## Photo-Point Monitoring

Photographs or digital photos are a common tool for detecting changes and trends in road decommissioning projects (Hall 2002). Photo monitoring is a simple, cost effective, and reliable procedure that documents the properties of a site. Repeat photos taken from the same location and angle are useful "change indicators" and can be sampled with dot grids to document change in vegetation and other attributes. In addition, photos can augment other more intensive monitoring.

In photographing road decommissioning work it is important to capture the appropriate scale, timing, location, and representative photo points. If this is the selected monitoring tool, or one used in combination with other monitoring, there are some key points that should be included in the monitoring plan to improve photo point monitoring quality.

Identify measurable objectives for photo documentation, including what and where to monitor. Questions related to why, when, and how to monitor should be included as a component of the monitoring plan.

Photo-point monitoring is used for implementation, effectiveness, and trend monitoring, with some attributes being easier to photograph than others. Commonly used indicators include soil cover, streambank stability, vegetative composition and revegetation of riparian areas. Table 3 provides information on the indicator, type of monitoring, and frequency.

**Keys to reliable and repeatable photo monitoring:**

Hall (2002) outline a useful set of instructions for effective photo point monitoring.

1. Take the photo from the same point, in the same direction each time the photo is repeated. Identify the location with tags or GPS readings to enable anyone to get back to the same site. Take a copy of the photo to the field for the correct settings. Don't set up a photo monitoring and record keeping system so that only you can get back to the site. A lot of invaluable information has been lost by poorly documented and maintained photo records.
2. If possible, use a camera that documents the date the photo is taken on the face of the photo. Use a white board or a photograph identification form with large letters to identify within the photo what the subject is, and its location.
3. Take the photos on or about the same time of year. Include a consistent tool for scale in each photo. Depending on what you are monitoring the scale will change, meter boards are often used for vegetation and stream bank stability. Select the appropriate tool and maintain consistency.
4. Maintain a photo notebook or use 3 X 5 cards to capture any additional information on the photo. This can be useful if other people are collecting the data. Many monitoring systems are now being designed that link Personal Desk Recorders (PDRs), Global Positioning Systems (GPS) and photographs together.

*Table 3: Items to consider when using photo-point monitoring for effectiveness monitoring of road decommissioning treatment.*

| Indicator | Considerations | Type and Time to Monitor |
|---|---|---|
| Channel Adjustment – channel cross section | This indicator is best to be measured directly and the use of photographs is in addition to the before and post treatment data. Photographs during or after an event help us understand what conditions look like during an event which can help us in design. Post event photos can capture any change in channel adjustment as a result of the event. | ***Effectiveness:*** Good quality photos can be used later in years that are not more intensively monitored and where change does not appear to be significant. ***Event:*** after storms that may "test" your design. In-channel measurements right after an event may not be feasible. |
| Soil Cover | If the treatment required a soil cover (mulch or natural) to be applied photos can be used to quantify cover. Use close-up shots of a defined plot that may be 1 square foot in size. | ***Implementation:*** taken during or immediately after project is completed. |
| Soil Cover | Photos can be taken each year to evaluate effectiveness of cover. | ***Trend and Effectiveness:*** should be taken at the same time of year. |
| Mass Wasting | It is hard to obtain before photos of this unless you have a specific area that you are concerned about. Otherwise most photos will be event driven or effectiveness monitoring. | ***Event:*** Photos taken after an event help to link weather conditions with effect. ***Trend:*** On -going monitoring of stream bank conditions or identified unstable areas taken annually can provide information on recovery. |
| Revegetation of Riparian Areas | The treatment may prescribe a certain number or density of cuttings, transplanting of sod plugs, or native seeding. | ***Implementation:*** During or right after to identify if the treatment was done correctly. |
| Revegetation of Riparian Areas | Good monitoring site selection is important since vegetation can increase dramatically. In some cases when vegetation is NOT the objective, it can obscure the indicator. | ***Effectiveness:*** annually during and or at the close of growing season. |

This is a good way to ensure that all the data is together, and that both the data and the photo point can be relocated.

5. Ensure the photo quality is adequate for its intended use. Not all digital cameras are created equal. Adjust the settings to be sure the highest resolution and image size is always used.

## Tracking Methodologies

Tracking methodologies are a tool to record completed road decommissioning treatments.

The objective of tracking tools is to record what was done, when it was done, and how much material was removed. The Forest Service tracks annual road decommissioning miles using INFRA (the FS infrastructure maintenance database). Accomplishments may also be tracked with spreadsheets or other database tools. Key information to record in spreadsheets includes the following:

- Date of activity
- Road number
- Road treatment
- Road length
- Number of road crossings treated
- Road crossing volume removed

This information may be recorded by watershed. Records can be obtained from inventory data on the condition of the road and the size of the road crossings. The database can be linked to GIS and photo documentation of each site.

## Conclusion

Interdisciplinary teams have several approaches available to monitor road decommissioning effectiveness. Each team needs to consider the goals and objectives of monitoring that are built on findings and assumptions stated in the WA and RA process. Monitoring can answer questions the interdisciplinary team has on the processes that are restored

by road decommissioning. For more information on road decommissioning effectiveness monitoring and monitoring forms, go to *http://fsweb.sdtdc.wo.fs.fed.us/programs/im/fy04/rdmt/*

**Road Decommission Monitoring Techniques Links**

http://fsweb.r5.fs.fed.us/unit/ec/water/final_bmpep_protocols/Final_BMPEP_Forms-Onsite_Evaluations_06_10_02.pdf . Link to Region 5 BMPEP for forms and protocol.

http://fsweb.r5.fs.fed.us/unit/ec/water/water-best-mgmt.pdf. Background information on R-5 BMP authority and procedures.

http://www.stream.fs.fed.us/ Link to Stream Team website

http://www.stream.fs.fed.us/publications/PDFs/RM245E.PDF Link to document on how to establish Stream Channel Reference Sites.

http://www.watershed.org/wmc/index.php - links to Watershed Management Council newsletter and database

http://www.mattole.org/ community based restoration and monitoring efforts.

http://www.cnps.org/archives/forms/releve.pdf - Vegetation Monitoring sample method use Releve' technique.

http://www.cnps.org/archives/forms/releveform.pdf - actual data form

http://www.firelab.org/firemon/pd.htm for information on ECODATA plot inventory.

http://www.fs.fed.us/pnw/pubs/gtr526/ Photo Monitoring tools

http://www.fs.fed.us/pnw/pubs/gtr503/gtr503f.pdf Photo Monitoring tools

http://anrcatalog.ucdavis.edu/pdf/8067.pdf Photo Monitoring for Better Land Use Planning and Assessment - Good resource for why and how to monitor.

http://fsweb.f5.r6.fs.fed.us/aquatics/monitoring/index.shtml Good example of watershed restoration effectiveness monitoring plan.

http://fsweb.wo.fs.fed.us/directives/fsm/7700/ References Transportation System and Roads Analysis process.

http://www.wildlandscpr.org/roads/RRtoolkit.htm Provides information on current wildlife monitoring of road decommissioning projects.

http://fsweb.nris.fs.fed.us/about_us/index.shtml NRIS website information.

http://www.fs.fed.us/rm/pubs/rmrs_gtr047.pdf Provides information on how to monitor vegetation in riparian areas.

http://fsweb.sdtdc.wo.fs.fed.us/programs/im/fy04/rdmt/ Link to San Dimas Technology and Development Center website for road decommissioning. Contains existing monitoring reports and forms by other forests.

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