Joint Fire Science Program
Biomass Roundtable

January 22-25, 2007
Homestead Conference Center
Midway, Utah

Research Needs Assessment

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In Collaboration with:

The Joint Fire Science Program and the USDA Forest Service, PNW Research Station, Focused Science Delivery Program.

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About this document

This document presents categories of research needs identified during the January 2007 Biomass Roundtable in Midway, Utah. It should not be construed as a commitment to fund projects on the part of the Joint Fire Science Program (JFSP), but rather as a catalog of ideas for research and synthesis topics generated during the roundtable discussion.

Background

To enhance the value of its work and work products, the JFSP is sponsoring a series of roundtables on key questions in order to better define and focus its lines of work. Results of these roundtables will be a topic-specific problem analysis that will inform the JFSP Governing Board's funding decisions and influence the scope, magnitude, and direction of JFSP activities. In addition to the biomass topic, the JFSP intends to hold roundtables on issues related to smoke management and risk in the coming months.

About the Biomass Roundtable

In January of 2007, the JFSP conducted the biomass roundtable with a group of 24 managers and scientists from partner agencies and stakeholder groups (see Appendix B for participant list). These participants shared their thoughts on issues, problems, and research needs related to biomass removal from the perspective of fuels management. The group considered two primary questions:

- How do you determine when it is the right management decision to cut and remove biomass from a landscape rather than apply other fuels treatment options?
- Once a decision is made to cut and remove biomass, what challenges do you encounter?

Summary of Discussion from the Roundtable

The group decided that there were a few types of situations where biomass removal would almost always be appropriate, a few situations where biomass removal would nearly never be appropriate, and a large number of situations that fell into a gray area with much uncertainty.

Managers would *almost always* recommend biomass removal in the following circumstances:

- Where the project must achieve a sustainability balance weighing economic, ecological, and social considerations);
- At the Wildland-Urban Interface (WUI), where biomass removal is better accepted by stakeholders. At the WUI, there are fewer logistical barriers to removal. Here, the clear goal is to create a buffer to protect people and property without the risk to property and exposure to smoke associated with prescribed fire;
- Where the the public clearly understands the negative consequences of no action, such as increased risk of wildfire;

Managers would *nearly never* recommend biomass removal in the following circumstances:

- Where there is a risk of damage to critical values (e.g., endangered species, fragile soils);
- Where physical constraints such as steepness of slopes, unstable soils, and accessibility preclude these projects; or
- Where the economics of removal projects prevent their implementation.

In practice, decisions about biomass removal are often complicated by lack of information. During the roundtable, participants identified these gaps and discussed potential research efforts to help fill them with the aim of allowing better management decisions. Across the agencies the JFSP represents, biomass removal opportunities may occur in grasslands, shrublands, woodlands, or forested ecosystems. In forested ecosystems, small and historically unmerchantable understory vegetation is a critical biomass component. The major research needs identified by roundtable participants, ranked by the group from highest to lowest priority, included:

1. Site specific methods for estimating the amount and type of biomass available;
2. Case studies about biomass projects across scientific, economic, and social parameters;
3. Resistance and resiliency as they relate to disturbance regimes and climate change;
4. Effects of biomass removal on plant community health;
5. Effects of repeated treatments;
6. Contribution of firewood programs to biomass removal;
7. Smoke, carbon dioxide, and carbon sequestration tradeoffs of fuels management options;
8. Landscape-scale assessment tools to guide decision-making;
9. Climate change information to predict vegetation dynamics;
10. Tools for better understanding tradeoffs to improve management decisions; and
11. Analysis of harvesting equipment for biomass removal related to cost and environmental impacts.

The following sections describe each issue and identify data gaps, research or synthesis suggestions, or tools to help address the need.

Need 1: Site specific methods for estimating the amount and type of biomass available

Need statement
Managers indicated that they did not have a good formula for estimating the amount of biomass slated for removal under some vegetative conditions. Estimates range widely, and there appears to be a lack of consistent estimation methods. The central issue is that managers are using methods or models developed for commercial timber species. Estimates for grasslands, shrublands, woodlands, and non-commercial woody species are lacking. Methods to conduct more detailed local assessments are needed. Managers need better tools to assess and estimate biomass based on a number of variables such as terrain and species, how much and what type of biomass is available for removal, at what rate it grows, and how much should be left for ecological and fire management purposes.

This raises a number of questions. What are the possible uses for the available supply of biomass? What are the appropriate removal mechanisms? What are the socio-economic impacts for communities? The quality of data available to answer those questions is highly variable. Managers need baseline fuels data with standard units for describing fuel (height, diameter, age, standing dead). In many cases, the difference between current condition (structure and composition) and desired natural ecological condition (structure and composition) helps define how much biomass can be removed to attain the desired condition. Accurate appraisals are necessary to enable more efficient contracting, meet management and reporting requirements, and provide data to understand smoke/particulate reduction and changes in fire effects.

Specific Needs:

1. Provide synthesis and evaluation of existing estimation methods
    a. Determine what system(s) most effectively meet the data managers' needs to classify biomass by size, type, and height
    b. With large projects, take sub-samples to estimate the amount of biomass.
2. Examine field tests of established methods. If necessary, develop and test new methods, including, perhaps, a more robust modeling system. Examine remote sensing tools to estimate biomass.
3. Examine methods to determine how much if any biomass is "excess" to the "desired ecological condition." It is important to know how much and what type of material should be left.

Need 2: Case studies across scientific, economic, and social parameters

Need statement
Managers need information to test assumptions about the benefits and impacts of biomass removal, increase their ability to communicate about options both internally among themselves

and externally to the public, and understand approaches and technologies that are actually working in order to guide strategic investment of biomass efforts.

Biomass removal attempts to utilize the by-products of other management activities. Many project decisions are made using a set of assumptions about both impacts and costs to the government and benefits to the economy and environment of local communities. Case studies of past and ongoing biomass removal projects are a good way to test assumptions and disseminate lessons learned, given the limited data and the variability of conditions. This information would help managers understand how to utilize available capacity across disciplines (e.g., social, economic, ecological, and fire) and expand or create the infrastructure to address the needs of the project.

There is a huge need to reduce fire suppression costs. We do not understand how biomass removal affects those costs, nor do we understand the options for changing suppression tactics in an area that has fuel treatments. Biomass removal may increase opportunities for more cost-effective fire management.

Specific Needs

1. Compare fire behavior and treatment effectiveness on biomass removal projects subjected to wildfires.
2. Synthesize case studies of past and ongoing biomass removal and utilization efforts evaluating:
    a. strategic investments (federal, state, private)
    b. partnerships/collaborative processes
    c. community and institutional capacity, and
    d. harvesting and utilization infrastructure that existed or was developed.
3. Provide data on the economics of hand labor to remove material versus mechanical removal. (Develop a catalog of retrospective information from existing studies/projects.)
4. Document the social and economic impacts of biomass removal
    a. How do projects affect subsistence uses?
    b. What are the direct economic benefits to communities across treatments (e.g., removal, prescribed burns, and firefighting)?
5. Understand how biomass removal affects suppression costs and/or the options for changing suppression tactics in the context of Appropriate Management Response.

Need 3: Resistance and resiliency as they relate to disturbance regimes and climate change

Need statement

The Society of Ecological Restoration defines resistance and resilience. **Resistance** describes an ecosystem's ability to maintain its structural and functional attributes in the face of stress and disturbances. **Resilience** is the ability of an ecosystem to regain structural and functional attributes that have suffered harm from stress or disturbance. For this discussion the scale is focused at the landscape level.

Recent decades have brought a shift toward more-frequent and more-severe fires, disrupting historical patterns and putting unaccustomed stress on forest ecosystems, especially those adapted to low-level periodic fire. Fires' effects are often exacerbated by drought and insect attack, both of which are expected to increase with rising temperatures. These add up to a complex of stressors from which a forest ecosystem may be unable to recover. Managers need a greater understanding about whether and how they can change vegetative conditions to make the ecosystems more resistant or resilient to disturbance in the face of climate change and disturbance regimes.

This is a complex problem and it will take many years, perhaps decades to reach a scientific consensus about what role management can play in protecting the existing vegetative structures and conditions that humans value or, when this is not possible, shifting the vegetative conditions in a particular place toward ones that we believe are sustainable. The Joint Fire Science Program can play a role but probably will not lead this effort. Accordingly, we want to develop information channels that will help to quickly inform our customers about the aspects of this problem where scientific consensus does exist and what new information is emerging.

Specific Needs

1. Develop techniques to help managers and policy makers decide when management efforts should stem from historical range of variation and when they should be based on anticipated future conditions.
2. Synthesize available scientific literature and conduct workshops to examine the appropriate role of biomass removal in sustaining or altering existing conditions in the face of climate change.
3. Improve visualization and analysis tools to provide alternative futures given possible changing climate and environmental scenarios.

Need 4: Effects of biomass removal on ecological and socioeconomic conditions

Need statement
There is a need for reliable data on biomass removal effects, including environmental, ecological, and socio-economic impacts, as compared to other fuel treatments' impacts across space and time.

Managers lack measures for impacts (both positive and negative indicators of change) and the ability to compare these impacts across treatment regimes. Better information on the effects of removal on commercial and non-commercial species would give managers a greater ability to understand tradeoffs and maximize treatment objectives. For example, it could enable them to manage fire risk while also reducing invasive plant species or consider the nutrient balance in the ecosystem while making treatment decisions. Information on the impacts to soils, plants, and animals could be weighed against risk-based assessments (e.g., no action).

How does biomass removal affect the growth, survival, and recruitment of the associated vegetation? Does removal of the biomass affect the ability of the pre-treatment plant community to reestablish?

Specific Needs

1. Is there accessible and reliable data on biomass removal impacts?
2. How do you evaluate vegetative response, particularly invasive species?
3. What are the re-entry times for reestablishment of vegetation under various fire regimes and condition classes?
4. Do people living in communities near wildlands feel safer after biomass removal as compared to treatments such as mastication (chipping/shredding?) or prescribed fire? Should they?
5. What are the critical indicators to measure ecological, environmental, and socio-economic impacts over time and space? What is the scale for critical indicators for different fire regimes and condition classes?
6. Where would the data be stored and how would the system be maintained?
7. What are the impacts on soils (e.g., compaction, nutrient cycling, overland water flow)?
8. Wildlife biologists can only predict impacts for a small number of species. What can we generalize about the impacts on species (plants and animals)?
    a. We need a better understanding of short term and future long-term effects/benefits.
    b. For most species, we do not have baseline thresholds for population numbers or specific habitat parameters (i.e. canopy closure, stand density, and understory structure needs)
9. We need to compare treatment impacts with the impacts (risk) associated with no activity.
10. What are the non-targeted impacts of removal (e.g., inadvertent impacts)?
    a. Are we creating areas with greater fire potential because of the return/invasion of certain species (e.g., cheat grass)?

Need 5: Effects of repeated treatments

Need statement
Managers need better information and tools to understand the impacts of repeated removal activities (e.g., environmental and socio-economic impacts).

Current models do not have enough baseline data to predict the cumulative effects of repeated treatments. To make informed decisions, managers should understand these effects at all levels – from long-term time modeling to spatial effects. This would allow managers to consider treatment decisions in a historical context and in light of future predictions (e.g., various climate change scenarios). There is some information available on the effects of harvest for commercial forest species. Little or no information exists on non-commercial species in grasslands, shrublands, and woodlands.

Specific Needs

1. What constitutes an adequate cumulative effects analysis?
2. What are the effects of repeated treatments on species of interest? What is the appropriate scale to measure impact? What are the effects of repeated treatments on the same acres over time and what is the tradeoff of treating new acres in the future?
3. What are the effects of repeated treatments on ecological processes and functions and on what scale and frequency? How do these affect:
    a. Nutrient cycling
    b. Carbon cycling and sequestration
    c. Soil structure
    d. Hydrological function?
4. What tools would help managers better conduct a life cycle analysis of biomass removal processes?
5. What is the full accounting of benefits from removal and utilization?

Need 6: Contribution of firewood programs to biomass removal

Need statement
We need to understand what role firewood programs can and do play in fire hazard reduction and what mechanisms best ensure that management objectives are met.

While we believe that firewood programs can simultaneously provide a cost effective method of community wildfire protection and biomass utilization, managers need more information about the successes and challenges of current firewood programs. This includes a better understanding of firewood cutters' preferences and compliance rates to design future programs. For example, do firewood cutters obey markings in the stand so that managers can steer them to participate in forestry improvement? If firewood harvesters are to be part of a hazard reduction strategy, managers must ensure that wood cutters take only what you want them to take, not the larger

trees or more-desirable species). Negative impacts must also be assessed. What is the relationship between firewood programs and increased poaching of preferred sizes and species, for example. What is the effect of invasive insect or plant species transported in firewood outside of quarantined or unquarantined outbreak areas? The question centers on the types of citizen and community voluntary actions are effective in reducing fire hazards.

Specific Needs

1. How much firewood is being removed from WUI, and what is the effect on fire behavior?
    a. What is the total demand for fuel wood and how does this relate to distance from the WUI?
2. What are firewood cutters' behaviors and preferences?
    a. What is their willingness to pay?
    b. What do they actually take?
    c. At what distance will they take from the road? How does slope affect what they will cut? How does proximity to the road affect the size of what they will take?
    d. What is their willingness to obey the rules?
3. What fuel bed is left after firewood cutting? Can a firewood program be managed to affect the fuel bed in ways that we want?
    a. Can we use this to help with fire hazard reduction?
    b. What is the likelihood that firewood programs will make things worse? How might they make things worse?
    c. Can a firewood program influence fire line construction and our ability to hold the line?
    d. What is the effect of a firewood program on resistance to control (RTC) in WUI and along strategic roads?
4. What are the effects of a firewood program on the local carbon balance and air quality as compared to other fuels?

Need 7: Smoke, carbon dioxide, and carbon sequestration tradeoffs of fuels management options

Need statement

Managers need to understand the emissions budgets from the suite of treatment options. In addition to traditional issues, such as health concerns related to smoke, new issues focused at regional levels are beginning to emerge. For example, in California it is extremely difficult to get a new point source permit for a co-generation plant for fear of exceeding air quality regulations. The same biomass that could be used in a co-generation plant may burn in a wildfire and create non-point source emissions far greater than that of the co-generation plant. A better understanding of lifecycle benefits and costs is needed to enable land management agencies to

engage in this debate with pollution control agencies, states, environmental interest groups, and the public.

Key parameters relating to air emissions include smoke, carbon dioxide (CO2), and carbon sequestration. In essence, managers lack the ability to get a total budget for the whole process and see how options compare. A greater understanding of fuels management options will help managers deal with biomass in a future of carbon emissions constraints. For example, managers need emissions data to compare the effects of various processes, such as burning in a furnace with a scrubber instead of letting the forest smolder. These are the kind of questions that will take a long time to answer.

Note: JFSP recognizes that smoke management is a high national priority and will schedule two roundtables on the subject – one in the eastern United States and one in the west in 2007.

Specific needs

1. How do we quantify and qualify emissions impacts for each treatment option or combination, including downstream impacts of biomass in its various end uses?
    a. For example, from an emissions perspective, is it better to send biomass to a co-generation plant rather than to burn it on site, or to send small-diameter material to furniture construction?
    b. Can you quantify carbon monoxide (CO), CO_2, visibility/regional haze, public health, economic impacts, and particulate reductions/emissions from various treatments?
    c. How do these emissions compare with the impacts of biomass removal?
2. What are the social, political, and environmental consequences and barriers of natural and anthropogenic fire and biomass removal with respect to air quality/carbon emissions?
    a. How do permitting requirements influence biomass removal options?
    b. What are the emissions merits of heating with biomass versus natural gas, coal or heating oil?
    c. How do we measure short-term impacts (e.g., Clean Air Act (CAA) or National Environmental Policy Act (NEPA)) versus long-term impacts/benefits (e.g., climate change or carbon sequestration)?
3. How can we improve our understanding of the ways various fuels reduction/biomass treatments alter fire behavior and the fire footprint on the landscape; and how can we compare emissions between actual wildfire case studies and modeled fire footprint effects without treatment?
    a. From an emissions perspective, what are the tradeoffs between prescribed burns and unplanned wildfires over various time horizons?
4. How can we better understand the beneficial and detrimental effects of various treatment options/regimes upon carbon sequestration?
    a. At the project/treatment or watershed level, how can we measure carbon storage for various fuels/biomass treatments and compare to “no action” for selected forest/vegetation communities at selected stand conditions/ages.

Need 8: Landscape-scale assessment tools to guide decision-making

Need statement
Current decision models are not easily scalable to the landscape or project level, do not acknowledge ownership boundaries, do not take into account externalities, do not encourage consistent data collection methods, and are not interactive.

Because fuels transcend jurisdictional boundaries, managers need a variety of landscape-scale tools to do strategic planning. In addition, tools must allow monitoring for outcomes, ensure quality control, involve stakeholders, and provide sound estimates for funding and prioritization. Better landscape-scale assessment tools would also provide better gross estimates for investors, entrepreneurs, and industry.

Note: The number one issue voiced by fire managers nationwide is to develop an integrated suite of analysis tools tailored for the needs of the field. The JFSP is working on this larger issue with Carnegie Mellon University to describe what software exists and more importantly to develop a roadmap to achieve what field managers need.

Specific Needs

1. What is the historic range of variability (HRV) for each potential natural vegetation (PNV)?
    a. Should we build a model to help determine an optimum mix of objectives for each area?
2. At a landscape scale, and across ownership boundaries, what tools are available/needed to assess biomass removal?
    a. How do these address feasibility of treatments (e.g., operational, economic, land-use suitability, etc.)?
    b. How do these address priorities, based upon landowner or stakeholder values?
3. Can we develop tools to assess the impacts of biomass removal—density reduction—on reducing the risk of insect infestation/damage such as that from the bark beetle and other insects)?
4. Can we improve modeling systems such as FIRESHED to be more seamless, user-friendly, web-based, and interactive?
5. Can we develop/integrate biomass growth and yield projections into models such as FIRESHED and others?

Need 9: Climate change information to predict vegetation dynamics

Need statement
Managers need information on how climate change will affect future vegetation dynamics. Insect outbreaks are occurring at higher elevations and latitudes. Fire seasons begin earlier.

Climate is influencing both the frequency and intensity of disturbance processes. Climate change models are needed to predict shifts in potential natural vegetation. The Vegetation Dynamics Development Tool (VDDT) and other state transition models should be modified to include climate change considerations. It is also essential to build these capabilities for rangeland, shrubland, and woodland ecosystems.

Climate change will affect not only the viability of existing stands and vegetation, it will also result in shifts in species types. Managers need to understand how climate change will affect their existing stands. For example, how will changing climate scenarios affect the amount of standing fuels? These are the kinds of questions that will take a long time to answer. Managers should therefore be prepared to answer them several years in the future. In addition, management decisions should account for future conditions.

It should be noted that Need 3 *Resistance and resiliency as they relate to disturbance regimes and climate change* and this question are closely related.

Specific Needs

1. Develop prescriptive climate models.
2. Update vegetative models (e.g., VDDT) to account for changes in climate.
3. Develop visualization tools in support of these models.

Need 10: Tools for better understanding tradeoffs to improve management decisions

Need statement
When considering trade-offs, managers need help to determine whether they have used appropriate data and analysis methods based upon the prevailing state of knowledge. In many cases, they must use assumptions that have significant uncertainty.

Science facts, information, and interpretations relevant to the real-world-problems managers face are extremely important. Yet forums to present, summarize, or periodically certify "relevant available science" are lacking.

This science information is tempered by local knowledge, experience, and trial-and-error wisdom. Yet there is little or no information sharing about "what works or what doesn't work" in the managerial community. Can we create forums to share practical knowledge and improve "learning by doing" in similar situations especially focused on the issues of biomass removal?

Specific Needs

1. Develop scientific summarizations for biomass information for various ecosystems that will inform planning and decision-making.
2. Develop forums where managers can exchange practical information about whether management practices actually worked, fell short, or created unintended results.
3. Integrate science, application, and monitoring into a learning system.

Need 11: Analysis of harvest equipment for biomass removal, related to cost and environmental impacts

Need statement

When conducting biomass removal activities, managers need information about optimal harvest equipment to minimize costs and environmental impacts. This need applies both to implementation and the environmental impacts of various equipment or technologies. Managers face the critical challenge of balancing the most efficient method with the associated ecological impacts. Operational concerns include the economics of different equipment, using technology appropriate for the topography and ecological conditions at a particular site, and employing the most advanced technology available on varying terrain and fuel types. In addition to operational questions, managers need data on the expected environmental impacts of different equipment (e.g., soil impacts and residual stand damage).

Specific Needs

1. How can we develop a tool (or find existing tools) that will help managers and/or contractors select the best equipment for a particular job, based upon both operational and environmental considerations?
    a. Can we develop and maintain a searchable database?
    b. Should we describe operational aspects (e.g., cost and transportation) and environmental impacts (e.g., soil and stand damage) of each technology?
2. What are, or will be, the tradeoffs of treating onsite versus removal in terms of loss of economic benefits, dollars lost to local economies, potential change to environment?
3. What is the economic break-point that current energy sources must attain for the use of fuels treatment residues to become economically viable?
4. At current and predicted fuel prices, what level of incentives or subsidies need to be offered for the private sector to fully engage in the program?
5. Can tools be developed to input local economic variables to analyze the potential for biomass utilization industries to start up and run under a sustainable basis (cost of transport, cost of treatment, cost of labor, cost of land, cost of electricity)?

Additional Items for Consideration

During the workshop, participants raised several ideas and offered suggestions that fell outside the main topics listed above or were more appropriate for one of the upcoming roundtable discussions, such as., smoke management or risk assessment. To ensure that this document reflects participants' contributions, these additional issues are presented below.

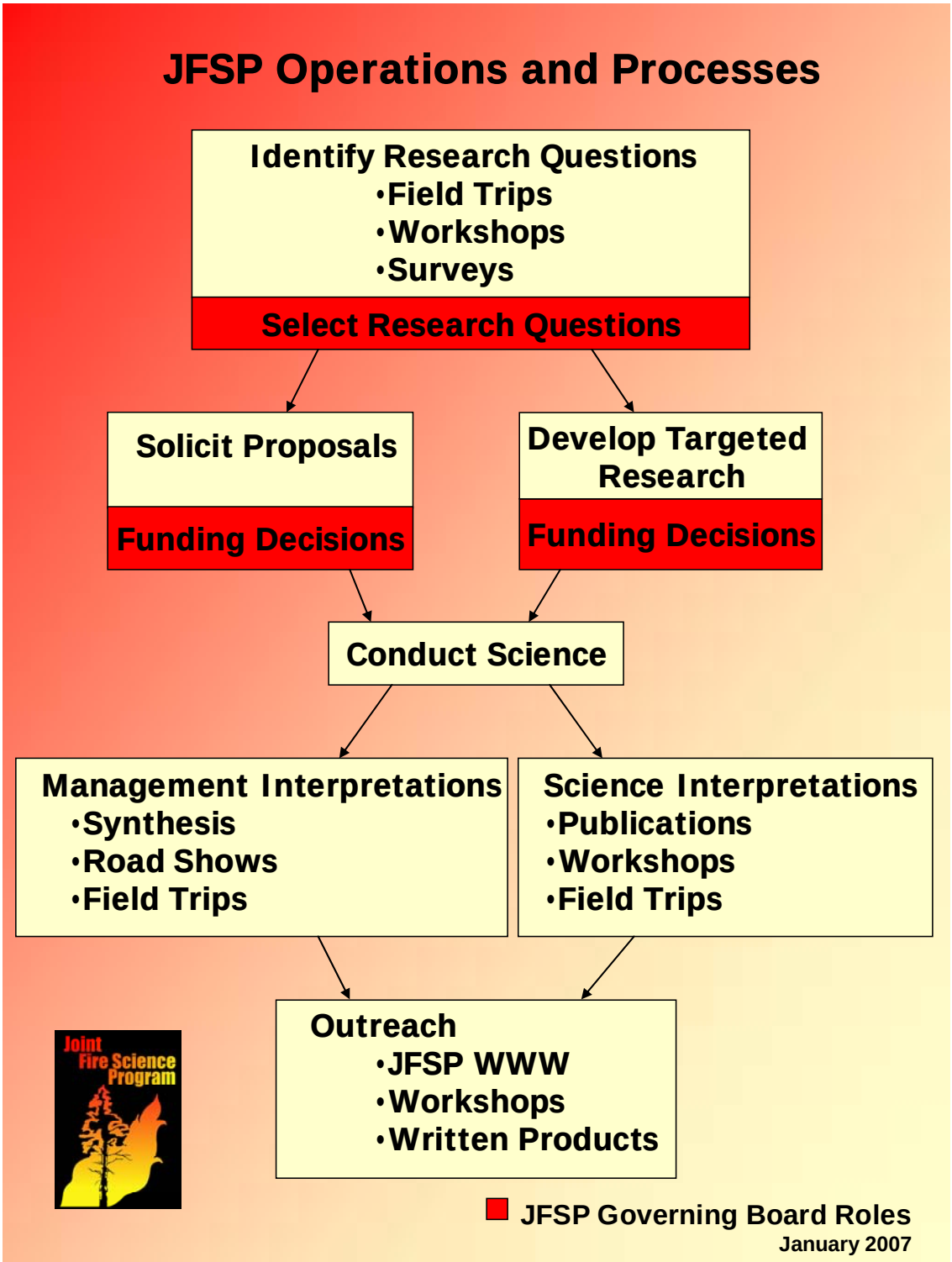
- Look for opportunities to use biomass as one way to create energy independence/self sufficiency on an Indian reservation or in a multi-reservation setting. Biomass could also be used by industry and homes for heat, biodiesel, and fuel oil, for example. If we could produce one demonstration project or model, it would be a perfect example for the rest of the nation.
- Work with the scientific community to integrate scientific rigor into project-level monitoring that is being implemented on the ground. Managers could have a real adaptive management process because of the rigorous evaluation researchers offer. The goal would be to integrate scientists with the people on the ground implementing the projects.
- Assemble a good crew of economists, biologists, and ecologists to understand what are the economic benefits of carbon sequestration, soil management, watershed management, and other approaches for every dollar government spends on biomass removal.
- Re-evaluate and synthesize the factors that have influenced the success or failure of current and past federal programs—including tax incentives, grant programs, loans, contracting authorities—aimed at encouraging woody biomass harvest and utilization to reduce fire hazard.
- Decide whether JFSP should fund the compendium of biomass technologies for biomass processing, and determine where that field is heading. Managers need a source that does regular evaluations.
- Determine the capacities of agencies to sustain the current level of fuel treatment.
- Assess the capacities of local infrastructure to support the desired work.
- Understand the performance measures, capacities, and targets that exist across programs/agencies. Targets depend on the goals of the individual agency/program. For example, some manage for ecosystem health, others for forestry goals or fire protection; Can the JFSP assess the nature of the acres that are actually being treated versus those that agencies have identified as priority needs?
- Determine if biomass removal is appropriate once a hazard is identified. Managers are struggling to define the "hazard" and lack guidance about modeling actual risk in certain settings. Managers need tools to make those decisions.

Consider research to use woody biomass for fire rehabilitation, particularly in burned wooded or forested ecosystems. Chips may be use in place of straw, but effective delivery systems are not developed including aerial applications.

Appendices

Appendix A: JFSP Operations and Process Flowchart
Appendix B: Biomass Roundtable Attendees

Appendix A: JFSP Operations and Process Flowchart



Appendix B: Biomass Roundtable Attendees

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