Road Decommissioning Effectiveness Monitoring Techniques

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PREFACE

The Road Decommissioning Effectiveness Monitoring Techniques report presents all the issues, instructions, and formats that an interdisciplinary team (IDT) needs for developing a road decommissioning monitoring program.

The material in this report is highly useful to IDT members, their supervisors, and anyone else, who works with, or is interested in developing effectiveness monitoring plans for road decommissioning.

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 detailed information useful.

INTRODUCTION

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 tools for developing and implementing a monitoring plan for the specific needs and unique ecological conditions of each forest.

Several national forests have developed road decommissioning monitoring plans and this report builds on their hard work. Instead of advocating one method for each monitoring project and budget, this document enables users to select a monitoring technique for each situation. Attached are monitoring forms and protocols can help a district or forest interdisciplinary team design a road decommissioning monitoring program for their area.

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 during monitoring treatment effectiveness. Treatments changed from hand tools and revegetation to dozers and excavators. The same equipment that created the road now decommissioned the road.

At the same time, national forests across the country began decommissioning. 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.

Road decommissioning reduces chronic sediment delivery, restores hillslope hydrology and reduces impacts to aquatic, riparian, and terrestrial ecosystems of roads crossings. The United States Department of Agriculture (USDA) Forest Service units use different levels of decommissioning treatments to reduce road hazards. USDA 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, FSM 7705 – Transportation System) 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 analyses and roads analyses determine what treatment level or combination of treatments is appropriate. 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 final decision.

Current Status

In 2003 1,157 miles of roads were decommissioned; 735 miles of classified roads and 422 miles of unclassified roads. Since 1999, national decommissioning mileage has ranged from 1000 to over 2,000 miles per year. With limited funding for watershed restoration and public concerns over the need for decommissioning, monitoring is critical for providing feedback on treatment effectiveness and watershed recovery. Only by understanding the complex interrelationships of ecosystems and redesigning impaired systems do we know what works well and what techniques improve watershed condition.

Every IDT must define the broad goals and objectives of watershed restoration and then measure specific resource indicators in the field. The goal of monitoring road decommissioning is to ensure the correct treatment is used for the desired condition.

PART 1—THE ROLE OF ROADS ANALYSIS AND WATERSHED ANALYSIS IN ROAD DECOMMISSIONNG MONITORING

Roads Analysis

“The objective of roads analysis in the Forest Service is to provide line officers with critical information to develop road systems that are safe and responsive to public needs and desires, are affordable and efficiently managed, have minimal negative ecological effects on the land, and are in balance with available funding for needed management actions. **(FS-643 1999)**

A completed analysis informs future management decisions on the merits and risks of building new roads in previously unroaded areas; relocating, upgrading, or decommissioning existing roads; managing traffic; and enhancing, reducing, or discontinuing road maintenance.

The roads analysis process is an on-going iterative process that builds a strong scientific foundation for implementing needed actions, monitoring, evaluating, and continued learning. Roads analysis fits with planning and other analytical activities, including watershed analysis, as a tool for adaptive management.

Watershed Analysis (WA) - What are the linkages between monitoring and WA?

Watershed analysis allows specialists and managers to understand connections at a broad scale of ecosystem components. Previous analysis focused on relatively small areas. The broad scale allows team members to see patterns and processes that shape the ecosystem. Conceptual models in of watershed analysis help identify linkages between resources, ecological processes, and environmental variables. (Norman, 2000)

After the team defines the desired condition they focus on bridging the gap between the existing condition and the desired one. The IDT then identifies effective monitoring questions for testing their understanding of how perceived processes operate. Monitoring enables teams to see what happened and to analyze the results.

Inventory and Monitoring

The Natural Resource Conservation Service (NRCS) defines inventory as the systematic acquisition, analysis, and organization of resource information needed for planning and implementing land management.

Inventory poses the following questions: What it is? Where is it? How much is there? With these questions answered, the interdisciplinary team knows the condition of the road, geographic distribution, extent, and amount of work required.

The Society of Range Mangers defines monitoring as the systematic collection, analysis, and interpretation of resource data to evaluate progress toward meeting management objectives. (Adapted from SRM 1989)

Monitoring poses the following questions: How is the resource changing over time? Is the resource moving toward or away from stated objectives? To answer these questions a monitoring plan identifies indicators and threshold values that show change.

TYPES OF MONITORING

Implementation

Implementation monitoring, which takes place during and immediately after road decommissioning, asks the fundamental question: Did we do what we said we were going to do? During the project, implementation monitoring identifies the suitability of the project design for that particular area. Implementation sets the stage for other types of monitoring. (Kershner 1997)

Effectiveness

The primary purpose of effectiveness monitoring is to determine whether resource objectives were met. (Kershner, 1997) To do so, monitoring must explore spatial, temporal, dynamics, and management contexts.

The spatial component requires choosing the scale of future management and policy decisions. The temporal component helps identify when monitors can detect change. Dynamics refers to the different processes that shape the ecosystem and the ease of observing the changes. Explicit dynamics are easily observable while implicit are not as easily observable. In addition the team needs to define the temporal occurrence of processes as “continuous”, “pulsed”, “chaotic” or “random”. For example, the team may note that road density has changed sediment delivery to streams, or that road density has changed the frequency of pulses from landslides.

The IDT can use the Table 1 below as a checklist of questions to ask when developing a road decommissioning monitoring plan. Table 1 helps the team identify what they already know about the system.

Table 1. Pertinent questions in developing an ecosystem monitoring plan (Maddox et al. 1999) (Modified from Quattrochi and Pelietier, 1991)

Questions of Space	What is there?
	-Species composition
	-Community types present: their absolute and relative abundance
	-Land cover attribute (e.g., forest, field, urban)
	-Terrain attributes (e.g. topography)
	What is the pattern of ecosystems attributes?
	What is the spatial scale required for management and policy decisions?
Questions of Time	What are the temporal dynamics of ecosystem components?
	What are the temporal scales of changes in ecosystem components?
	What are the temporal scales of the effects of management?
Questions of Dynamics	**What kinds of processes shape the ecosystem?**
	-Explicit (i.e., easily observable)
	-Implicit (i.e., not easily observable)
	-Natural (i.e., undisturbed)
	-Uncontrolled disturbances (e.g., exotic species)
	-Controlled disturbances (e.g., resource harvest, controlled burning)
	Temporal occurrence of these processes
	- Continuous
	-Pulsed
	-Chaotic or random
	Biological levels that reflect or indicate these processes
	-Population dynamics
	-Community composition
	-Spatial arrangement
	-Ecosystem process (e.g., nutrient cycling)
	-Statistical index (e.g. "Index of Biological Integrity")
Questions of Management	What are the human uses?
	What are the management goals
	What are the reporting requirements (I.e., what kind of information is known to be critical for policy making and reporting to the public?

Trend

Trend monitoring reflects the change of an indicator over time, a less rigorous form of monitoring, trend monitoring usually involves visual estimates or photographs rather than absolute measures.

Validation

Validation monitoring more closely linked to research, verifies the basic assumptions behind the monitoring. Validation monitoring is a research tool with which the team can examine the basic scientific understanding of how systems work.

Tracking

Tracking is the collection of data to record accomplishments, and identify future projects. The USDA Forest Service has developed spatial and tabular databases INFRASTRUCTURE (INFRA) and Natural Resource Information System (NRIS) to track the spatial and tabular components of road decommissioning and watershed restoration. The NRIS and INFRA programs are Oracle databases. Both database systems are being improved, so that teams can better capture the important details of road decommissioning work. Good reporting enables the USDA Forest Service to monitor the effectiveness of road decommissioning and to share this information both internally and externally.

NRIS contains analysis tools that focus on data from several natural resource areas including, soils and water. When completed, NRIS can integrate resource information systems for meeting the agency's resource inventory and monitoring needs. NRIS will support field-level users on National Forests with a common set of basic data and data standards, in a common computing environment. NRIS gives everyone access to data used for natural resource decisionmaking. NRIS will continue to develop and will track and spatially record watershed improvement. (NRIS website)

COMPONENTS OF A MONITORING PLAN FOR ROAD DECOMMISSIONING

There 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. Be sure to tie monitoring results to management decisionmaking and goals. You can 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 respond to management's calendar?

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 overall goal or goals. Use findings in the Roads and Watershed analysis, LRMP goals, or Aquatic Conservation Strategy.

   Following are sample goal statements from the Aquatic Conservation Strategy:

   - 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 breakdown the goals, be patient during this step and look at the ecosystem from a broad scale.

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 watershed analysis, roads analysis, or Land and Resource Management Plan (LRMP) for the forest. If you can not find specific, measurable objectives, refer to indicators of “healthy” systems and use these for objectives.

Select monitoring objectives that best indicate change and measure them in the appropriate areas 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 your 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. Use pretreatment inventory data as a benchmark of pre-restoration condition.

6. Prioritize monitoring activities: identify what needs doing and prioritize it. For example, evaluating 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 a less intensive monitoring over a longer duration.

7. Implement field prescriptions and techniques The FSM 7712.11 identifies five treatment levels for road decommissioning. Depending on the site, you may need a combination of treatments.

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. Better yet, share the team’s findings during field trips with the leadership team or local conservancy 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.” (FS -643 1999)

Part 1 Review

The previous section provided a framework for organizing a road decommissioning monitoring program. You can use information from the watershed analysis and roads analysis to identify watershed restoration goals and objectives. Once you have identified restoration goals and objectives you can select appropriate treatments. The monitoring plan is the critical feedback mechanism for answering your questions on both implementation and effectiveness.

You should get both guidance and feedback from management on questions, activities, resources and schedules. Your team needs the skills for the design, analysis, interpretation and annual reporting of findings to management and the public.

Part 2—DESIGNING A ROAD DECOMMISSIONING EFFECTIVENESS MONITORING PLAN

The following section will help your teams write its monitoring plans. Part 2 offers a menu of different monitoring techniques from which each team can select what is most appropriate to its needs.

The first table gives examples of goal and objective statements. Later tables illustrate the links that teams can create from watershed and roads analysis findings to restoration objectives, treatments, and to measurable indicators for monitoring treatment effectiveness.

Part two describes and exemplifies the four most common monitoring methods used in monitoring road 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.

The section concludes with information on what other individuals found works well in monitoring plans and why; including links to on-line references.

The table on the following page identifies both goal and objective statements for building a monitoring plan. Remember that goal statements must be very broad, while objective statements are very specific, concise, and measurable. In some cases, teams have to write objectives from the best data available. Monitoring helps to answer questions that clarify your understanding of how complex ecosystem processes work.

Table 2: Tools for selecting goals and objectives for your monitoring plan

Select the appropriate goals for your situation:	Select the appropriate objectives for your situation:
☐ 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. ☐ Improve juvenile steelhead habitat to restore runs of summer steelhead. ☐ Restore spawning and rearing habitat for summer steelhead in the subwatershed. ☐ Restore hillslope hydrology and improve infiltration on compacted road prisms. ☐ Restore watershed functions to improve water quality, fish and wildlife habitat, and scenic value ☐ Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species. ☐ Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands. ☐ Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations. ☐ 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.	☐ 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. ☐ Remove identified unneeded crossings to achieve < 2 crossings per mile of perennial stream. ☐ Increase Channel Bank Stability to obtain an upward trend in stability, with target of 85% stability for reaches. ☐Upward or stable trend in W/D measures, as compared to reference stream data, measured at flat water habitat types. ☐ Increase structurally complex rearing habitat for juvenile steelhead as measured for deep pools and woody debris frequency in the current administrative policy. ☐ Increase the numbers of juvenile steelhead to meet downstream migrant numbers defined as optimal in state management plan. ☐ Decrease the percentage of fines in spawning gravel to less than 10% during spawning and incubation. ☐ Decrease near stream road density to 1 mi/sq mi in key watersheds. ☐ Roads occupy less than 3% of all near-stream areas within a sub-watershed. ☐ 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.

Indicators

The term indicator refers to a measure or record of change. Select indicators you can observe and measure. The following five indicators are used for determining the effectiveness of road decommissioning projects:

1. Channel adjustment both above and below the crossing.
2. Erosion rate changes from both existing road prisms (surface erosion) 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, and miles of road decommissioned.

Some of these indicators are direct indicators of change while others are indirect. You may select direct or indirect indicators depending on resource availability, priority, and treatment type.

The team may use other indicators included in the monitoring plans that are not listed above. The goals and objectives of the monitoring plan determine what indicators are included. Remember to select an indicator that will change and it is measurable or observable.

The following table provides a template for tracking watershed analysis findings, and linking restoration objectives to treatments and, eventually, to 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.

Table 3: Linking watershed process 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

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.

Forests across the country have identified four monitoring methods most often used:

1. Quantitative measurements with repeat evaluation on channel cross section, vegetative recovery transects, and evaluation of erosion rates on site.
2. Use of BMP evaluation forms 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 actual stream channel dimensions, erosion amount, and revegetation measurements taken in the field.

The team and forest management may be implementing road decommissioning with the goal of improving juvenile steelhead 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 actual stream measurements to evaluate treatment effectiveness. (See references and sample monitoring plans for the Clearwater NF, Six Rivers NF, and MT Baker Snoqualamie pp.20)

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 involves random transects across numerous segments of the treated prism. The team must ask: is their 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. (See USGS Firemon, ECODATA, on-line links for existing protocols pp. 20)

For monitoring stream channel excavations the team has several choices: First, baseline inventory data of the volume of material in the crossing is invaluable. Many times this information is available within the NEPA document or restoration contract. The monitoring questions at stream crossings include the amount of horizontal and lateral adjustment of the stream channel, and surface erosion or mass wasting. To answer these questions commonly used measurements include longitudinal channel profile, and cross sections.

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 channels characteristics. (See reference guidebook on stream channel measurements pp. 20) (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. (See volume spreadsheet or reference 6 River NF forms pp.20)

The line intercept transect used on the road prism stabilization can measure surface erosion and effective soil cover. Mass wasting documentation is evaluated the following 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 the stream.

Revegetation monitoring goes beyond 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.

The team may want protocols that best capture the type of vegetation the area is capable of producing. For example, use the Greenline protocols for monitoring meadow vegetation response after restoring a water table. In drier sites, use ECODATA, Firemon, or Releve' protocols to capture the species composition and community types present. For forested areas, the use of Forest Inventory Analysis (FIA) protocols may be most useful.

Strengths of the Actual Measurements

If the team ties actual measurement data to specific monitoring questions and succinct objective statements, it can clearly identify the effectiveness of the treatment. However, if the team has only general objectives and poorly defined monitoring questions, even actual measurements, it will make the determination difficult. Therefore matching the monitoring technique with the overall monitoring strategy is crucial.

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 the actual measurements for erosion, stream channel adjustments, and vegetation with a variety of proven and effective protocols. Mixing and matching them according to available resources, schedules, and personnel. Depending on the team's questions, it may give more emphasis to stream channel adjustments, then 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 cannot visit as many sites.

As with all monitoring, the team needs to design the method of data analysis before any data is collected. For actual measurement monitoring, an access 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. Otherwise it will be difficult for the team to meet report time frames and data may end up in a binder and not being used for adaptive management.

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 the agencies responsible for implementing the State Water Quality Management Plan must be designated as a Water Quality Management Agency (WQMA). In California, the USDA 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, both randomly and selectively basis for road decommissioning. (See R-5 website on BMPs, pp. 21)

Each region implements a BMP program. The monitoring report varies from region to region, depending on Section 208 of the Clean Water Act that determines the agencies responsible for implementing the State Water Quality Management Plan.

Most regional monitoring programs use criteria to identify BMP implementation and effectiveness. Teams conduct random or selective field evaluations with a standard protocol based on the BMP evaluation form.

BMP monitoring for includes the following:

- Annually develop a sample pool of all road decommissioning projects (old and new)
- Conduct and 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.
- 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)
- 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, the 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 also highlights missing information about water quality objectives giving feedback to the team.

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

Finally, a second field review within two years of project implementation helps assess stabilization and recovery.

Limitations of BMP Monitoring

However, districts need to consider the limitations of BMP monitoring.
The team needs to 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, mild weather conditions during the two years may not “test” the treatment fully. The team should consider the climatic factors and design storm when monitoring.

BMP monitoring can lump dissimilar sites and treatments as one. The team has to sort out treatment types, differences in 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. Although lacking in statistical significance photo monitoring is a simple, cost effective, and reliable procedure that documents the properties of a site. 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 photos 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.

The team identifies measurable objectives for photo documentation. This tells what, and where to monitor. Questions related to why, when, and how to monitor should be included as a component of the monitoring plan. For road decommissioning effectiveness monitoring, key indicators are channel adjustment, soil cover, surface erosion, mass wasting, and revegetation of riparian areas. There may be additional indicators relative to the effectiveness of your treatment on animal and aquatic response that can be included. (See wildlife monitoring website by Wildlands CPR, pp. 20)

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. Following is a table that provides information on the indicator, type of monitoring, and frequency.

Table 4: Photo-Point Monitoring Uses in Road Decommissioning

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 helps 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.

Keys to reliable and repeatable photo 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. Use a camera, which documents the date the photo is taken on the face of the photo. Utilize a white board or a photograph identification form with large letters to identify within the photo what the subject is and its location. Refer to USDA General Technical Report on Photo Point Monitoring Handbook for specifics on technique and documentation.
3. Take the photos on or about the same time of year. Include a consistent tool for scale. 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. This is a good way to ensure that all the data is together and 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. Check the settings to be sure the highest quality setting is used.

TRACKING METHODOLOGIES

The objective of tracking tools is to identify what was done, when it was done, and how much material was removed. The USDA Forest Service tracks annual road decommissioning miles using INFRA. Other groups including watershed conservancies track accomplishments with spreadsheets. Key information on 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 tracked by watershed and is especially helpful when tracking accomplishments in mixed ownership watersheds. Some of this information can be obtained from inventory data on the condition of the road and the size of the road crossings. This type of data can be entered into a GIS and access database with links to photo documentation of each area. The interdisciplinary team will want to design tracking tools that meet their needs in addition to the upward reporting at the national level.

Additional tracking tools that Forests can use and modify include INFRA and NRIS (once fully operational) to monitor changes to the transportation system and effectiveness of treatments.

INFRA

The Government Performance and Results Act of 1993 applied the principles of sound business management to the Federal government, requiring future funding to be tied to measurable needs and accomplishments. INFRA was developed as a tool to obtain complete, accurate and current information about National Forest resources. INFRA database and application tools include GIS and integration with other national applications such as the Foundation Financial Information System (FFIS), the Natural Resources Information System (NRIS), and the Automated Lands Program (ALP).

The INFRA application supports the spatial and tabular components to provide a transportation atlas for roads and trails. This is consistent with current direction found in FSM 7711.1 Forest Road Atlas:

1. The forest road atlas is a key component of the forest transportation atlas and consistent with the road inventory includes all classified and unclassified roads on National Forest System lands.
4. Unit transportation managers shall document changes in road management status. Such changes may include roads that are decommissioned, converted to other uses, added to the system, or transferred to other jurisdiction.

Direction found addressing road decommissioning data storage is located within the Travel Routes National Data Dictionary on Roads, (Version 1.3 January, 2003) This document is continually upgraded and improved to provide both National direction and consistency in our record management. It does however provide individual forests and regions latitude to utilize optional fields to document road analysis, NEPA decisions involving road decommissioning, road decommissioning level of treatment, and to maintain a chronicle of events.

There are two tools that can be utilized in the INFRA database. These include the Record of Events and the Linear Events categories. The Record of events provides the data structure to hold date related linear event information. That means data that is date related to changes that may occur on a road. This is a generic data structure that allows storage of items such as construction and decommissioning dates, or when there are route status changes. The change in the status of a road to decommission can be tracked as well as the initial analysis found in the RAP, NEPA document, and any inspection records that could include monitoring dates.

Linear Events is another category where more specific information relative to the road can be summarized. The following is a list of the various areas within the Linear Events where decommissioning information can be tracked.

Levels of Treatments

The level of treatments is a summary of the treatments completed on a decommissioned road or a road placed in storage. It describes the intensity of the work performed in relation to hydrologic, vegetative, and stability factors.

Objective maintenance level

The objective maintenance level identifies the maintenance level to be assigned at a future date. Considering future road management objectives, traffic needs, budget constraints, and environmental concerns. Once a road has been determined to no longer be needed it should be assigned a “D” for its objective maintenance level. It may be used up until that date when it is decommissioned.

Route Status

Route status is the current physical state of being of the road segment. A road segment will receive the “D” status once a RAP, NEPA, and the decommissioning work has been completed.

System

A system is a network of travel ways serving a common need or purpose, managed by an entity with the authority to finance, build, operate and maintain the route. Once a road has been identified in RAPS as being Not-needed, the route is referenced on the system and cross references with the objective maintenance level of decommission.

Strengths of INFRA and NRIS

New developments in the INFRA database make it easier to use and can accommodate additional data fields as illustrated above. Tracking and recording changes to the transportation system is imperative to the management of the national forests and allows the USDA Forest Service to share information both internally and externally.

Limitations of INFRA and NRIS

The current use of INFRA as a road decommissioning monitoring tool is limited for several reasons. First, the development of the database has not kept up with road decommissioning monitoring and many interdisciplinary teams have monitoring plans that address their goals and objectives.

Secondly, the INFRA database is maintained by individuals who are not always involved in the interdisciplinary team that develops the road decommissioning monitoring. INFRA has improved and become a more accessible tool, yet INFRA is limited to tracking rather than analysis of road decommissioning effectiveness.

NRIS is still being developed and populated so that it has the ability to track watershed improvements. Interdisciplinary teams should stay familiar with this database as it should provide valuable analysis tool in the next several years.

WHAT WORKS WELL AND WHY?

Both individuals and teams will learn from designing and implementing a road decommissioning monitoring program. Some of the lessons learned in the research for this project include:

- Individual project reports that fully document the road decommissioning effort from start to finish. This type of work is being done at RNP by each geologist assigned a road decommissioning project. The amount of material actually removed is documented, the length of time required to do the project, I project costs, and perhaps most importantly is additional considerations and information regarding how the project went. For example if they thought they would hit the channel bottom at a certain depth and did not, or hit a layer of decomposed logs that modified the project, this information was included. Individual project reports work well in giving a complete description of the project.

- California State Parks monitors the amount of time spent on each component of the decommissioning process. For example if the road decommissioning requires use of an excavator for placing slash on one mile of road that is recorded by activity. At the end of the project, they can identify the percentage of time and funds spent on removing fills, pulling culverts, excavating crossings, and placing mulch. This helps California State Parks track expenditures, compare contractors, and improves their estimate of necessary funds for future projects.

- RNP conducts erosion and turbidity monitoring of treated stream crossings evaluating the erosion following road removal at excavated stream crossings. The turbidity monitoring required specific time frames for sample collection. The location and access to the crossings was difficult to reach with in the limited timeframe. This is a good example of the protocol scrutiny the team must use to ensure data collection is do-able. Safety concerns with access to sites (during or immediately after a storm), or the chance that the only two storms over the winter occur. Would there be adequate data to analyze?

- Many individuals felt that they attained better results in the road decommissioning if they did the following:

    - Conducted on-site pre-project hikes with both the contractor and inspector to clarify expectations.
    - Conducted post-project inspections with the contractor and inspector immediately after work completed.
    - Conducted one year post project reviews with contractors. This included both new contractors as well as contractors who had actually performed the work.

This helped to clarify expectations for road decommissioning. Contractors and inspectors also benefited from the one year follow-up to see how recovery occurred.

- Several individuals had changed their monitoring strategy over time for the following reasons:

    - Erosion pin monitoring on the road prism was generally removed from the monitoring strategy after one to two years because the change was undetectable.
    - Surface erosion measurements on road prisms were also removed because of undetectable change.
    - Access trails for monitoring were designed into the road decommissioning to allow for safety.
    - Photo documentation is a very common monitoring tool since there are limited resources and personnel for monitoring. Photo point monitoring is conducted on sites that are of highest priority.
    - More intensive measures were used when interdisciplinary teams had questions of the effectiveness of the treatments.
    - Invasive plant and noxious weed monitoring was added due to concerns with the spread of these plants.
    - Monitoring questions started to change either due to regulatory agency input, or the findings from the monitoring answered the initial question.

CONCLUSION

Interdisciplinary teams have several ways to monitor road decommissioning effectiveness. Each team needs to consider the goals and objectives of monitoring that are built upon 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.

The remainder of this report contains links to websites which provide information on monitoring. In addition, monitoring forms and protocols are attached that can help a district or forest interdisciplinary team design a road decommissioning monitoring program for their area.

The remainder of this report provides information on references that are available on-line.

Glossary

Decommission. Demolition, dismantling, removal, obliteration and/or disposal of a deteriorated or otherwise unneeded asset or component, including necessary cleanup work. This action eliminates the deferred maintenance needs for the fixed asset. Portions of an asset or component may remain if they do not cause problems nor require maintenance. (Financial Health – Common Definitions for Maintenance and Construction Terms, July 22, 1998)

Forest Transportation System Management. The planning, inventory, analysis, classification, record keeping, scheduling, construction, reconstruction, maintenance, decommissioning, and other operations undertaken to achieve environmentally sound, safe, cost-effective, access for use, protection, administration, and management of National Forest System lands. (FSM 7705 – Transportation System)

Road Decommissioning. Activities that result in the stabilization and restoration of unneeded roads to a more natural state. (36 CFR 212.1, FSM 7705 – Transportation System)

Road. A vehicle travel-way more than 50 inches wide.

Classified road. A road constructed or maintained for long-term highway vehicle use. Classified roads may be public, private, or forest development

Unclassified road. A road that is not constructed, maintained, or intended for long-term highway vehicle use, such as roads built for temporary access and other remnants of short-term-use roads associated with fire suppression; timber harvest; and oil, gas or mineral activities; as well as travel-ways resulting from off-road vehicle use.

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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.