

PLANNING ENVIRONMENTAL MONITORING PROGRAMS WITHIN THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

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Monitoring of impacts resulting from proposed projects has been included as a component within the environmental impact assessment (EIA) process of numerous countries and entities since the mid-1980s. Many studies have delineated both purposes and benefits of such monitoring. However, lesser attention has been given to technical guidance for planning and implementing monitoring programs as part of the EIA process. This paper summarizes several technical elements that should be included in monitoring programs; the elements were identified via published literature and the systematic review of described programs in nine environmental impact statements (EISs) prepared in the 1993–94 time frame. The EISs ranged from timber sales to developments in recreational areas to resource management planning. Based upon this review, 12 elements are recommended for inclusion, as appropriate, in planning and implementing monitoring programs.

Keywords: Monitoring programs; EIA process; environment

1. INTRODUCTION

Environmental monitoring was not explicitly delineated or required by the wording of the National Environmental Policy Act (NEPA) in the United States. However, such monitoring can be implemented as part

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of the NEPA process, pursuant to Sections 1505.2 (c) and 1505.3 of the 1979 Council on Environmental Quality (CEQ) regulations. Section 1505.3 states in part that... "agencies may provide for monitoring to assure that their decisions are carried out and should do so in important cases" [1]. The relevant portion of Section 1505.2 (c) is that... "a monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation [1]. As can be surmised from these two stipulations, they are primarily focused on implementing and improving mitigation measures. However, no all-encompassing guidance has been delineated on how monitoring programs should be planned, implemented, and utilized within the environmental impact assessment (EIA) process in the United States.

Several publications from the 1980s advanced the concept of post-EIS (environmental impact statement) monitoring as an extended component of the EIA process [2-4]. These illustrations and other delineated examples of monitoring objectives, and the advantages and limitations of monitoring programs [5-9]. Recent books on EIA have included separate chapters focused on monitoring [10, 11]; in addition, one addressed resource specific monitoring in separate chapters dealing with impacts on such environmental resources or components thereof [12].

Many EIA professionals have indicated that environmental monitoring can improve the EIA process through providing information for: (1) refinements in impact prediction technologies; (2) evaluation of mitigation measures; (3) warnings of unanticipated or significant impacts; (4) documentation of project need; and (5) more thorough descriptions of the affected environment. In addition to the lack of overall guidance, other factors hindering the effective implementation of monitoring programs include limited funding, time constraints, resistance by project proponents to plan and implement monitoring programs, the belief that monitoring is already done by other agencies, and agency staffing requirements.

Detailed planning for a monitoring program can include many considerations; examples of such considerations are related to delineating monitoring objectives, selecting sampling locations and parameters to be measured, utilizing appropriate analytical procedures, storing and retrieving data, interpretation of the collected information, preparation of written reports, and implementing certain

follow-on measures based on the monitoring results. An overall framework for planning a monitoring program is available [7]. Monitoring planning in relation to specific environmental media or resources is addressed in several other publications [12–15]. Specific detailed information on monitoring planning for environmental components is also available; for example, biological or ecological monitoring is addressed in several books [16–18].

Some federal agencies have developed guidance on environmental monitoring. For example, the U.S. Forest Service has published an Environmental Policy and Procedures Handbook [19]. Subsection 53 of the Handbook addresses requirements for monitoring actions, environmental safeguards, necessary adjustments which may be required to achieve desired results, and possible management actions for various results.

While the focus herein is on monitoring in conjunction with the NEPA process, it should be noted that approximately one-half of the 50 states in the United States have laws, regulations, or policies that have created “little NEPAs” at the state level. Further, such state emphases can include monitoring; for example, monitoring and reporting requirements are specified in the amended California Environmental Quality Act (CEQA) of 1989 [20].

2. COMPONENTS OF AN ENVIRONMENTAL MONITORING PROGRAM

Monitoring programs can be defined in terms of certain fundamental components (or elements). Table I summarizes an early list of 8 such elements for planning and implementing a program [7]. It should be noted that iterations within and between elements may be necessary during both the planning and implementation of a program. Over time, the 8 elements in Table I have been sharpened in focus via the identification of related or additional concepts such as: (1) provision of feedback from the program to the EIA process; (2) adaptation in the program; (3) use of testable hypotheses for impact predictions; (4) clear delineations of temporal and spatial scales; (5) use of consistent documentation; and (6) provision of public participation opportunities.

TABLE I Examples of Elements in an Environmental Monitoring Program [7]

<i>Element</i>	<i>Tasks Associated with Element</i>
(1) Identify and define major impacts.	<ul style="list-style-type: none"> • Identify impacts for consideration for monitoring on the basis of impact significance described in the EIS.
(2) Coordinate with governmental agencies already conducting monitoring in the area, or who would be interested in monitoring, or have responsibilities related thereto.	<ul style="list-style-type: none"> • Contact all agencies having pertinent monitoring responsibilities in area to be impacted. • Identify agencies' major areas of environmental concern. Determine for what aspects of the environment and for what type of impacts the agencies are responsible. • Identify individual agency basis of authority to control impacts through decisionmaking, planning, regulation, monitoring, and enforcement.
(3) Define monitoring objectives.	<ul style="list-style-type: none"> • Define monitoring objectives in terms of major potential impacts and in terms of agency authority. • The objectives should be specified as to whether they relate to establishing baseline conditions, conducting impacts (or effects) monitoring, or to implementing compliance monitoring relative to mitigation or environmental requirements.
(4) Determine data requirements for achieving monitoring objectives.	<ul style="list-style-type: none"> • Reevaluate impacts identified for monitoring (element 1) on the basis of monitoring objectives; eliminate overlap in monitoring objectives and monitoring effort. • Select impact indicators (these are the parameters that must be monitored to assess the magnitudes of impacts). Several parameters may be indicative of a particular impact. Impact indicators should be selected on the basis of their utility for decisionmaking, planning, regulation, and enforcement. • Determine frequency and timing of data collection. Frequency of data collection should be the minimum necessary for trend analysis, enforcement of regulations, and correlation of cause and effects. Timing of data collection should relate to timing of activities causing the impact.

- Determine monitoring sites or collection areas. These should be based on the location of the activities causing the impacts, predictions of areas most likely to be affected, and locations where integrated measurements would assist in gaining comprehensive understanding.
 - Determine method of data collection. Data can be collected in several ways; for example, vegetative-cover data can be collected by field collection methods or by remote-sensing techniques. Determine analytical requirements, as appropriate, for the collected samples.
 - Determine data storage and retrieval requirements and necessary formats.
 - Determine budgetary, personnel, and time requirements for obtaining data.
 - Determine whether proposed monitoring system is feasible within budgetary, personnel, and time constraints. If program has to be reduced, several potential approaches are available for reducing the monitoring system to a feasible level: the scope of monitoring objectives can be reduced; alternative impact indicators can be selected; the frequency of data collection can be reduced; and alternative methods of data collection can be used.
- (5) Develop implementation plan, including budgetary requirements and individuals /groups/or agencies responsible for various elements.
- Identify baseline condition or impact trends; identify rate of change. (The rate at which an impact is increasing may be significant because of the need to respond to impact trends in a timely fashion before critical impact levels are reached).
 - Identify impacts that have reached critical impact levels. (Critical impact levels requiring immediate notification of participants should be set for each impact being monitored.) Identify impacts that have exceeded legal limits.
 - Evaluate effectiveness of mitigating measures, as appropriate.
- (6) Collect and analyze the monitoring data (and project operational data; if appropriate) in view of the identified monitoring objectives (element 3).
- (7) Implement project management activities, as appropriate, to manage/mitigate undesirable impacts.
- Plan responses to impact trends. Responses to unacceptable impacts can be directed at the activity causing the impact or at the impact itself.
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TABLE I (Continued)

<i>Element</i>	<i>Tasks Associated with Element</i>
(8) Prepare periodic monitoring reports.	<ul style="list-style-type: none"> • Respond to critical impact levels; stop or modify activities causing impact; treat impact. • Respond to evaluations of mitigation measures by revising, terminating, or adding measures as appropriate. • Prepare reports at regular time intervals to document the monitoring program, key environmental trends, and response actions.

An environmental monitoring program should be conducted with the intention of obtaining useful data to improve the EIA process and not merely to perform monitoring in and of itself. Accordingly, such programs should include feedback into the overall process. This feedback should improve impact predictions, thereby reducing future time and resource requirements in the overall process. The increased efficiency of EIA due to feedback should enhance the credibility of project proponents, regulatory agencies, and EIA agencies [10].

Monitoring programs should be designed to be adaptable based on the results obtained. Currently, an EIS presents a “stationary” or “snapshot” view of a proposed project or action. The value of this picture is limited considering that the project is being constructed or the action taken in a dynamic environment. To account for project or action changes and to continually update the nature of resultant impacts, it would seem reasonable that a monitoring program be adaptable [2].

Several EIA professionals have suggested that monitoring programs should treat impact predictions as testable hypotheses. In fact, the hypotheses should be viewed as “null” hypotheses, which are to be found inaccurate only if observed impacts are substantially far from the natural variation. Current literature is lacking relative to examples of monitoring programs based on this concept. One reason is that in the real-world, projects or actions are not experiments in the classic sense; that is, rigid control over what happens on the ‘treated’ and ‘control’ sites simply does not occur [9]. However, while a monitoring program may not be situated where parameters can be controlled, adherence to sound scientific principles should be used in program planning [4, 6, 9].

The time scale (temporal aspect) of the monitoring program should be linked to the identified objective(s). This is important because it is difficult to identify natural change in the absence of long term data [17]. Further, the spatial (size aspect) scale of a program is critical to determining its appropriate design and magnitude.

Good documentation procedures are critical, with such procedures necessary for routine reporting and environmental audits, and also for program facilitation with normal personnel turnover. Valuable data and information may not be collected or assessed adequately when new staff become engaged in a monitoring program. The new staff will

be unfamiliar with the project or action and program, and they will not possess the same situational knowledge as more experienced staff. Good documentation will minimize this problem because new staff can review the documentation and continue with monitoring activities with minimal concerns regarding not collecting or not interpreting important data.

A final component of an environmental monitoring program should involve public participation opportunities. Allowing various publics to review monitoring results will enable them to become more familiar with the project and its value. Also, the publics will see that the proponent is taking steps to protect human health and the environment by affording such participation opportunities. In much the same way as public participation is also important to the overall EIA process, public participation is important to monitoring programs and should be provided for in their structure [6, 21].

3. REVIEW OF MONITORING PROGRAMS

In evaluating how environmental monitoring programs are currently being applied by federal agency proponents, nine EISs were analyzed. The EISs were chosen following contacts with several federal agencies. As shown in Table II, the proposed actions ranged from timber sales to developments in recreational areas to resource management planning. The federal agencies that undertook these actions included the U.S. Forest Service singly and in combination with the U.S. Bureau of Land Management. The study group of nine EISs is not intended to be representative of all EISs prepared by either preparing agency nor all agencies in the United States. Rather, they can be considered as indicative of the monitoring programs being included in EISs prepared by these two agencies.

The review was based on 14 criteria questions which had been developed via an examination of published literature, cursory reviews of over 15 EISs, and verbal communications with several EIA professionals. Table III comparatively displays the responses drawn from the nine EISs relative to the 14 criteria questions. Additional details on the review are available elsewhere [31].

TABLE II Brief Information on the Reviewed EISs

<i>EIS (Reference)</i>	<i>Comments on Proposed Action</i>
Jenkins Timber Sale (U.S. Forest Service 1993b) [22]	This proposed action involved constructing roads and harvesting timber in the Jenkins timber sale. The roads to be constructed and harvesting conducted will occur over 2,555 acres that extend partially within and adjacent to areas in the Payette National Forest in Idaho.
Snowmass Ski Area (U.S. Forest Service 1993a) [23]	The Aspen Skiing Company (ASC) requested the creation of a new Master Development Plan (MDP) for the Snowmass Ski Area in Aspen, Colorado. The new MDP would replace the MDP authorized by the U.S. Forest Service in 1983. The specific actions proposed in the new MDP include: upgrading existing snowmaking, lifts, and other facilities within the currently developed portion of the permit area (Baldy Mountain); expansion of ski area development onto the upper portion of Burnt Mountain; adding a second access/egress portal at the base of the mountain in the future East Village area; and expanding summer recreational uses throughout the permit area.
Fox Ecosystem Restoration Project: Day and Dunning Timber Sale and Other Projects (U.S. Forest Service 1994c) [24]	The ultimate goals of this proposed action included establishing healthy forest stands within the Fox Ecosystem Planning Area (FEPA) in Oregon and supplying wood products in order to help meet demand for timber. The specific proposed actions to accomplish these goals included: harvesting 2, 217 acres of dead, dying, and damaged timber from the Malheur National Forest in which the FEPA was designated; fuels reduction, site preparation for restoration, and reforestation of harvest units; construction of 15.1 miles of roads; reconstruction of approximately 31 miles of roads; maintenance and management of big game cover; underburning 905 acres of forest stands to reduce existing fuels levels to reduce the threat of wildfire; broadcast burning of 545 acres of rangelands to improve forage quality and production; initiation of 21 miles of riparian improvements; initiation of 12 acres of upland watershed improvements; and initiation of 9 miles of instream habitat improvements.
Newberry National Volcanic Monument Comprehensive Management Plan (U.S. Forest Service 1993c) [25]	A management plan was proposed in association with the creation of the Newberry National Volcanic Monument (NNVM) in Oregon. The NNVM serves as a remarkable landscape area which could be enjoyed by thousands of visitors annually. The

TABLE II (Continued)

<i>EIS (Reference)</i>	<i>Comments on Proposed Action</i>
Oregon Dunes National Management Plan (U.S. Forest Service 1994b) [26]	<p>management plan's objective was to conserve, protect, interpret, and enhance the area as a national treasure so that future generations would be able to enjoy the recreational, scenic, and other values of this area. The proposed actions included: consideration of a full range of existing and appropriate new facilities and programs for year-round recreation; consideration of a full range of management options, and a program to re-establish old-growth ponderosa pine ecosystems; consideration of general roads and facilities location, design, construction, and maintenance; consideration of a full range of management options for fuel hazard reduction and prescribed fire and fire control strategies; consideration of general prescriptions for wildlife habitat improvements; identification and prioritization of research opportunities; and monitoring of air, water, wildlife, soil, and geothermal resources to identify and assess any impacts from geothermal development on the NNVM and Special Management Area values, and on other resources.</p> <p>The proposed actions are related to revisions in the Oregon Dunes National Recreation Area (NRA) Management Plan. The Dunes are located along a segment of the Oregon coastline. The proposed actions included: (1) removing certain paved roads; (2) constructing more facilities and modifying existing buildings; (3) establishing natural resources education programs at specific sites; (4) establishing more non-motorized recreational activities (e.g., fishing and wildlife-related activities); (5) establishing riding restrictions on operational recreation vehicles; (6) identifying 5,000 acres of a primary treatment area addressing a variety of resource objectives, including habitat creation and maintenance, visual resource management, fire hazard reduction, and recreation enhancement; and (7) managing areas to increase fish, wildlife and plant populations, habitat diversity, and related recreation.</p>
Wild and Scenic Snake River Management Plan (U.S. Forest Service 1994a) [27]	<p>This EIS addresses proposed amendments to the Wild and Scenic Snake River Recreation Management Plan within the Wallowa-Whitman National Forest located on the border between Oregon and Idaho near the State of Washington. Updates to the Plan were related to the Forest Land and Resource Management Plan; where the</p>

goal is to establish recreation use allocations in the Wild and Scenic Snake River Corridor within the Hells Canyon National Recreation Area. The proposed actions included the following considerations; (1) provide for access to aviators on the Oregon side of the River for fishing and camping by proposing to open airstrips to private aircraft; (2) make allocations to River users that are equitable and that manage continuing growth in visitor use; (3) initiate closure on motorized personal watercraft to protect and enhance the diverse recreational users' experiences and provide protection for fisheries and wildlife resources; (4) refine management of the floatboat use levels in addition to protecting and enhancing the recreation resources and the associated recreation experience for the diverse groups of River users; and (5) establish use season, party size, campsite, stay limits, and recreation experiences.

The Newberry Geothermal Pilot Project EIS addresses a project proposed by the CE Exploration Company (CEE) of Portland, Oregon, that would entail the construction and operation of a geothermal pilot project with supporting facilities capable of generating 33 megawatts of electric power in the Deschutes National Forest in central Oregon. This project is near the Newberry National Volcanic Monument described above. The actions proposed entail the construction and operation of a power plant, access roads, exploration and production wells, power transmission line, and a switchyard.

The proposed action was for harvesting of Pacific Yew (*Taxus brevifolia*) for extraction of the chemical compound taxol, over a five year period (1993 – 1997), from public lands administered by the U.S. Bureau of Land Management and the U.S. Forest Service. The land encompasses portions of California, Oregon, Washington, and Montana. The need for the proposed action arose from demands for the chemical taxol that can aid in cancer research and treatment. According to the EIS, the purpose of the proposed action is to make a reasonable amount of yew available for taxol from federal lands while sustaining yew and minimizing the adverse effects on the ecosystem. The preferred action alternative would involve the harvest of 258,000 to 386,000 pounds of dry bark, and/or 686,000 to 1,030,000 pounds of dry needles, from an estimated 52,000 to 78,000 yew each year from Forest Service and Bureau of Land Management lands. The environmental impacts from these actions were to be evaluated relative to the ecosystem, biodiversity, soil environment, water resources, aquatic habitat, wildlife, and threatened and endangered species.

Newberry Geothermal Pilot Project (U.S. Bureau of Land Management and U.S. Forest Service 1994b) [28]

Pacific Yew (U.S. Bureau of Land Management and U.S. Forest Service 1993) [29]

TABLE II (Continued)

<i>EIS (Reference)</i>	<i>Comments on Proposed Action</i>
<p>Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (U.S. Bureau of Land Management and U.S. Forest Service 1994a) [30]</p>	<p>This Supplemental EIS on habitat management for the endangered northern spotted owl encompasses the western portions of Washington and Oregon, and the northwestern portion of California. Examined are proposed actions consisting of combinations of:</p> <ul style="list-style-type: none"> (1) land allocations managed to protect and enhance habitat for late-successional and old-growth forest related species and to protect and enhance aquatic resources; and (2) standards and guidelines for the management of these land allocations.

TABLE III Comparative Analyses of Nine EISs In Relation to Criteria Questions

<i>Criteria Questions</i>	<i>Jenkins Timber Sale EIS</i>	<i>Snowmass Ski EIS</i>	<i>Fox Ecosystem EIS</i>	<i>Newberry National Volcanic EIS</i>	<i>Oregon Dunes EIS</i>	<i>Wild and Scenic Snake River EIS</i>	<i>Newberry Geothermal Pilot Project EIS</i>	<i>Pacific Yew EIS</i>	<i>Mgmt for Late-Succ. and Old-Growth Forest EIS</i>
(1) What types of monitoring are to be implemented (i.e. baseline, effects and/or compliance)?	Compliance	All Three	Compliance	All Three	Compliance	All Three	Baseline and Effects	Base line and Compliance	All Three
(2) What laws are stipulated as requiring the implementation of monitoring programs?	None	NEPA and CEQ regulations	None	Newberry National Volcanic Monument Law	Oregon Dunes National Recreational Area	Hells Canyon National Recreational Act and Wild and Scenic Snake River Act	NEPA, CEQ regulations, Section 3200 CFR, and Geothermal Steam Act	None	NEPA, CEQ regulations, ESA CWA, CAA, and Forest Management Act
(3) Is the monitoring program structured with a feedback process?	No	No	No	No	No	No	No	No	Yes
(4) Is monitoring provided for with a budget? If so, how?	Yes, USFS annual budget and private funds	Yes, by the Aspen Ski Commission	No	No	Yes, USFS annual budget	Yes, but only described for certain resources	No	No	Yes, USFS annual budget

TABLE III (Continued)

<i>Criteria Questions</i>	<i>Jenkins Timber Sale EIS</i>	<i>Snowmass Ski EIS</i>	<i>Fox Ecosystem EIS</i>	<i>Newberry National Volcanic EIS</i>	<i>Oregon Dunes EIS</i>	<i>Wild and Scenic Snake River EIS</i>	<i>Newberry Geothermal Pilot Project EIS</i>	<i>Pacific Yew EIS</i>	<i>Mgmt. for Late-Succ. and Old-Growth Forest EIS</i>
(5) Is it stipulated in the EIS that if monitoring is not budgeted then the project will not be implemented?	Yes	No	No	No	No	No	No	No	Yes
(6) Is the time scale and spatial scale of monitoring delineated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(7) Are potential impacts to be monitored at the ecosystem level?	No	No	No	Yes	Yes	No	No	Yes	Yes
(8) Is monitoring to be utilized in determining cumulative impacts?	No	Yes	No	No	Yes	No	No	No	Yes

(9) Who will conduct monitoring (i.e., third party members or in-house staff)?	In-House Staff	In-House and Third Party	Not stated	Unclear, assumed to be In-House Staff	Third Party Review	Unclear, assumed to be In-House Staff	Unclear, assumed to be In-House Staff	Not stated	In-House Staff and Third Party Review
(10) Is monitoring designed to assess short-term and/or long term impacts?	Short-term impacts	Both	Short-term impacts	Both	Both	Short-term impacts	Unclear, assumed to be short-term	Short-term	Both
(11) Are monitoring activities designed in a testable hypothesis format?	No	Yes	No	Yes	Yes	No	Yes	No	Yes
(12) Are cost estimates of monitoring activities delineated?	No	No	No	No	Yes	Yes	No	No	No
(13) Is a rationale for conducting monitoring provided?	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
(14) Is monitoring defined?	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes

NEPA = National Environmental Policy Act; CEQ = Council on Environmental Quality; CFR = Code of Federal Regulations; ESA = Endangered Species Act; CWA = Clean Water Act; CAA = Clean Air Act; and USFS = U. S. Forest Service.

Analyzing the nine EISs relative to which type of monitoring was specified revealed an almost even split between compliance monitoring and all three types of monitoring (baseline, effects, and compliance) together. The implementation of a particular type of monitoring program was based more on the stated scope of the proposed action in the EIS than any other factor. Although other factors may have played a role in the proponent's selection of the type of monitoring (for example, cost or time factors), these factors were not specifically mentioned in the EISs.

Regarding laws requiring monitoring, the most common law(s) delineated were enabling ones for land use designations (including federal laws applicable to local areas). The Newberry National Volcanic Monument Comprehensive Management Plan EIS, Oregon Dunes Management Plan EIS, Wild and Scenic Snake River Management Plan EIS, Newberry Geothermal Pilot Project EIS, and the Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (referred to hereafter as the Management of Habitat for the Northern Spotted Owl EIS) EIS stated how such enabling laws were the primary reasons for implementing a monitoring program. NEPA (and the subsequent CEQ regulations) was the second most cited law noted as a basis for a monitoring program.

Only the Management of Habitat for the Northern Spotted Owl EIS described a feedback process in the monitoring program whereupon the results of monitoring would be utilized to improve future actions associated with the project. This adaptive management approach is relatively new; thus, the newness is the reason for the limited incorporation of this concept into the monitoring programs.

A critical criteria question was related to sources of funding for monitoring programs. Four of the nine EISs did not identify the budgetary source for monitoring. The other five EISs stated that funding would be provided from the proponent agency's annual budget and/or a private source.

Another budget-related question concerned whether the proponent specified that the project would not be undertaken if there was no funding for monitoring. According to the results, the majority of the EISs did not identify this as an issue. However, the Jenkins Timber Sale EIS and the Management of Habitat for the Northern Spotted

Owl EIS did state that if monitoring funding was not available, then the proposed action would not be implemented.

All nine EISs delineated time and spatial scales for the monitoring activities. In response to the question concerning ecosystem level monitoring, only the Newberry National Volcanic Monument Comprehensive Management Plan EIS, Oregon Dunes Management Plan EIS, Pacific Yew EIS, and the Management of Habitat for the Northern Spotted Owl EIS identified how monitoring would be conducted to evaluate impacts on ecosystems. The other EISs primarily addressed the evaluation of impacts on individual environmental resources.

The Snowmass Ski Area EIS, Oregon Dunes Management Plan EIS, and the Management of Habitat for the Northern Spotted Owl EIS identified monitoring as a tool for examining potential cumulative impacts on the environment.

Several of the EISs were unclear as to whether in-house or third-party staffs would be conducting the monitoring. Only the Jenkins Timber Sale EIS specifically stated that monitoring would be conducted by in-house staff members. The Snowmass Ski Area EIS, Oregon Dunes Management Plan EIS, and the Management of Habitat for the Northern Spotted Owl EIS stated that third-party individuals would be used to aid the monitoring efforts and/or evaluated in-house staff monitoring results to minimize the potential for bias. The Fox Ecosystem EIS and the Pacific Yew EIS did not address who would conduct the monitoring, or if the monitoring results would be verified for accuracy.

Given the limitations confronting monitoring implementation, it is not surprising that the results in Table III indicate that monitoring was often planned for assessing short-term rather than long-term impacts. The Jenkins Timber Sale EIS, Fox Ecosystem EIS, Wild and Scenic Snake River EIS, Newberry Geothermal Pilot Project EIS, and the Pacific Yew EIS were the ones concerned with short-term impacts. The remainder of the nine EISs indicated plans to address both short-term and long-term impacts.

Five of the nine reviewed EISs included testable hypothesis formats for some components of their included monitoring programs. These formats are desirable and illustrate more careful monitoring planning based on sound scientific approaches.

It was interesting to note that the majority of the EISs (7 out of 9) did not provide information nor determine the cost of specific monitoring activities to be implemented. The cost of these monitoring efforts could be significant and affect the scope of the monitoring program; such costs should have been delineated for all the nine EISs.

The rationale for why monitoring was needed was addressed in eight of the nine EISs; the only exception was the Fox Ecosystem EIS. The final criteria question examined if the EIS even defined the term "monitoring". Monitoring should have been defined in all nine EISs to enable the determination of whether the federal agencies were developing monitoring programs based on the same concepts. The Snowmass Ski Area EIS, Newberry Geothermal Pilot Project EIS, and the Pacific Yew EIS did not include a definition of monitoring. The other six EISs sufficiently defined the term to aid the reader in better understanding the purposes and scope of such monitoring.

4. EXAMPLES OF MONITORING PROGRAMS

To illustrate specific elements in the monitoring programs in the nine EISs, three have been selected for further description. The Snowmass Ski Area EIS illustrates monitoring related to specifically constructed components and their usage. The Snake River Management Plan EIS relates to monitoring the impacts of a variety of management activities in a river-related recreational area. Finally, the Management of Habitat for the Northern Spotted Owl EIS includes regional decisions and the monitoring of multiple environmental resources.

4.1. Snowmass Ski Area

The proposed developments in the Snowmass Ski Area would potentially affect numerous environmental components, including air quality, watersheds, wildlife and biological diversity, visual resources, wilderness areas, cultural resources, alpine skiing, non-alpine skiing recreation, land use, socioeconomics, transportation, utilities/energy, and noise levels. The fundamental rationale for monitoring was to

ensure that project design features and mitigation measures are adequately and effectively implemented [23].

This EIS stipulated that the monitoring program would be implemented because NEPA and the CEQ regulation require that “all relevant, reasonable mitigation measures that could improve the project must be identified” and, therefore, a monitoring program must be implemented to identify means of improving such mitigation measures [23]. Although NEPA and the CEQ regulations do not specifically require project proponents to monitor as a means of improving mitigation measures, the U.S. Forest Service recognized the value of such monitoring in this case.

No specific terminology regarding the types of monitoring (baseline, effects/impacts, and/or compliance) was provided; however, it could be inferred from the EIS that all three types were to be conducted. For example, refining mitigation measures and implementing them during the project to lessen environmental impacts would require effects/impacts monitoring data. Also, baseline had compliance monitoring were implemented because the project had to meet the requirements of various environmental laws, regulations, and standards.

The monitoring program was focused on potential impacts on individual environmental resources; however, there was no provision for or description of ecosystem monitoring. Monitoring for individual resources included detailed descriptions of sampling and analysis and the time frames for conduction. Short and long-term impact monitoring was planned, with cumulative effects to be determined for the riparian, water quality, and soil productivity resources [23].

Several other aspects of the proposed monitoring were reflective of a well-designed program. For example, the use of a testable hypothesis format with quantifiable data was planned. Complex tests in lieu of simple physical observations were to be conducted. The complex tests will yield quantifiable data which can be used to determine the accuracy of impact predictions and refine mitigation measures. Establishing that the U.S. Forest Service and other third party scientists will be performing monitoring activities was another feature indicating that this monitoring program was well-planned. In having third party persons involved, accusations of biasing results so that the project could be approved would be eliminated.

In the Snowmass Ski Area EIS, funding for monitoring was briefly stated as being the responsibility of the Aspen Ski Company (proponent); however, no details were provided. If the funding aspect had been included, then this EIS would have been one of the better ones in the study group relative to describing an environmental monitoring program.

4.2. Snake River Management Plan

The Wild and Scenic Snake River Management Plan EIS listed two laws that require monitoring. First, the Hells Canyon National Recreation Area Act requires monitoring for the purpose of “ensuring the administration of the river corridor in accordance with the laws, rules, and regulations applicable to the national forests for public outdoor recreation” [27]. The Wild and Scenic Snake River Act establishes that monitoring must be performed for preserving “the wild and scenic characteristics of the Snake River as part of the national wild and scenic rivers system” [27]. Implications were also made that monitoring will also be in consonance with the requirements of NEPA, the CEQ regulations, and the National Forest Management Act.

According to the program description, the planned monitoring would be comprehensive and useful for evaluating the impacts of the proposed actions from “idea conception” to after such actions were completed. In other words, baseline, effects/impacts, and compliance monitoring would all be conducted. Although only compliance monitoring was specifically mentioned, baseline and effects monitoring were implied.

Individual features which were to be monitored included recreational resource settings, visual resources, dispersed campsites, cultural and historic resources, fisheries habitat, jetboat and spawning fall chinook interactions, accidental catches of listed fishes, tributary stream fisheries, bald eagles, peregrine falcons, bats, MacFarlean’s Four O’Clock, and noxious weeds [27]. There was no planned ecosystem monitoring. No attention was directed to the potential for cumulative impacts that could occur from future proposed actions. According to the monitoring program description, short-term impacts were of greater concern.

Although adequate descriptions of the monitoring activities for each environmental resource were provided, the planned activities were not based on testable hypotheses nor the generation of quantifiable data. The activities primarily involved physical observation surveys. For example, the impacts of boating on fish populations were to be monitored annually by physical site-specific observations of the watershed and fish habitats. Chemical analyses of the water and collected fish could have been planned to determine detrimental biological impacts to fish populations, however, complex testing for any of the environmental resources was not planned.

Although the monitoring program did include an analysis of the costs for each monitoring activity, the program description noted that monitoring would only be conducted “where funds were available” [27]. This indicates that monitoring was not a very high priority. However, funding sources already exist for some important environmental resources. For example, monitoring fisheries habitat resources would be financially supported by a separate stream survey program.

In specifying who would conduct the monitoring, the program description indicated that, depending on the environmental resource monitored, the Area Ranger, Forest Monitoring Coordinator, or the Forest Recreation Staff would perform the activities. There was no elaboration on whether these monitoring officials would be aided by third party individuals.

Overall, the monitoring program described in the Wild and Scenic Snake River Management Plan EIS was good. Baseline, effects, and compliance monitoring were all to be conducted. An analysis of the estimated costs for monitoring was provided; and this was typically absent in the other reviewed EISs. Also, a rationale for monitoring was delineated. However, the program was deficient relative to an evaluation of the long-term impacts of the proposed actions. Further, the absence of clear financial support for all resource monitoring was also a deficiency, as was the potential biasing of the collected data by not utilizing third party specialists.

4.3. Management of Habitat for the Northern Spotted Owl

An original EIS related to timber harvesting in areas that also provided habitat for the northern spotted owl was highly controver-

sial. The fundamental reason was the conflict between timber harvesting interests and the need in the Pacific Northwest and Northern California for maintaining forest habitat for the endangered northern spotted owl and other species. Timber harvesting would not only supply consumer demand for wood products, but also support the local economy in the region through timbering contracts and timber sales. The importance of fulfilling both development and conservation needs came to the forefront in April, 1993, when President Clinton sponsored a Forest Conference in Portland, Oregon. The Conference was attended by various concerned organizations and citizen groups.

After the Conference, a Forest Ecosystem Management Assessment Team (FEMAT) was assembled and charged with the responsibility of developing an impact study that took an ecosystem approach to forestry management. The results were organized into a Supplemental EIS by the U.S. Bureau of Land Management and the U.S. Forest Service, along with the U.S. Department of Agriculture. The described monitoring program focused on potential impacts to aquatic ecosystems, air quality, water quality, soil productivity, threatened and endangered species, nonvascular plants and allies, vascular plants, invertebrates, vertebrates, timber harvest yields, regional employment, rural communities, and American Indian peoples and cultures.

Although no specific laws were mentioned as being the impetus for requiring the implementation of a monitoring program, several laws were referred to in the Supplemental EIS as having a potential role in affecting the proposed action. The relevant laws or regulations that played a part in the included monitoring program were NEPA, the CEQ regulations, the Endangered Species Act, Clean Water Act, Clean Air Act and Forest Management Act.

The monitoring program section of the Supplemental EIS was presented in great depth. The section began with a statement that the rationale for monitoring was to “detect changes in ecological systems from both individual and cumulative management actions and natural events and to provide a basis for natural resource policy decisions” [30]. A discussion was then provided as to what types of monitoring would be conducted. Implementation, effectiveness, and validation monitoring were the types explicitly mentioned. In addition, it was implied that baseline and effects/impact monitoring were to be

performed. Implementation and effectiveness monitoring are essentially the equivalent of compliance monitoring.

The monitoring program was also focused on both short-term and long-term impacts of the proposed actions. The program included specific reference to monitoring potential cumulative impacts on environmental resources. Ecosystem monitoring as well as individual resource monitoring was to be performed. The monitoring activities were not limited to physical observations; they included complex quantifiable hypotheses testing. In fact, specific reference to formulating the monitoring activities for the testing of various hypotheses of impact predictions was included.

Identification of who would conduct the monitoring activities was also provided. The agency or agencies responsible for the proposed action will be the parties that conduct monitoring. The proponents addressed potential claims of biased monitoring results by stipulating that local interdisciplinary teams (third parties) will review the monitoring data. Also, the proponents stated that other governmental agencies wanting to review the results may also do so.

In the monitoring program description, funding was implied as being provided in an annual U.S. Forest Service budget. A clear statement regarding the actual amount allocated for monitoring in such an annual budget, and cost estimations for specific monitoring activities, were the only items missing. It was apparent that monitoring was considered a high priority of the proponents by the statement that “monitoring... (should) be carefully and reasonably designed” [30].

The proponents described how this monitoring program would reflect the utilization of adaptive management principles. According to the Supplemental EIS, adaptive management “is a continuing process of action-based planning, monitoring, researching, evaluating and adjusting with the objective of improving the implementation and achieving the goals of the selected alternative”, and it “acknowledges the need to manage resources under circumstances that contain varying degrees of uncertainty, and the need to adjust to new information” [30]. Therefore, a feedback loop was provided into the on-going decision-making process for the purpose of adjusting to improve implementation of the plan, while ultimately hoping to achieve the objectives of regulatory standards and guidelines.

In comparison to the other eight reviewed EISs, this Supplemental EIS was the most complete one in terms of the described monitoring plan. Virtually all the criteria identified herein as important issues were addressed. Even though two details, specific monitoring cost estimations and a clear statement of the funding source, were missing, the proponents provided some information on financial resources. The controversial nature of the proposed actions addressed in the original EIS, which even gained Presidential recognition, may have been the main reason why so much care was taken in developing and describing the environmental monitoring program. Regardless of this supposition, the fact remains that the included monitoring program in this Supplemental EIS was well-designed, planned, and delineated.

5. SUMMARY AND RECOMMENDATIONS

Over the past few years environmental monitoring within the EIA process has been an issue advocated by both academic analysts and practitioners. The main reason for the increased focus has been due to the results of implemented monitoring programs which have revealed that monitoring can yield many benefits not previously recognized (i.e. monitoring can be used to improve impact prediction methods, help to refine mitigation measures, etc.). However, obstacles exist relative to the successful implementation of monitoring programs within the EIA process. One major obstacle is the absence of explicit requirements in NEPA or subsequent CEQ regulations to plan and implement monitoring programs.

The study described herein was focused on the development of recommendations for the effective planning of monitoring programs in the EIA process. The following recommendations are based on a systematic review of monitoring programs as described in nine selected EISs; the recommendations relate to improving the planning, implementation, and utilization of monitoring as a component of the EIA process [31]:

- (1) NEPA and/or the CEQ regulations should be revised to explicitly require monitoring for federal actions that will have a significant impact on the environment; however, detailed designs for

monitoring programs should be considered in a project-specific manner.

- (2) All federal agencies involved in EIA should implement necessary procedural changes in their NEPA guidance to have monitoring formally recognized as an integral component of their EIA process.
- (3) Several basic elements have been identified as characterizing a good monitoring program. Accordingly, it is recommended that the following 12 elements be included, as appropriate, in planning and implementing monitoring programs: (a) identification of impacts to be monitored; (b) a definition of monitoring to encompass the planned program; (c) specification of related laws and/or regulations; (d) description of related extant monitoring programs being conducted by other agencies or entities; (e) delineation of the specific objectives of the program in terms of establishing baseline conditions, conducting impacts/effects monitoring for the short terms and long term, and/or compliance monitoring (note that some objectives could be stated in an hypothesis format, particularly as related to impacts/effects monitoring); (f) technical details related to what will be monitored, when monitoring will take place, and where it will occur (inferred here is the need for defining temporal and spatial scales for the program); (g) attention to special issues such as ecosystem and cumulative impacts monitoring; (h) implementation procedures for collection and evaluation of data according to standard protocols, and who will be responsible for monitoring (in-house staff and/or third party groups); (i) provisions for the use of data via feedback into EIA decisionmaking processes (adaptive management principles could be utilized); (j) specifications for reporting frequency and distribution of reports; (k) provisions for public participation opportunities within the overall monitoring program; and (l) inclusion of budgetary requirements and actual or potential sources of funding.

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