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THE NATIONAL FOREST MANAGEMENT ACT
IN A CHANGING SOCIETY, 1976-1996

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I. Summary

The USDA Forest Service has adopted ecosystem management as its guiding management philosophy. Under this philosophy, the agency will attempt to maintain or restore the sustainability of ecosystems while providing goods and services consistent with achieving sustainability. This paper examines how strategic planning methodologies will need revision to reflect the philosophy of ecosystem management and recent work on ecosystem sustainability and planning techniques. The paper also makes suggestions for additional instructions to guide strategic forest planning to this goal.

Strategic planning methods in recent use on the National Forests, such as FORPLAN, were developed under a management philosophy that emphasized the sustained production of timber products. These methods were broadened over time to reflect production of other outputs such as forage and to allow constraints to control environmental effects. They still, though, emphasize production efficiency, human activities as the major source of disturbance, and the control of nature to meet human needs. These approaches have been widely used on public and private forests for more than 30 years. By and large, these methods use solution techniques, especially linear programming, that were developed more than 40 years ago.

Emerging concepts of ecosystem management and ecosystem sustainability argue for new approaches to strategic forest planning that recognize broad landscapes, long-term ecological and economic goals to guide actions, the cumulative effects of multiple owners, the formative power of major disturbances such as fire and floods to shape landscapes, the spatial patterns of forests and streams, and the need for planning

methods that enable collaborative learning. In addition, recent developments in operations research allow the consideration of more complex problems than previously thought possible and linkages to GIS allow visual projection of results that should aid collaborative learning.

We present an example from the Sierra Nevada to demonstrate strategic forest planning methodologies that consider concepts of ecosystem management and sustainability and apply these new solution techniques. This example emphasizes the restoration of Sierra Nevada ecosystems while recognizing fire across the landscape as a major factor in ecosystem sustainability.

We make suggestions about additional guidance needed to ensure that strategic forest planning supports ecosystem management including the role of timber production on the National Forests, the role of the National Forests in mixed ownerships, the portrayal and use of information about the probabilistic nature of major disturbances, and the direction of future efforts in developing planning methodologies.

II. The USDA Forest Service has adopted ecosystem management as its guiding management philosophy.

   A. In his initial guidance to the Forest Service, Chief Thomas listed "practicing ecosystem management" as one of the agency's three guiding precepts.

   B. Recently the Chief stated that ecosystem management "is a concept to which the agency is deeply committed (Thomas and Huke 1996)."

III. Ecosystem management as practiced by the Forest Service has the general purpose of meeting human needs while maintaining or restoring the sustainability of ecosystems.

   A. According to Chief Thomas, "the general purpose of the Forest Service's adoption of ecosystem management is to manage forests and grass lands to meet human needs while maintaining the health, diversity, and productivity of these ecosystems (Thomas and Huke 1996.)"

B. The Forest Service's proposed new regulations to implement the National Forest Management Act state that "the principal goal of managing the National Forest System is to maintain or restore the sustainability of ecosystems." Achieving this goal will result in "providing multiple benefits to present and future generations." Another goal is that "the level and flow of benefits from the National Forest System should be compatible with the restoration of deteriorated ecosystems and maintenance of ecosystem sustainability (60 Fed. Reg. 18922 [Pr 36 CFR 219.4] and Sedjo 1996)."

IV. Current strategic planning methodologies used by the Forest Service were developed for a management philosophy of "sustained yield" management.

A. Human activity in our public forests and larger industrial forests is guided, to a considerable degree, by strategic forest plans. These plans attempt to delineate the type, amount, and location of activities, such as timber harvest and road building, consistent with the long-run objectives and constraints of the landowner.

B. Traditional sustained-yield management focuses on stabilizing the flow of one or more products within constraints imposed by environmental and economic factors (SAF 1993, Gordon 1994, Johnson 1996). Strategic forest plans have largely been utilized to specify the even-flow level of timber harvest (the allowable cut) with the view that an even-flow of timber would provide for an even-flow of all forest outputs. The Forest Service, as an example, recently completed plans for each National Forest that were, at their heart, plans to determine the even-flow (or non-declining) timber harvest level (SAF 1993, Johnson 1996).

C. Both the methodologies that underlie these plans and the inventories that provide them data reflect traditional sustained-yield management. FORPLAN, the strategic planning model most commonly used by the Forest Service, grew out of refinements to classical timber management models whose purpose was to find a sustainable level of timber harvest (Johnson 1992, SAF 1993).

D. Over time, these methods were broadened to reflect production of other outputs such as forage, to allow sophisticated constraints to control environmental effects, and to set targets for desired future condition. Recent variations of FORPLAN such as SPECTRUM contain these improvements. They still, though, emphasize production efficiency, a deterministic and limited disturbance, and the determination of desired activities without spatial considerations (Johnson, 1992, SAF 1993).

E. These methods have proven largely impervious to attempts by the public to understand them, retarding pubic understanding of forest plans and public participation in their development (Johnson 1992). This has occurred for a number of reasons. First, their developers apparently saw other analysts as their audience for these methods, with the result that relatively little time was spent on features to facilitate public learning. Second, with only limited ability to project the location of activities over time, the methods have proven generally inadequate in portraying the spatial implications of proposed plans.

IV. Ecosystem management differs from traditional sustained yield management in many ways (SAF 1993):

	Traditional sustained-yield management	Ecosystem management
Objective processes	Sustained flow of specific products to meet human needs, constrained to minimize adverse effects	Maintains ecological and desired forest condition, within which the sustained-yield of products to meet human needs are achieved
Strategy for accomplishment	Resembles agricultural model	Reflects patterns of natural disturbance
System character	Emphasizes production efficiency but within environmental constraints	Retains complexity and processes, provides framework for the whole system
Unit of management	Stands and aggregations of stands within an ownership	Landscapes and aggregations of landscapes across ownerships
Time unit	Multi-rotations with rotation length determined by land-owner objectives	Multi-rotations with length reflecting natural disturbance, although intensive management will cause some to be shorter
Current status	In transition, new knowledge is bringing in new values. Remains a valid strategy for portions of the landscape.	Evolving, accepted for management on national forest lands

As stated by Gordon (1993, 1994), "The major change in forestry thinking wrought by ecosystem management has been the abandonment of the concept of a stable flow of wood from the land as a universally dominant management objective" and replacement with "management of whole systems for a variety of purposes."

The National Forests have traditionally used the goal of an even-flow of timber harvest as a dominant objective in its management and an organizing principle for its planning. The movement away from a stable wood flow as a dominant management objective under ecosystem management raises the question of the place and usefulness of this goal in National Forest planning--a topic to which we will return at the conclusion of the paper.

V. The emerging concepts of ecosystem management and ecosystem sustainability argue for new approaches to strategic forest planning.

A. Key elements in these approaches will be to:

1. recognize ecological planning and analysis units such as watersheds, habitat areas, and forests. As pointed out by numerous authors (Craig 1987, FEMAT 1993, Aplet, et. al. 1993)), ecosystem management will require a shift from the past emphasis on political boundaries for planning to an emphasis on ecological boundaries. This will include simultaneously recognizing multiple spatial scales such as patches, stands, and groups of stands within watersheds or forests, and the relationships among the different scales.

2. consider federal actions in the light of the cumulative effects of actions by all owners in these planning and analysis units (Craig 1987, FEMAT 1993). Past forest planning efforts that often treated each National Forests as an isolated island will need renovation to recognize the geographic context in which federal decisions are made. The regulations to implement the National Environmental Policy Act require that federal agencies consider the cumulative impact of their actions which the regulations define 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 . . . or person undertakes such other actions (Craig 1987)." As Craig (1987) points out, the courts have ruled that the Forest Service must bundle its

proposed actions in such a way as to reveal their cumulative effects.

3. portray desired ecological conditions and seek their attainment (Thomas and Huke 1996, Leavell, et. al. 1995). Forest management planning has historically considered attainment of a "regulated forest" as an important goal in forest planning (Davis and Johnson 1987). Recent efforts have broadened this focus to include future forest, stream, and watershed conditions, especially those related to fish and wildlife habitat, while adding the realization that these conditions have historic variation (Thomas and Huke 1996, Sedjo 1996).

4. portray the formative power of major disturbances such as fire and floods to shape landscapes including the episodic and probabilistic nature of these events (FEMAT 1993, SNEP 1996, Johnson, et. al. 1996). As Thomas and Huke (1996) state, "Natural resource managers and scientists are realizing that maintaining an ecosystem in a static state runs counter to natural disturbance processes, can be difficult to maintain, and may have long-term undesirable effects. ... One challenge in practicing ecosystem management is communicating to the public that forests are dynamic... "

5. portray spatial patterns and relationships of stands, streams, and forests (Hunter 1990, Johnson 1992, FEMAT 1993, SNEP 1996). Many habitat relationships have a spatial component; many policies, such as limits on size of harvest units, also have spatial components. Representing the effects of policies on aquatic health often requires explicit portrayal of stream networks. Lack of recognition of spatial detail haunted past forest planning especially in terms of enabling realistic estimates of commodity production. Future efforts will need spatial representation.

6. allow simultaneous pursuit of multiple goals. It is clear that the management of the National Forests cannot be compressed into a single goal. Thus, strategic forest planning methods will need to recognize and

consider multiple goals. As part of this, goal hierarchies portraying which goals have the highest priority will be needed.

7. find efficient solutions given the multiple goals. The National Forests have the responsibility to be efficient in their management (Bowes and Krutilla 1989). This responsibility does not require the Forest Service to manage these lands to maximize monetary return, but it does require that planning methodologies attempt to find the highest level of goal attainment possible and that they demonstrate economical use of public funds.

8. enable public participation though collaborative learning. Daniels, et. al. (1996) point out that collaborative learning is well suited to the complexities and controversies of public land management. Planning methodologies of the future will need to be useable and understandable by the public to enable effective public participation. Sophisticated use of Geographic Information Systems linked to spatially-based projection methods will be needed to paint pictures of future landscapes under different scenarios. Without public understanding, there is little hope for the development of lasting management strategies for public lands.

B. Recent developments in solution methodologies for large forest management problems allow movement away from traditional solution techniques like linear programming which have greatly limited our ability to recognize essential features of ecosystem management problems. These new solution methodologies use heuristic algorithms to solve large integer (and mixed integer) problems arising from the combinatorial nature of spatial planning problems. Three heuristics which have received recent attention in forestry are simulated annealing (Lockwood and Moore 1993), tabu search (Bettinger et al. 1996), and genetic algorithms (Pesonen et al. 1995). These new methodologies allow recognition of spatial relationships and portrayal of the stochastic nature of major disturbances-- two aspects of ecosystem management which have proven especially difficult to represent with mathematical programming. Previous approaches to forest planning such as FORPLAN (and similar models like SPECTRUM) have proven largely impervious to understanding by the public. Without such understanding, these approaches have only limited usefulness in forging strategic forest plans. Recent advances in Geographic Information Systems have greatly increased the potential for public participation in, and understanding of, strategic forest planning. When GIS, connected to a landscape simulator, visually projects the implications of forest policies over time (as shown below), the potential increases for collaborative learning among many different interests.

VI. An example of strategic forest planning for ecosystem management

A. The Sierra Nevada Ecosystem Project (SNEP) was commissioned by Congress to assess the state of Sierra Nevada ecosystems (SNEP 1996, Sessions, et. al. 1996, Johnson, et. al 1996). As part of that effort, SNEP had the charge to "develop and evaluate management strategies to maintain the health and sustainability of these ecosystems while meeting human needs (Charter, SNEP steering Committee (SNEP 1994))." This case study attempts to develop and evaluate management strategies for federal forests of the Sierra Nevada.

B. Suggestions from the SNEP Science Team for improving the health and sustainability of Sierra Nevada ecosystems:

1) rebuild late-successional forests,

2) restore riparian areas and watersheds,

3) reduce the likelihood of severe fire,

4) reintroduce historic ecosystem processes

5) produce a sustainable supply of timber in a cost-effective manner

C. Goals and measures of goal attainment in the strategic forest planning analysis

Goal	Measures of goal attainment
Rebuild late-successional forests (LS/OG)	Average late-successional, old growth rank
	Distribution of forest among LS/OG ranks
Restore streams and watersheds	Watershed disturbance level in three riparian influence zones
Reduce likelihood of severe fires	Distribution among severity classes
Reintroduce historic processes	Predominance of low/moderate intensity fire, use of harvest to mimic fire effects
Produce a sustainable timber supply	Timber harvest level over time, net revenue

D. Approaches considered to achieve the goals: undisturbed growth, prescribed fire, timber harvest (commercial, biomass, fuel breaks)

E. General goal hierarchy for most analysis:

Areas of Late-Successional Emphasis (ALSEs): First: Limit watershed disturbance, Second: Rebuild late-successional forests, reduce fire severity.

Matrix (other forest): First: Limit watershed disturbance, Second: Rebuild late-successional forests, reduce fire severity, Third: Produce the highest sustainable supply of timber.

F. Analysis. Compared strategies that differed in emphasis on different goals and on the types of activities permitted. We compare four of the strategies here: 1) No active management, 2) Prescribed fire only, 3) Prescribed fire across the landscape; timber harvest in matrix, 4) Prescribed fire, timber harvest, and fuel breaks across the landscape.

G. Conclusions (with a focus on the pine and mixed conifer forests):

1) We can rebuild late-successional forests and watersheds of the Sierra Nevada at the same time that we reduce the likelihood of severe fire.

2) All strategies result in the rebuilding of LSOG forests and watersheds to varying degrees. Without active management, though, pine and mixed conifer forests will become increasingly susceptible to severe fire.

3) Many combinations of timber harvest and prescribed fire would allow progress on restoring LSOG forests and watersheds and reducing the likelihood of severe fire. Timber harvest generally pays for itself; funds will be needed for prescribed fire.

4) Controlling watershed disturbance could have a major impact on timber harvest unless innovative, low-impact technologies are used. This is especially true in mixed ownership drainages where we assumed that watershed disturbance on private lands could limit federal harvest, i.e., we assumed that federal activities would only proceed if they did not violate cumulative limits on disturbance considering all owners in the watershed.

VI. Strategic forest planning for ecosystem management needs additional guidance to be successful in instructing people as to the alternative possibilities for the National Forests. We highlight here a few of the issues that we encountered in our recent work on the Sierra Nevada.

A. Guidance is needed on the role of timber production in management of the National Forests. In our Sierra Nevada study, we assumed that timber production was a goal in the matrix (albeit a third order goal), but not in the Areas of Late Successional Emphasis. We did this to demonstrate the implications of different alternatives; guidance is lacking as to where timber production should be an objective for management of these forests. Is timber production simply a by-product of achieving other goals or is it a goal by itself, even though it might be a secondary or tertiary goal?

B. The stipulations in the National Forest Management Act (NFMA) on timber production may need reexamination. Two major "timber clauses" in NFMA are:

1) Marginal lands: "the Secretary shall identify lands within the management area which are not suited for timber production...and shall assure that except for salvage sales or sales necessitated to protect other multiple use values, no timber harvesting shall occur on such lands for a period of 10 years. (Sec. 6k). What is the meaning of this division into suited and unsuited lands under ecosystem management where much of the timber harvest will occur to support other goals and is rarely, if ever, the primary goal? On many National Forests of the West, such as the Lake Tahoe Basin and the Suislaw National Forest, much of the timber harvest may come from lands that are "unsuited" for timber production. The suited/unsuited division may be useful when you can clearly divide lands into "timber production lands" and "other lands." Few if any lands remain in the National Forests where timber production is the primary objective; it is at most a secondary or tertiary objective. On other lands it is not an objective per se but is occasionally employed to reach other goals. In the world of ecosystem management on the National Forests, the suited/unsuited division appears to have lost its meaning.

2) Limitations on timber removal: "the Secretary ...shall limit the sale of timber from each national forest to a quantity equal to or less than a quantity which can be remove from such a forest annually in perpetuity on a sustained-yield basis. That in order to meet multiple-use objectives, the Secretary may establish an allowable sale quantity for any decade which departs from the projected long-term average sale quantity that would otherwise be established. . . (Sec. 13)." This provision of the law has been interpreted by the Forest Service in its implementing

regulations to require that planning achieve a "non-declining yield" of timber volume unless a departure is justified. And departures have been few and far between. If timber production is a secondary or tertiary goal, or largely a by-product of achieving other goals, why should we adhere to nondeclining yield? The use of timber harvest to achieve ecological goals, as described in the case study, may result in an irregular harvest since timber harvest may only occasionally be needed. Even when timber production is a secondary or tertiary goal, a stable harvest cannot be assured. The Forest Service has convinced the public that an even-flow of timber from the National Forests is feasible and desirable. Perhaps it is time to rethink this article of faith in the same way that we are rethinking the desirability of the "10:00" am fire policy.

C. Guidance is needed on the role of the National Forests in controlling cumulative effects in mixed ownerships. In our analysis, we assumed that the National Forests would account for the actions of all other owners in determining whether they would take action. With watershed disturbance limits, that approach often meant that the National Forests could not under take timber harvest and roadbuilding activities in mixed ownership drainages. Is this the appropriate approach? While NEPA calls for federal agencies to <u>divulge</u> the cumulative effects of their actions, it is less clear about federal agency responsibilities to <u>prevent</u> cumulative effects.

D. Guidance is needed on consideration of risk from major disturbances. Explicit consideration of disturbances in a probabilistic sense, as demonstrated in our case study, is an important advance in reflecting ecosystem concepts in strategic forest planning. It does, though, open up for consideration the issue of how to consider the variance in outcomes. Making decisions based on the mean effects of major fire, as an example, may not capture public concern about catastrophic fire. On the Plumas NF, as an example, about 5% of the forest burned per decade in our simulations. On some simulations, though, much of it burned over the 50-year simulation period. Guidance is needed on how to display the variance in outcomes and how that variance should influence decisions.

E. Guidance is needed on the direction of development of strategic forest planning methods. Land management planning in the Forest Service has continued to invest much of its development resources in improving FORPLAN-type approaches to strategic forest planning. These approaches, tied as they are to mathematical programming solution techniques, have not demonstrated an ability to handle the probabilistic nature of major disturbances nor the spatial nature of many biological relationships and policies on the National Forests. An evaluation of the future direction of this effort is needed to ensure that this development will support ecosystem management.

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