Understanding and Evaluating Cumulative Watershed Impacts

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Introduction

Considerable effort is devoted to evaluating cumulative watershed impacts during planning for forestry activities on federally managed lands. With the recently increased emphasis on reducing forest fuels, cumulative impact analyses must now evaluate a new suite of activities over a broader scale than had generally been considered in the past. It is useful to review the concept of cumulative impacts and the variety of methods used for impact analysis to identify approaches capable of addressing the new challenges.

This paper first outlines the history and definition of cumulative watershed impacts and discusses the types of interactions that complicate their evaluation. Methods used for cumulative impact evaluation are then described. Finally, the types of errors found in evaluations are identified, and the relevance of such problems is assessed by identifying flaws found to be significant by federal courts. A variety of earlier publications can provide additional insight and detail concerning cumulative impact analysis (CEQ 1997; MacDonald 2000; Reid 1993, 1998).

History and Definition

Cumulative impacts are nothing new. The importance of cumulative watershed impacts was widely recognized by the mid-1800s when a French economist described the increasing incidence of debris flows in the Alps:

> "The elements of destruction are increasing in violence...The devastation advances in geometrical progression as the higher slopes are bared of their wood, and 'the ruin from above,' to use the words of a peasant, 'helps to hasten the desolation below'" (Blanqui 1843, Address to the French Academy of Moral and Political Science, quoted by Marsh 1864).

George Marsh observed the problems caused by altered runoff and erosion in Europe and the Middle East and noted that analogous conditions were developing in America:

> "The rivers which rise in [deforested uplands of the Adirondacks], flow with diminished currents in dry seasons, and with augmented volumes of water after heavy rains. They bring down much larger quantities of sediment,

> and the increasing obstructions to the navigation of the Hudson, which are extending themselves down the channel in proportion as the fields are encroaching upon the forest, give good grounds for the fear of serious injury to the commerce of the important towns on the upper waters of that river, unless measures are taken to prevent the expansion of 'improvements' which have already been carried beyond the demands of a wise economy" (Marsh 1864).

The U.S. Congress passed the Forest Reserve Act in 1891 largely in response to the increasing concern over downstream impacts arising from rapid upland deforestation. This Act authorized the President to set aside selected forestlands, and these reserves eventually became the first national forests. The focus on watershed concerns was evident in the 1911 Weeks Law, which authorized purchase of lands for national forests if they were in the watersheds of navigable streams. In a sense, the Forest Service exists because of early recognition of cumulative watershed impacts.

The term "cumulative impacts" did not become widely used until the Council on Environmental Quality (CEQ) produced guidelines for implementing the National Environmental Policy Act (NEPA) of 1969. This particular issue arose because NEPA planning focused on specific projects or programs. The CEQ realized that a broader perspective on problems could be overlooked under these conditions—examination of a project in isolation would not reveal the impact levels that would actually be experienced. The CEQ thus specified that the overall, or "cumulative," impact level also must be evaluated, and defined the cumulative impact as:

> "...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR § 1508.7).

The term "cumulative effect" is widely used as a synonym for "cumulative impact," and the CEQ defines "effect" to be the same as "impact" in the context of NEPA (40 C.F.R. 1508.8). The CEQ did not specifically define "watershed impact," but common usage indicates that this refers to any impact that involves water flowing through a landscape, either because water-related resources are impacted or because a change in watershed processes generates the impact. Cumulative watershed impacts are just one variety of cumulative impact, but watershed impacts often are important influences on other types of cumulative impacts. Analyses of cumulative impacts on terrestrial wildlife, for example, often need to consider the cumulative influences of watershed impacts on riparian habitat.

The notable point about the definition is that there is nothing sophisticated or mysterious about it. "Cumulative" is being used simply as an adjective with thesaurus synonyms of "aggregate," "collective," "accruing," and "combined," rather than as part of a name for a new type of impact. The net impact that a resource experiences usually represents the combined effects of multiple influences, so evaluation of the cause and severity of any impact ordinarily involves assessment of multiple influences and so is, in effect, an analysis of the cumulative impact.

Interactions Between Impact-Generating Influences

The overall impact on a resource—the "cumulative" impact—differs from an "individual impact" if the total impact is affected by more than one anthropogenic influence. Influences can interact in several ways, contributing to impacts that can accumulate through time, space, or both. Impacts can accumulate as a result of repetition of an activity at a site (example: multi-cycle logging in the transitional snow zone periodically increases rain-on-snow peakflows, increasing the cumulative cost of excess downstream flood damage) or from progression of the activity to new sites (example: additional logging increases the spatial scale of the increased rain-on-snow flooding, also increasing the cumulative cost of flood damage), and they can accumulate from different coexisting activities or from different activities occurring sequentially (example: logging, housing developments, and fire all increase rain-on-snow flood peaks). Impact severity can increase either because one type of change accumulates (example: the cumulative cost of increased flood damage accrues through time) or because different influences affect the same entity (example: flood damage increases because of both increased flood peaks and increased channel aggradation). If influences from a single activity impact a resource progressively through time (CEQ 1997) or by way of multiple mechanisms (example: logging can contribute to both increased peakflows and increased aggradation, both leading to increased flood damage), the overall impact can also be evaluated as a cumulative impact.

The most widely recognized subdivision of cumulative impacts is into "additive" and "synergistic" impacts. Impact severity for additive impacts can generally be inferred by summing the effects of the component impacts. For example, reductions in municipal water supply from reservoir aggradation can be estimated by summing sediment input rates from the variety of sediment sources in a watershed. In contrast, synergistic impacts require additional knowledge if outcomes are to be predicted. For example, increased stream temperature reduces salmonid survival, as does decreased pool habitat. However, if salmonids cope with increasing temperatures by taking refuge in deep, cool pools (Nielsen and others 1994), the combined effect of increased temperatures and infilled pools would have a much greater impact than could be predicted by considering each impact separately.

Cumulative increases in impact severity can occur if an existing adverse condition increases in magnitude, duration, or frequency. Although these kinds of changes usually are associated with one another, it may be useful to consider them separately because their influences on an impacted resource may differ. Increased turbidity magnitude, for example, usually accompanies an increase in duration of high turbidity periods and an increased frequency of high turbidity spikes. If magnitudes are high enough, turbidity itself can become lethal to salmonids. At lower turbidity levels, protracted duration can result in lengthy periods during which salmonids cannot see and capture prey, while an increased frequency of moderate turbidity peaks may lead to cumulative gill damage (Newcombe and Jensen 1996). Each type of impact holds different implications for the impacted resource and requires a different approach to analysis.

Impacts can also occur because a new condition is created by an activity, as when a new chemical or species is introduced. In other cases, impact severity may increase because the sensitivity of the resource is altered. Warmer stream temperatures, for example, might increase salmonid metabolic rates, thereby increasing the salmonids' susceptibility to impacts from heightened dry-season turbidity caused by recreational off-highway vehicle use, mining, and riparian grazing.

Impacts also occur if the mechanisms that moderated impact severity during natural shifts in condition are no longer operative. In the past, for example, coho salmon may have been able to escape high turbidity events in the mainstem by taking refuge in intermittent clear-water tributaries and seasonal wetlands on floodplains (Peterson 1982). That coping strategy is defeated if road culverts block access to the tributaries or development fills the wetlands. The fish then become susceptible to impacts from conditions that once could have been tolerated or avoided. At a larger scale, regional depletion of populations can reduce a species' resilience and resistance both to anthropogenic changes and to natural disturbances such as major storms and fires.

Impacts like those affected by changes in turbidity represent the combination of multiple influences—that is, are "cumulative"—in several senses. First, an increase in turbidity is likely to be caused by multiple activities that occurred at different times in the watershed, and it is the cumulative influence of these activities that leads to the turbidity levels now seen. Second, the impact to the resource accumulates through time as altered conditions persist. Third, the impacted resource often exhibits the effects of multiple impact mechanisms associated with the changed condition. As a hypothetical example, chronically high turbidity levels might leave fish weakened to the point that they succumb to infection induced by gill abrasion during a high turbidity spike. And fourth, altered turbidity is usually just one of many impact mechanisms that combine to produce the overall impact on the resource of interest.

Interaction between responses can also lead to moderation of impact levels. For example, water releases from the base of a reservoir might reduce downstream temperatures that had been artificially raised by loss of riparian shade. Mitigation strategies are based in part on inducing responses that can compensate for, or reduce. undesired responses from other management activities.

Linkages Between Land Use Activities and Impacts

The impact mechanisms discussed above are "proximal" mechanisms—the changes experienced by the resource of concern that result in impact. In the case of watershed impacts, these proximal mechanisms often take effect at some distance downstream from the activities that ultimately caused them, and they are often delayed in time. Developing an understanding of the ultimate causes for a particular impact can be challenging both because of the inherent complexity of process interactions and because of the spatial and temporal lags those interactions create.

Off-site impacts can occur only if there is a physical transfer of material or energy from the activity site to the impact site. The flow of water provides the transfer medium for watershed impacts. Most land use activities occur on hillsides (figure 1), and most activities modify characteristics such as vegetation, topography, and soil conditions. Changes to these characteristics, in turn, influence the magnitude and timing of inputs of water, sediment, heat, chemicals, nutrients, and wood to streams. If inputs to the stream system are modified, the downstream transport of these watershed products is also modified, and downstream conditions change in response to the shift in transport rate and capacity. Furthermore, changes in the input and transport of one watershed product usually influence the input and transport of others. Decreased wood inputs, for example, may result in decreased channel roughness, causing increased flow velocities, which can increase bed and bank erosion and thereby increase sediment loads. Or, an increase in

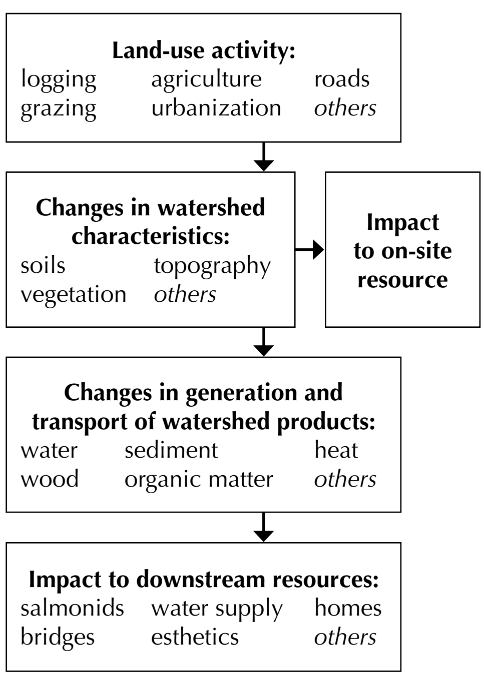

Figure 1. Relation between hillside land use activities, on-site, and off-site environmental impacts.

sediment input can aggrade a channel, causing it to shift course and undermine banks, thereby increasing wood inputs. The cascade of influences that takes effect after an upstream change depends partly on the location and nature of the change and partly on its timing relative both to other changes and to large events such as storms and droughts.

The spatial decoupling of downstream impacts from the upslope activities that triggered them obscures the circumstantial linkages between cause and effect. The locations at which an impact becomes evident depend on the distributions of

1. activities that contribute to the impact,
2. locales likely to respond to the changes, and
3. resources that might be impacted by the changes.

Different sites often respond to the same kind of change in different ways. An increased input of fine sediment, for example, may not affect channel form along steep boulder reaches but may contribute to aggradation downstream in a low-gradient reach or lake.

Temporal decoupling is also common and obscures evidence of causal linkages. Time lags between cause and response can arise for several reasons.

1. A long period of accumulation may be required before impacts become significant enough to arouse concern (example: gradual declines in a species' abundance may not be evident for a long time).
2. Different steps in the cascade of influences require different lengths of time to recover, so impacts may continue to accumulate downstream long after on-site impacts have recovered (example: an initial hydrologic change may destabilize channel banks, which continue to produce sediment even after the hydrologic regime is restored).
3. An impact may not become evident until the occurrence of an environmental trigger, such as a major drought or storm (example: slopes may appear to have remained stable until a landslide-generating storm occurs).
4. The change may not occur until the accumulated effect is great enough to trigger another suite of processes (example: accelerated sedimentation in a wetland may not be of concern until it has progressed to the point that a particular plant species begins to die out).

Interpretation of linkages may also be challenging because different kinds of changes can lead to the same response, so the cause for an impact often cannot be inferred from observation of the impact alone. The distribution and manifestation of future watershed impacts thus depends on the geography, history, and ecology of an area, as well as on the nature of contemplated land use activities. For these reasons, and because of the potential importance of synergistic interactions, causes and effects of changes must be evaluated in the context of specific locales and resources of concern.

Assessing and Managing Cumulative Watershed Impacts

Cumulative impact assessment became a challenge for federal land management agencies with the adoption of the CEQ's regulations for implementing NEPA in 1978 (40 C.F.R. 1500). The importance of environmental impacts was widely appreciated before then, but there was no mandate to consider a project as complicit in causing an impact if that project did not by itself create a significant impact. The new regulations indicated that if an impact is already significant and a new project adds to the impact, that project contributes to a significant impact. Such influences would now need to be disclosed and evaluated for projects subject to regulation by NEPA. Subsequently, various states passed legislation that requires similar evaluations for state and private projects not subject to NEPA oversight.

Before the need for cumulative impact analysis, forest management had tended to focus on the forest stand level and was based on identifying an appropriate action for the given stand condition. Hydrologists and geomorphologists were necessary for meeting forestry related goals only insofar as those goals concerned infrastructure. After implementation of NEPA, however, analysis of off-site cumulative impacts required hydrological and geomorphological expertise, but foresters, hydrologists, and geomorphologists within forest management agencies did not have a history of working together. Methods for cumulative impact analysis had to be developed that would enable the interdisciplinary work now needed and could be carried out routinely by existing personnel.

First Generation: Tactical Manuals

The Forest Service provided a decentralized response to the need for cumulative impact analysis, with approaches being designed as needed in different Regions. Most prominent among the early approaches were the Equivalent Clearcut Area method developed for Idaho and Montana, the R1/R4 Sediment-Fish Model used in the Idaho Batholith, and the Equivalent Roaded Acres method from California. This first generation of analysis methods consisted of detailed procedures that lead the user through specific calculations. Each approach effectively provides an accounting system for activity level, making it possible to manage cumulative impacts by holding a watershed's activity level below that associated with impact generation. The methods differ in assumptions about which impact is most important and in the strengths of their technical foundations.

Equivalent Clearcut Area

The Equivalent Clearcut Area approach to cumulative impact analysis was developed in the 1970s for application in northern Idaho and Montana (Galbraith 1975; USFS 1974). In this area, the impact of most concern was identified to be channel destabilization due to increased peakflows resulting from decreased evapotranspiration after logging. Altered evapotranspiration is associated directly with changes in canopy cover, so the net influence of an activity—including logging, road construction, burning, and other forest management activities—can be assessed by determining its effect on canopy cover by calculating the "equivalent clearcut area" (ECA) the activity represents. The ECA for the proposed project is then added to that already present in the watershed. If the resulting total is above the threshold considered acceptable for the area by experts, activities are deferred until the ECA recovers through time or activities are modified to produce a smaller increase in ECA.

A major advantage to the ECA approach is that it is relatively simple to implement. The analysis requires no specialized expertise and can be carried out from the office. Furthermore, anyone carrying out the analysis with the same input data will get the same answer.

Disadvantages, however, are significant. First, the method is specific to a particular type of impact. If other impacts are of concern in an area, other analyses must be done. It might be argued that if the most sensitive impact is screened for, others will be handled implicitly. However, if other impacts are caused by unrelated mechanisms, there is no reason that screening on the basis of one mechanism would produce results relevant to problems caused by another mechanism. For example, screening on the basis of increased peakflows would not identify areas sustaining impacts from acid mine drainage. Second, recovery is calculated according to that estimated for hydrologic response and does not account for the recovery rate of impacted channels. If channel morphology or fish populations require years to recover after hydrologic changes are reversed, impacts can continue to accrue from new activities taking place after hydrologic recovery. Testing of the method suggests that it may underestimate the magnitude of peakflow changes following logging (Belt 1980; King 1989).

R1/R4 Sediment-Fish Model

In the Idaho Batholith area, declining salmonid populations were a major concern, and research suggested that deposition of logging-related fine sediment in streams was contributing to salmonid decline. Considerable research was devoted to evaluating the link between specific forest management activities and erosion rates, between sediment inputs and sedimentation (Cline and others 1981), and between sedimentation and salmonid survival (Stowell and others 1983). The result is a series of models that can be used to estimate impacts on salmonid survival from the distribution of forestry related activities through time in a watershed. Recovery rates for surface erosion are incorporated, so inputs from old activities are lower than for recent ones.

This approach also is easily implemented, once the initial work is done to quantify the necessary relationships. However, the model depends strongly on the considerable research done to evaluate linkages between forestry and salmonid survival in the Idaho Batholith, so the model cannot be transported to a new area without substantial research. As was also the case with the ECA method, the approach is targeted for a particular impact mechanism and type of impact—analysis of other impacts would require different approaches.

The R1/R4 model has more recently been combined with a water balance model to construct the WATSED model (USDA 1992), now used widely in the area to estimate the combined effects of changes in runoff and sediment associated with logging.

Equivalent roaded acres

The approach for evaluating cumulative impacts developed by USFS Region 5 in California is similar to the ECA method. The focal concern in California had been identified as an increase in peakflows, and research in Oregon suggested that peakflows increase if more than 12 percent of a watershed surface is compacted. On this basis, the area compacted by each activity in a watershed is summed to determine whether the total “equivalent roaded acres” (ERA) is greater than the threshold considered appropriate for an area (for example, Haskins 1987). Here, too, recovery is assessed on the basis of recovery from compaction rather than recovery of the impacted resources. It was quickly recognized that impacts other than those from increased peakflow had to be considered. Descriptions of the method were soon revised to indicate that the calculation resulted in an index of the activity level in a watershed (USFS 1988). Thresholds of concern and weighting factors for various activities are intended to be modified to reflect conditions in each area, such as rock type and topography, and can be calibrated by measuring the activity levels associated with observed impacts. More detailed analysis is triggered if the calculated ERA approaches a threshold of concern for the watershed.

Advantages of this approach are its reproducibility and relative simplicity in calculation. The method can also be calibrated to apply to specific areas and impact types, as long as the thresholds for impact can be associated with particular activity levels.

The ERA approach shares most of the disadvantages of the ECA approach, and it also carries the implied responsibility for the user to ensure that it is appropriately calibrated for each application. As was also the case for the ECA and R1-R4 methods, there is no assurance that a single screening tool can adequately address multiple, unrelated impact mechanisms—an initial impact analysis would be needed to identify the impacts of concern and assess their associations with ERAs. The ERA approach has also not been independently tested. One study suggests that increased ERAs within 200 m of a stream are associated with impaired aquatic invertebrate communities (McGurk and Fong 1995), but it is not clear whether ERAs are a more efficient index of buffer-strip effectiveness than other metrics.

Second Generation: Strategy Guides

Use of standardized procedures such as the ERA method is very different from the approach that had been adopted by most other spheres of activity. For non-forestry applications, there did not seem to be a perceived need for a single “cumulative impact analysis tool” to address all cumulative impacts. Instead, it was recognized that any activity can influence many types of impacts at a variety of spatial and temporal scales. Each impact needs to be evaluated by analytical methods pertinent to that specific impact. A highway construction project, for example, might require analysis of cumulative changes in long-term traffic patterns at a regional scale, of cumulative peakflow changes at a small-watershed scale, and of the short-term effects of construction on cumulative siltation in a reservoir far downstream. This problem-based strategy is simply an extension of approaches to impact evaluation that have been used in the past when particular impacts were of concern. Several forestry applications have adopted the problem-based strategy, and the CEQ has provided further guidance on appropriate analysis strategies.

CDF checklist

By the early 1990s, forestry related applications began to incorporate a broader view of cumulative impacts, as exemplified by the approach eventually adopted by the California Department of Forestry and Fire Protection (CDF). Because NEPA does not apply to non-Federal jurisdictional issues, the California legislature in 1970 passed the California Environmental Quality Act (CEQA), which applies requirements similar to those of NEPA to activities under state jurisdiction. At first, CDF responded to the need to address cumulative impacts for state and private forestry by applying "best management practices" (BMPs), asserting that if direct impacts are held to a minimum, the cumulative impact will be insignificant. This approach was found by the courts to be invalid as it did not reflect the legal definition of cumulative impact (Environmental Protection Information Center v. Johnson, 170 Cal. App. 3d 604, 1st Dist., 1985). (Note: published legal opinions are here cited by volume number [170 for this case], the abbreviated name of the source [California Appellate Reporter], the series number [Third], the page number on which the opinion begins [604], the court providing the opinion, and the year of the decision; unpublished district-level opinions are cited by case number, court, and year).

In the early 1990s, CDF instituted a checklist (CDF 2009 revised) to guide Registered Professional Foresters (RPFs) through the logic trail needed to support a professional opinion of whether or not cumulative impacts were likely from a Timber Harvest Plan (THP). This kind of open-ended approach has the advantage of flexibility, potentially allowing use of appropriate analytical methods for the specific types of impacts relevant for an area.

In practice, however, the documentation required is minimal, consisting primarily of a checklist and a brief explanation of the conclusion. Although the procedure has withstood legal challenges, various commentators have questioned its credibility and effectiveness. Dunne and others (2001), for example, noted that members of their review committee had "...been told explicitly by some RPFs that, in preparing a THP, they would never conclude that a CWE [cumulative watershed effect] is likely because of the unnecessary regulatory burden that such an admission would bring."

CEQ guidance for cumulative impact evaluation

By the late 1990s it had become clear that an appreciable proportion of the cumulative impact assessments prepared for NEPA documents were inadequate (Burris and Canter 1997). In 1997, the CEQ published a manual (CEQ 1997) that outlines an appropriate approach to cumulative impact evaluation under NEPA. The recommended steps are similar to those used for more general environmental impact assessments (table 1), encompassing identification of the impacts of concern and their spatial and temporal scales of expression; description of the baseline conditions, proximal impact mechanisms and tolerance to change; determination of the influence of the project on the impact mechanisms; and description of the impact level expected after completion of the project.

The same document summarizes principles of cumulative impact analysis (table 2). Several of these points are particularly important. First, analysis is carried out from the perspective of the impacted resource. Each significant impact must be evaluated in its own right since each will be influenced by different mechanisms, appear in different places, and have different recovery rates. Second, the boundaries of the analysis area are determined by the locations of the entities that might be influenced by the activity

Table 1. Steps in cumulative effects analysis to be addressed during the components of environmental impact assessment (after CEQ 1997).

Assessment component: Scoping
1. Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals.
2. Establish the geographic scope for the analysis.
3. Establish the time frame for the analysis.
4. Identify other actions affecting the resources, ecosystems, and human communities of concern.

Assessment component: Describe affected environment
5. Characterize the entities of concern in terms of their response to change and capacity to withstand stresses.
6. Characterize stresses affecting the entities of concern and their relation to regulatory thresholds
7. Define a baseline condition for the entities of concern.

Assessment component: Determine environmental consequences
8. Identify important cause-and-effect relations between human activities and issues of concern.
9. Determine the magnitude and significance of cumulative effects.
10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.

Assessment component: Implementation
11. Monitor the cumulative effects of the selected alternative and adapt management.

Table 2. Principles of cumulative effects analysis (after CEQ 1997).

1. Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions.
2. Cumulative effects are the total effect, including both direct and indirect effects, on a given resource, ecosystem, and human community of all actions taken, no matter who (federal, nonfederal, or private) has taken the actions.
3. Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, and human community being affected.
4. It is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful. (*The boundaries for evaluating cumulative effects should be expanded to the point at which the resource is no longer affected significantly or the effects are no longer of interest to affected parties*)
5. Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries. (*Cumulative effects analysis on natural systems must use natural ecological boundaries and analysis of human communities must use actual sociocultural boundaries to ensure including all effects*)
6. Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects.
7. Cumulative effects may last for many years beyond the life of the action that caused them.
8. Each affected resource, ecosystem, and human community must be analyzed in terms of the capacity to accommodate additional effects, based on its own time and space parameters.

in question, so each issue is likely to require analysis over a different area. This need to define the analysis scope from the point of view of the impact also holds for temporal boundaries, because rates of impact expression and recovery will differ for each impact considered.

Clearly, these analytical issues are not compatible with strict adherence to standardized impact analysis methods such as the ECA, ERA, and R1/R4 approaches, and those approaches are now often supplemented by additional information concerning specific issues of concern.

The Eastwide strategy

Forest Service Regions in the eastern United States developed an analysis approach that incorporates much of the CEQ guidance (Tetra Tech 2002). The Eastwide approach follows the structure suggested by MacDonald (2000), which is based largely on the CEQ (1997) approach but differs from it in sequencing of steps, reliance on "natural range of variability," and omission of an evaluation of impact significance. Appropriate levels of analysis effort are described for different analytical contexts (a highly controversial issue, for example, would require a higher level of effort), and options for content and approach are described for each level of effort. The Eastwide Technical Guide notes that a variety of landscape- and watershed-scale analyses are available for many areas, and that these provide much of the information needed for cumulative impact analyses.

The approach outlined by the Guide differs from the other methods designed for Forest Service use because it consists of a strategy for problem solving that ensures that the appropriate topics will be considered during analysis while allowing the user to choose the analysis scales and tools appropriate for the specific issues and conditions present. Some of the issues important for cumulative impact evaluations in these Regions—and in all other Forest Service Regions—include impacts of forestry, fire, recreation, minerals exploration and mining, oil and gas exploration and mining, and rural development; relevant waterbodies include streams, wetlands, lakes, reservoirs, and groundwater; and potentially impacted resources include flora, fauna, recreational values, domestic and municipal water supplies, recreational and commercial fisheries, and many others.

An important advantage to the Eastwide Strategy is that it incorporates most of the suggestions provided by CEQ (1997). It allows any impact to be evaluated using the specific analytical techniques most appropriate for the issue and for the local conditions; provides for selection of temporal and spatial analysis scales appropriate for the problems present; and makes good use of the technical expertise present within the agency. A potential weakness, however, is the omission of guidance concerning evaluation of impact significance.

Identifying Shortcomings in Cumulative Impact Assessments

Because the need to modify standardized cumulative impact analysis procedures seems likely in view of the suggestions provided by CEQ (1997), it is useful to identify the particular aspects of non-standardized cumulative impact analyses that are likely to present analytical problems. A series of cumulative impact analyses that did not incorporate standardized methods were thus evaluated for technical content. Whether the types of problems found would be considered significant to the implementation of NEPA depends on how those technical flaws are treated by the courts, so recent legal decisions involving cumulative impact analyses were then reviewed to determine how federal courts deal with the common problems.

Problems in Cumulative Impact Analysis for Private Lands

Analytical problems were identified in 14 non-standardized cumulative watershed impact analyses and supporting documents that had been prepared for logging-related activities on private forestlands in northwest California (Reid 2004). Most of these documents were intended at least in part to meet requirements of the California Environmental Quality Act.

Each document incorporated analytical flaws that generally fell into four categories. First, the legal definition of cumulative impacts was often disregarded. Several analyses progressed without an evaluation of existing impact levels or of the contribution from "legacy" impacts, even though the definition of "cumulative impact" focuses on the combined influence of exactly these types of impacts. Another analysis argued that the cumulative impact of the plan would be beneficial because the preferred alternative would have a lower impact than one of the other alternatives. The cumulative impact, however, is the impact "on the environment"—if the overall impact is detrimental, it cannot be presented as "beneficial" simply by comparing the project's incremental addition to that of an even more damaging alternative.

The second set of problems involves evaluation of impact significance. Several analyses argued that an activity would simply perpetuate the existing level of impact instead of increasing its severity, thereby implying that the cumulative impact of the new activity is insignificant. However, the severity of an impact is necessarily defined by the level of damage to the impacted resource, and the level of damage usually increases as an impact persists. Consequently, prolonging an impact generally increases its severity.

In most of the documents examined, impact significance was determined simply through professional opinion, without any documentation of how the significance thresholds were established. One analysis evaluated the sediment input expected from a proposed project and then asserted that the added sediment would result in a negligible risk of significant impact. The analysis neglected to note that the existing impact level for sediment in the watershed had already resulted in the stream's addition to the 303d list under the Clean Water Act, so a regulatory threshold of significance had already been surpassed.

A third set of problems reflected the projects' reliance on mitigation plans to reduce expected impact levels to non-significance. Either BMPs or offsetting mitigation usually were part of the management strategy, but rarely was evidence provided that mitigation would be effective, and the overall effects of the mitigated activities on the impacted resources were not evaluated. Instead, analyses simply noted that the impact levels would be "reduced" by mitigation. However, few of the planned mitigation measures would be capable of preventing the expected impacts because mitigation generally was planned for other sites, was designed to offset different kinds of impacts, or would become effective only after the planned impacts had occurred.

The final set of problems involved technical errors in the analyses, and most of these could have been corrected by technical review. In this case, too, unsupported assertions were common. For example, one document arbitrarily considered bank erosion to be half natural and half anthropogenic. No evidence was provided to support this assumption, yet the analysis conclusions depended on it.

Problems in USFS and BLM Cumulative Impact Analysis for NEPA Documents

Examination of the private-sector analyses disclosed the general types of analytical errors that might be expected in non-standardized cumulative impact analyses, but it did not indicate whether such problems are operationally important. The operational test for the effectiveness of an impact analysis procedure is whether the method produces results that withstand legal challenges. Operational success does not imply technical success. An analysis would be considered technically successful only if its predictions are found to be accurate. Little information is available concerning the accuracy of predictions from analyses prepared under NEPA, and technical success is not considered in this paper.

Whether an analysis is litigated involves a variety of considerations, including how controversial the activity is, the nature of the population likely to be affected by the activity, and the level of legal expertise and funding within that population. An inadequate analysis for a non-controversial plan is thus likely to receive little attention, while a carefully prepared analysis for a controversial project appears to be more subject to challenge.

Federal agencies responsible for managing forestlands have received adverse decisions in a variety of recent cases involving cumulative impact analyses under NEPA. Earlier studies have examined the Forest Service record in NEPA litigation (for example, Jones and Taylor 1995; Malmsheimer 2004; and Smith 2005) evaluated federal agency success in cumulative impact litigation at the appellate level between 1995 and 2004. Most litigation is resolved at the district court level, however, so district-level opinions would also need to be examined to identify the most common operational problems with cumulative impact analysis.

Sixty-two federal district and appellate court opinions were examined to identify analytical deficiencies that were considered significant by litigants or judges. All cases were selected for review that fit the following criteria:

1. the case resulted in a final decision after January 1, 2000, that had been catalogued by LexisNexis as of June 1, 2005, or was accessible on the internet;

2. the complaint involved analysis of cumulative impacts; and either
3. the U.S. Forest Service was a defendant (39 district opinions, 13 appellate; representing 45 individual cases); or
4. the case involved forest or rangeland management (exclusive of mineral exploration) and the Bureau of Land Management was a defendant (9 district opinions, 2 appellate; 9 individual cases).

The USFS and BLM were co-defendants in one case. Of the 47 district-level opinions examined, 10 were appealed; 5 additional appellate opinions were reviewed for which district-level opinions were not available. Two of the district cases were combined into one of the appellate cases.

At the district court level, the Forest Service received adverse decisions regarding cumulative impact analysis in 21 of the 45 cases, and in two other cases, the Forest Service prevailed on cumulative impact issues but lost on other grounds. At the appellate level, the Forest Service received adverse decisions in six of 13 cases; six of the lower court decisions were reversed. Overall, the Forest Service prevailed in 47 percent of the final cumulative impact decisions for the 45 original cases. Regions 6 (Oregon and Washington; involved in 29 percent of the cases) and 9 (Lake States and Northeast; 20 percent) together accounted for nearly half of the cases. District courts under the 9th Circuit Court of Appeals handled 70 percent of the cases.

Twenty-nine of the 53 initial BLM and USFS cases (table 3) involved Environmental Assessments (EAs) leading to a "Finding of No Significant Impact" (FONSI). In most of these cases, plaintiffs argued that the EA does not adequately demonstrate that a significant impact is not likely because either

1. the analysis is technically invalid;
2. it does not consider the appropriate past, present, or foreseeable future actions; or
3. the finding of insignificance is insufficiently supported (in other words, "conclusory").

If the EA is found to be inadequate, either it must be revised to correct its deficiencies, or, if evidence is compelling that the evaluated impacts may be significant, an EIS

Table 3. Issues contested in cases involving cumulative impact analysis.

	All cases (EA, EIS, or CE)					EA		EIS	
Contested issue	**Number of cases[a]**	**Percent of cases[b]**	**Agency losses (number)**	**Category percent lost[c]**	**Total percent lost[d]**	**Number of cases**	**Cases lost**	**Number of cases**	**Cases loss**
Technically inadequate analysis	45	82	25	56	45	23	11	21	14
Combined activities disregarded	36	65	23	64	42	21	13	14	10
future activities	29	53	19	66	35	16	10	13	9
present activities	21	38	14	67	25	12	7	8	7
past activities	14	25	12	86	22	7	6	7	6
Conclusory non-significance	27	49	17	63	31	20	11	6	6
Other regulations violated	26	47	15	58	27	13	6	11	8
Data insufficient or out of date	18	33	10	56	18	9	6	9	4
Mitigation inadequately supported	17	31	11	65	20	10	7	7	4
Inappropriate tiering	17	31	15	88	27	9	9	8	6
Inappropriate analysis area	13	24	7	54	13	8	4	5	3
Other views inadequately disclosed	10	18	8	80	15	3	3	7	5
Specific impact not evaluated	10	18	9	90	16	6	5	3	3
Improper segmentation	6	11	4	67	7	2	1	4	3
Overall	**55**	**100**	**33**	**60**	**60**	**29**	**16**	**24**	**16**

[a] Two cases involving both an EA and an EIS are evaluated separately for each category.
[b] Percentage of the cases examined in which the issue was contested.
[c] Calculated from the number of decisions adverse to an agency on a particular issue divided by the number of cases in which the issue was contested (e.g., agencies received unfavorable opinions regarding analysis of future activities in 19 of the 29 cases regarding future activities, resulting in adverse decisions on that issue in 66 percent of those cases).
[d] Calculated from the number of decisions adverse to an agency on a particular issue divided by the total number of cases examined (e.g., agencies received unfavorable opinions regarding analysis of future activities in 19 of the 55 cases, resulting in adverse decisions on that issue in 35 percent of the cases).

must be prepared—the latter was required in nearly one-third of the adverse decisions. Plaintiffs ultimately prevailed on cumulative impact issues in 55 percent of the EA cases, five of them after appeal.

Twenty-two of the cases challenged an EIS, and two others challenged both an EA and an EIS. Agencies ultimately prevailed on cumulative impact issues for an EIS in only 33 percent of these cases. The significance of a prospective impact is not itself a central issue in most EIS cases because lack of impact is not a requirement for proceeding with a project. Instead, adequacy of the document is based primarily on whether it demonstrates that the agency has the appropriate information to allow an informed decision. However, significance becomes important indirectly because an informed decision cannot be made if an impact was omitted from the analysis because it was incorrectly determined to be insignificant. Although the commonly alleged deficiencies are similar to those raised for EA cases, technical challenges are slightly more prevalent in EIS cases. If the EIS is found to be inadequate, it must be revised to correct the deficiencies.

The two remaining cases concern Categorical Exclusions (CE), and these decisions focus on whether the planned activity fits the criteria needed to allow the activity to proceed without further NEPA documentation. Categorical Exclusions are based on an assumption that particular types of activities usually do not generate impacts and so usually do not require impact analysis. However, the Forest Service Handbook indicates that in some cases the generalization does not apply (FSH 1909.15 ch. 30.3.3). Excluded activities thus must be screened to ensure that the particular application of the activity will be as benign as expected, and if this initial evaluation suggests that the specific implementation of the activity may be problematic, additional analysis is required. Cumulative impact arguments can become important in such cases if the exclusion is being challenged on the basis of potential cumulative impacts.

Overall, the two most common complaints are inadequate technical evaluation and inadequate consideration of the impacts of other past, present, or future actions. Even though courts generally accord agency experts deference in technical issues, plaintiffs prevailed in 56 percent of the cases in which the quality of the technical evaluation was in question. The most common technical inadequacies are conclusory assessments unsupported by evidence and reliance on models that had not been validated for the conditions present. In addition, data were alleged to be insufficient or out of date in one-third of the cases, and plaintiffs prevailed in 56 percent of the cases in which data sufficiency was challenged.

Plaintiffs also prevailed in 64 percent of the cases in which adequacy of the evaluation of impacts from past, present, or reasonably future activities was at issue. The most frequent flaw in this category was the failure to include analysis of specific future actions that either (1) would follow logically from the proposed action (such as maintenance activities that necessarily follow if a particular activity is initiated) or (2) were already proposed and could have impacts that would overlap with those of the proposed activity. Analyses were generally considered flawed if past or future actions were simply listed or if activities on other ownerships were ignored.

The need to evaluate interactions between the effects of the proposed project and those of reasonably foreseeable future projects was carefully distinguished from the need to avoid improper segmentation of analyses: projects that are themselves "cumulative," "similar," or "related" need to be combined under a single NEPA document to avoid obscuring potential interactions between impacts. Courts generally provided agencies with the discretion to determine which projects should be combined for consideration in a single EA or EIS. However, even when segmentation was found to be justifiable, the individual projects needed to be evaluated as reasonably foreseeable future projects in each others' EA or EIS—cumulative impact analysis could not be avoided by preparing multiple documents.

The third most common issue of contention was lack of support for determinations of non-significance. This issue was most common in EA litigation because a FONSI cannot be obtained unless the project will have no significant impact, but an EIS must also demonstrate non-significance for particular impacts if further analysis is not to be provided for those impacts. Findings of non-significance were determined to be inadequately supported for particular impacts in all six EISs for which the issue was raised.

Assessment of the effectiveness of mitigation becomes important in EAs if a potentially significant impact is found that must be mitigated to insignificance in order to obtain a FONSI. The effectiveness of mitigation thus was contested in 34 percent of the EA cases. Here, too, agency analyses tended to prevail unless no evidence was provided for mitigation effectiveness.

Twenty-seven percent of the documents were found to be flawed in part because they were tiered to other documents that were either outdated, incomplete, or were not themselves NEPA documents. "Tiering" under NEPA refers to the common practice of incorporating the findings of a more general NEPA document—such as an EIS for a Forest Plan—into a project-specific NEPA document to avoid duplication of effort. With tiering, the NEPA document can simply state that a particular analysis was carried out in an earlier NEPA document that has already undergone review; the earlier analysis is then not subject to additional review. However, an EA or EIS cannot tier to a document that has not already been reviewed under NEPA. Information from non-NEPA documents, such as watershed analyses and published papers, is expected to be used in an EIS or EA, but the NEPA document applies the information to the specific project in question. The apparent importance of tiering as a legal issue may in part reflect *post hoc* rationalizations for why analyses of particular issues were not included in an EIS or EA.

The area selected for the cumulative impact analysis was at issue in 24 percent of the cases. For this issue, too, courts are strongly inclined to defer to agency judgment unless the decision is not explained or clearly conflicts with legislative intent. Agencies lost on this issue, for example, if the analysis area was shown to exclude a potentially significant impact to which the planned activity would contribute.

Courts' Requirements for Valid Analyses

The most common flaws identified by federal courts in cumulative impact analyses prepared by federal land management agencies are similar to those found in private-sector analyses in northwest California In both contexts, misunderstandings of the definition of cumulative impacts and inappropriate evaluations of significance and mitigation effectiveness are common, as are technical errors. For many of the problem areas, courts have described the standards expected of a valid analysis as they explained why particular analyses are inadequate. Such instructions from an appellate court are held as precedent-setting by district courts in the same circuit (for example, a California or Idaho District Court would apply the standards set by the 9th Circuit Court of Appeals), and are also often cited by appellate courts in other circuits (for example, 9th Circuit decisions regarding cumulative impact analysis are often cited as a basis for opinions in other Circuits where such cases are uncommon). District-level opinions, in contrast, do not establish precedent and are rarely cited, but are useful indicators of how the precedents set by appellate courts are being applied.

General Standards for Evaluation

Cases concerning documentation required by NEPA are usually evaluated according to standards set by the Administrative Procedure Act. The Supreme Court described what constitutes a violation of that Act: "Normally, an agency rule would be arbitrary and capricious if the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise" (Motor Vehicle Mfrs. Assn. v. State Farm Mutual, 463 U.S. 29, Supreme Court 1983). Courts further indicate that an agency decision is not valid if it "is contrary to the governing law" (Lands Council v. Powell, 379 F.3d 738, 9th Cir. 2004), and that agency expertise need not be accorded deference if there is a "clear error of judgment" (Kern v. BLM, 284 F.3d, 9th Cir. 2002). In Earth Island Inst. v. USFS (351 F.3d 1291, 9th Cir. 2003) the 9th Circuit Court of Appeals noted that factual errors, too, may undermine agency discretion if it can be shown that an agency "unreasonably relied upon inaccurate data," because of the requirement that "Agencies shall insure the professional integrity, including the scientific integrity, of the discussions and analyses in environmental impact statements" (40 C.F.R. § 1502.24). Barring such conditions, however, courts generally defer to agency personnel on technical issues.

The governing laws in most litigation regarding USFS cumulative impact analyses include NEPA, the National Forest Management Act, the Endangered Species Act, and occasionally the Clean Water Act. Under NEPA, agencies are required to take a "hard look" at the environmental consequences of planned actions to ensure that agency decisions are fully informed. Litigation thus commonly focuses on whether agency personnel "abused their discretion" by approving a NEPA document that failed to "take a hard look" at environmental impacts.

Overall Analysis

Several appellate opinions discuss the types of information needed in cumulative impact analyses under NEPA. The 9th Circuit Court of Appeals explained, "To 'consider' cumulative effects, some quantified or detailed information is required. Without such information, neither the courts nor the public, in reviewing the Forest Service's decisions, can be assured that the Forest Service provided the hard look that it is required to provide...general statements about 'possible' effects and 'some risk' do not constitute a 'hard look' absent a justification regarding why more definitive information could not be provided" (Neighbors of Cuddy Mountain v. USFS, 137 F.3d 1372, 9th Cir. 1998).

Courts frequently stress the intended utility of the analysis: "The cumulative impact analysis must be more than perfunctory; it must provide a 'useful analysis of the cumulative impacts of past, present, and future projects' " (Kern v. United States Bureau of Land Mgmt. 284 F.3d 1075, 9th Cir. 2002). And again, "The EIS must analyze the combined effects of the actions in sufficient detail to be 'useful to the decisionmaker in deciding whether, or how, to alter the program to lessen cumulative impacts' " (Muckleshoot Indian Tribe v. USFS, 177 F.3d 800, 9th Cir. 1999).

The 1985 decision for *Fritiofson v. Alexander (*772 F.2d 1225, 5th Cir. 1985, reversed on other grounds by Sabine River Auth. v. Dep't of the Interior, 951 F.2d 669, 5th Cir. 1992) explained, "Given the CEQ regulations, it seems to us that a meaningful cumulative-effects study must identify:

1. the area in which the effects of the proposed project will be felt;
2. the impacts that are expected in that area from the proposed project;
3. other past, present, and reasonably foreseeable actions that have or are expected to have impacts in the area;
4. the impacts or expected impacts from these other actions; and
5. the overall impact that can be expected if the individual impacts are allowed to accumulate."

This list was subsequently cited by the DC. Circuit Court of Appeals in Grand Canyon Trust v. FAA (290 F.3d 339, DC Cir. 2002) and by district courts in the 1st, 2nd, 4th, 5th, and 11th Circuits.

Past, Present, and Reasonably Foreseeable Future Actions

Several decisions provide insight into requirements for evaluating the effects of other actions. According to the 9th Circuit, for example, "The general rule under NEPA is that, in assessing cumulative effects, the Environmental Impact Statement must give a sufficiently detailed catalogue of past, present, and future projects, and provide adequate analysis about how these projects, and differences between the projects, are thought to have impacted the environment" (Lands Council v. Powell, 379 F.3d 738, 9th Cir. 2004).

A district court opinion pointed out, in addition, that because the cumulative impact is the overall impact, the aggregate impact of past, present, and future actions would need to be evaluated (EPIC v. Blackwell, no. C-03-4396 EMC, N. Dist. California 2004). This comment underscores the central point of cumulative impact analysis: the cumulative impact on a resource is the overall anthropogenic impact experienced by the impacted resource.

The CEQ has recently provided additional guidance on this issue (Connaughton 2005), noting that a listing of individual past, present, and future projects is not necessarily required because it is the aggregate effect of projects that is important. However, individual projects would still need to be identified "if such information is necessary to describe the cumulative effect of all past actions combined." Courts are explicit in indicating that the present condition, representing an existing aggregated impact level, cannot be interpreted as the condition against which the cumulative level of impact is to be judged (see, for example, Grand Canyon Trust v. FAA, 290 F.3d 339, D.C. Cir. 2002). Instead, the current condition would need to be compared to the naturally occurring condition to identify the current and likely future levels of impact: the CEQ specifies that a description of the "baseline" condition of the resource of concern "should include a description of how conditions have changed over time and how they are likely to change in the future without the proposed action" (CEQ 1997). For example, the significance of a project's addition of 50 t yr^{-1} km^{-2} of sediment to an existing sediment load of 800 t yr^{-1} km^{-2} can be interpreted only if the naturally occurring sediment load is estimated. If the natural load were itself 800 t yr^{-1} km^{-2}, the cumulative post-project input of 6 percent over the natural background load would not likely be significant. In contrast, if the natural load were originally 30 t yr^{-1} km^{-2} and other human activities had already raised the pre-project load to 800 t yr^{-1} km^{-2}, the cumulative post-project input of about 2,700 percent over the natural background load would be highly significant. In the latter case, the existing aggregated impact level at the time of the project would already be about 2,600 percent over naturally occurring levels, and the project would add further to an already significant cumulative level of impact.

Information concerning individual past projects also may be needed to allow prediction of a project's direct and indirect impacts (Connaughton 2005), which then provides the basis for analyzing the project's contribution to the cumulative impact. This is the function noted by the 9th Circuit's opinion in Lands Council v. Powell (379 F.3d 738, 9th Cir. 2004) regarding the need to "...provide adequate analysis about how these projects, and differences between the projects, are thought to have impacted the environment," and by an opinion from a district Court: "While this argument [assessing current aggregated impact levels without identifying activities that contributed to the current levels] may have some validity in that current conditions will obviously reflect in some measure the effects of past environmental degradation, it ignores the failure of the Whiskey South EA to discuss in sufficient detail the connection between prior activities and the current project, which is critical to understanding what alternatives may produce the least environmental harm while still meeting project goals" (Idaho Conservation League v. Bennett, CV 04-447-S-MHW, District of Idaho, 29 Apr 2005). Unless the projects that led to existing impacts are identified and their characteristics are contrasted with those of the proposed project, it is difficult to support an argument that the outcome from proposed activities will be different than in the past.

Incorporation of Professional Opinion

Courts do not consider simple reliance on professional judgment to be adequate—decisions based on expert opinion are considered "conclusory" unless some supporting evidence is provided. The 9th Circuit explained the limitations of professional judgment: "...allowing the Forest Service to rely on expert opinion without hard data either vitiates a plaintiff's ability to challenge an agency action or results in the courts second guessing an agency's scientific conclusions. As both of these results are unacceptable, we conclude that NEPA requires that the public receive the underlying environmental data from which a Forest Service expert derived her opinion. In so finding, we note that NEPA's implementing regulations require agencies to "identify any methodologies used and ... make explicit reference by footnote to the scientific and other sources relied upon for conclusions" used in any EIS statement. 40 C.F.R. § 1502.24." (Idaho Sporting Congress v. Thomas, 137 F.3d 1146, 9th Cir. 1998; internal citations omitted). In contrast, when the basis for the expert opinion is documented and supporting evidence is provided, courts routinely defer to the opinions of agency experts on technical matters (for example, Shenandoah Ecosystems Defense Group v. USFS, 144 F. Supp. 2d 242, W. Dist. Virginia, Harrisonburg Div., 2001).

Courts have also indicated the importance of disclosing and discussing reasonable opposing opinions or alternative interpretations: "...the court should 'ensure that the statement contains sufficient discussion of the relevant issues and opposing viewpoints to enable the decisionmaker to take a 'hard look' at environmental factors, and to make a reasoned decision'" (Natural Resources Defense Council v. Hodel, 865 F.2d 288, D.C. Cir. 1988; and Izaak Walton League of America v. Marsh, 655 F.2d 346, D.C. Cir. 1981).

Reliance on Modeling

Courts often find expert opinion to be inadequately supported if the experts have relied on modeling tools that have not been validated for the particular areas or conditions to which they were applied. In a recent case, the 9th Circuit noted, "The Forest Service, granted appropriate deference, still does not demonstrate the required reliability of the spreadsheet model. We are asked to trust the Forest Service's internal conclusions of the reliability of the spreadsheet model when the Forest Service did not verify the predictions of the spreadsheet model. Under the circumstances of this case, the Forest Service's basic scientific methodology, to be reliable, required that the hypothesis and prediction of the model be verified with observation" (Lands Council v. Powell, 379 F.3d 738, 9th Cir. 2004).

The same decision explained that "NEPA requires that the Environmental Impact Statement contain high-quality information and accurate scientific analysis. 40 C.F.R. § 1500.1(b). If there is incomplete or unavailable relevant data, the Environmental Impact Statement must disclose this fact. 40 C.F.R. § 1502.22." On this basis, the court also found the use of a model relating hydrologic change to increased sedimentation to be inappropriate: "The Forest Service's heavy reliance on the WATSED model in this case does not meet the regulatory requirements because there was inadequate disclosure that the model's consideration of relevant variables is incomplete. Moreover, the Forest Service knew that WATSED had shortcomings, and yet did not disclose these shortcomings until the agency's decision was challenged on the administrative appeal. We hold that this withholding of information violated NEPA, which requires up-front disclosures of relevant shortcomings in the data or models."

Assessing Impact Significance

Conclusory statements are particularly prevalent in findings that impacts will not be significant. Accordingly, the 9th Circuit stressed that "An agency's decision not to prepare an EIS will be considered unreasonable if the agency fails to supply a convincing statement of reasons why potential effects are insignificant" (Save the Yaak Committee v. Block, 840 F.2d 714, 9th Cir. 1988).

In assessments of significance, courts frequently refer explicitly or implicitly to the CEQ definition of cumulative impact to determine whether the intent of the regulation is being met. For example, a district court in Ohio found that a Forest Service analysis of significance did not actually address cumulative impacts: "...The Forest Service considers the following statement to be cumulative impact analysis: 'If the 150 bats wintering on the Forest were to be lost for any reason, over 99.9 percent of the total population would remain unaffected.' This is not cumulative impact analysis. The Forest

Service fails to acknowledge whether all of the other federal agencies with populations of Indiana bats present take such a cavalier attitude toward the preservation and recovery of the species. If each National Forest, National Refuge, National Park, and other federal lands does take such an attitude, then the effects are truly significant and, in layman's terms, catastrophic... " (Buckeye Forest Council v. United States Forest Service, No. 1:04-Cv-259, S. Dist. Ohio, W. Div., 2004). The Forest Service analysis was clearly inconsistent with the CEQ definition: "...Cumulative impacts can result from individually minor but collectively significant actions...."

Legal opinions provide additional guidance concerning the standards against which significance is to be assessed. For example, the Forest Service had argued in an EA that sediment inputs from salvage logging following a wildfire would be insignificant because they would be small compared to those caused by the fire. The Court responded, "Whether the increased erosion from logging and roadbuilding is smaller or larger than that produced by the fire is irrelevant. The proper evaluation should identify the impact of the increased sediment from the logging and roadbuilding on the fisheries habitat in light of the documented increases that already have resulted from the fire" (Blue Mountains v. Blackwood, 161 F.3d 1208, 9th Cir. 1998).

Similarly, defendants in a case not included in the present survey argued that the relevant standard against which to evaluate the significance of an impact is the current condition, the "no-action alternative." By doing so, they found that the proposed project would not provide a significant increase in impact over existing levels. The court, however, held the argument untenable, reaffirming that significance is to be evaluated for the overall impact and not for the incremental addition caused by the project: "Because there is no analysis of cumulative noise impact on the Park against which the additional noise impact of the replacement airport can be evaluated, the FAA's error in ignoring cumulative impact of man-made noise is not harmless...for the FAA has impermissibly taken 'a foreshortened view of the impacts which could result from the act' of constructing the replacement airport" (Grand Canyon Trust v. FAA, 290 F.3d 339, D.C. Cir. 2002).

Once the overall impact level is evaluated, assessment of the significance of that impact level must then take into account both the context of the impact and its intensity, and regulations identify particular aspects of intensity that should be considered (40 CFR 1508.27). As noted by the regulations (table 4), other governing legislation may establish specific criteria for significance. For example, if a waterway is listed as impaired

Table 4. Factors to consider for evaluating impact "significance" under NEPA (40 CFR 1508.27).

(a) **Context.** This means that the significance of an action must be analyzed in several contexts, such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.

(b) **Intensity.** This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity

- (1) Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.
- (2) The degree to which the proposed action affects public health or safety.
- (3) Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
- (4) The degree to which the effects on the quality of the human environment are likely to be highly controversial.
- (5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
- (6) The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
- (7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.
- (8) The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.
- (9) The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.
- (10) Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

under section 303(d) of the Clean Water Act, the impact level is already deemed significant by regulatory agencies.

Effectiveness of Mitigation

If an impact being evaluated in an EA is potentially significant, plans often include a mitigation program to reduce the overall impact to insignificant levels, and this practice creates additional analytical challenges because the document must then evaluate the effectiveness of mitigation (FSH 1909.15, Ch.10.15). Courts then may need to determine whether the mitigation plans are indeed adequate to ensure that impacts will be insignificant: "In evaluating the sufficiency of mitigation measures, we consider whether they constitute an adequate buffer against the negative impacts that may result from the authorized activity. Specifically, we examine whether the mitigation measures will render such impacts so minor as to not warrant an EIS" (National Parks and Conservation Association v. Babbitt, 241 F.3d 722, 9th Cir. 2001).

A District Court opinion further indicates the kind of analysis considered appropriate: "BLM...relied entirely upon future permits and mitigation plans in determining that these impacts would not be significant.... The mitigation measures must be 'developed to a reasonable degree,' however, and neither a 'perfunctory description' nor a 'mere listing' of measures, in the absence of 'supporting analytical data,' is sufficient to sustain a finding of no significant impact" (Western Land Exchange Project v. BLM, 315 F. Supp. 2d 1068, Dist. Nevada 2004; internal citations omitted). The same opinion also notes that BLM intended to institute a monitoring program to determine the nature of likely impacts and plan future mitigation efforts, but "Where research is necessary to determine the extent of an unknown and possibly significant environmental risk, an EIS should be prepared so that the research can be done and the decision made in reliance on that information, rather than the other way around....BLM's reliance on an unwritten, untested, and unsupported monitoring plan in the face of unknown and possibly significant environmental impacts does not excuse its decision to forego an EIS" (internal citations omitted).

Courts also have noted that the timing of mitigation is important if impacts are to be reduced to insignificance. In Klamath-Siskiyou Wildlands Center v. USFS (no. Civ. S 03-1334 FCD DAD, N. Dist. California 2004), mitigation work was scheduled after the planned logging, so the near-term impacts of logging on runoff would not be offset by mitigation: "The fact remains, however, that short term impacts to the watershed will occur, and those impacts appear significant and highly uncertain. Neither the net long term benefits of the program, nor the risk associated with not implementing the project, relieve the Forest Service of its duty to conduct an EIS when the project will have significant environmental impacts. 40 C.F.R. §1508.27(a)."

Conclusions

As federal courts repeatedly note, the role of NEPA documents is to demonstrate that there has been a "hard look" taken at the potential impacts of a project and that those impacts are understood well enough that surprises are unlikely. It is then the responsibility of agency personnel to decide how to use the resulting information: "NEPA merely prohibits uninformed—rather than unwise—agency action" (Robertson v. Methow Valley Citizens Council, 490 U.S. 332, Supreme Court 1989). Given the guidance provided by the CEQ and the federal courts, it is clear that the preparation of a useful cumulative impact analysis is not unduly complicated or onerous ("NEPA does not require the government to do the impractical" Inland Empire Public Lands Council v. USFS, 88 F.3d 754, 9th Cir. 1996).

Much of the confusion surrounding analysis of cumulative watershed impacts for forest management applications appears to arise from misunderstandings of the nature of cumulative impacts. In this context, "cumulative" simply means "total" or "combined";

a directive to evaluate the cumulative impact on a resource simply means that the overall impact on that resource is to be assessed. The influence of an individual project is then evaluated as the extent to which that project will augment or diminish the overall impact level for the resource. Such an analysis would take into account potential interactions between environmental changes caused by the project and by past, present, and reasonably foreseeable future projects. Spatial and temporal scales for analysis would be determined by the spatial and temporal scales at which potential impacts would be expressed, and would vary by impact. Similarly, the level of quantitative rigor employed would be selected to be appropriate for the context and issues present.

Such an approach might be facilitated by rephrasing the underlying question from "What are the cumulative impacts of the project?" to "What are the impacts of concern in the area, and how might the proposed project influence those impacts?" With this reformulation, the focus is shifted to specific impacts, those impacts are defined from the perspective of the impacted resources, and the problem becomes recognizable as one that agency resource specialists already know how to address.

Most of the problems encountered with the private-sector and agency analyses that were examined would have been avoided had the analyses been subject to rigorous technical review and had the procedure outlined by CEQ (1997) been followed. The analysis steps required for such an evaluation have already been carried out to some extent if a watershed analysis is available for the area in question. Such analyses should already outline the impacts of concern and their severity, distribution, and causal mechanisms. Watershed analysis carried out under the Northwest Forest Plan (REO 1995), for example, accomplishes steps 1, 2, 3, 4, 6, 7, and 8 of the CEQ procedure outlined in table 1. Although a project-based NEPA document cannot simply state that cumulative impacts have already been analyzed through watershed analysis (in other words, it cannot "tier" to a watershed analysis), it can take advantage of the analytical work already done by watershed analysis in the same way that it makes use of other scientific literature, as long as the "...study is reasonably available to the interested public" (Connaughton 2005). The increment added by the NEPA document would then evaluate how the particular project influences the mechanisms and impacts already evaluated by the watershed analysis. This approach has the added advantage of efficiency: a single watershed analysis can provide the background information necessary for analyzing the cumulative watershed impacts of any number of projects occurring within the watershed. The most useful route to development of effective cumulative impact assessments for federally managed forestlands may be through adaptation of the watershed analysis procedure to more consistently provide the information that will be needed by future cumulative impact analyses.

Whatever procedure is used for analysis, three issues remain that are of particular importance. First, more guidance would be useful for assessing the significance of impacts. The CEQ has provided a list of factors to be considered to assess significance (table 4) and calls for evaluating the capacity of a resource to withstand additional change, but the ultimate determination of significance is often a value-based decision. Development of a defensible procedure for making such determinations would simplify future analyses. Second, the information needed to determine whether past analyses provided accurate predictions is not available. A study to compare on-the-ground outcomes with predicted impact levels would be useful, as would a program to monitor the accuracy of future analyses. Only through such work can analytical procedures, mitigation, and management practices be improved. Finally, and perhaps most importantly, the quality of any analysis ultimately depends on the expertise and technical knowledge of those preparing the analysis.

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