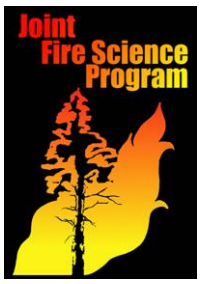
Evaluation of Science Delivery of Joint Fire Science Program Research



Final Report to the Joint Fire Science Program

JFSP Project # 07-S-04

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Executive Summary

Since its inception in 1998, the Joint Fire Science Program (JFSP) has funded over 400 projects. The Joint Fire Science Program has long recognized that the investments made in wildland fire science need to be accompanied by an emphasis on science interpretation and delivery. Program success is ultimately measured by how well information from research efforts is being conveyed to resource managers and end users, and whether this information is improving management decisions.

This study reviewed a sample of environmental documents from three JFSP sponsoring agencies to determine to what extent JFSP research is being incorporated into local planning efforts and to identify contributing factors for the adoption of new science at the project level. Joint Fire Science Program results and applications were present in over half the projects examined with over 30 JFSP studies being represented.

The study reveals an enormous amount of variation in the application of fire science within the planning process. A variety of circumstances likely affect this factor from personal attributes to the amount of conflict or insulation a particular environment experiences.

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Introduction

The National Environmental Policy Act (NEPA) is the cornerstone of project development, planning, and implementation for Federal government sponsored projects. Federal agencies must complete some type of environmental analysis prior to implementing a project, such as a fuels reduction thinning project or wildfire use plan. The Joint Fire Science Program (JFSP) has generated a variety of research related to fuels and fire benefits and impacts. The question remains on whether this information is currently being incorporated into these planning processes and thus affecting the decision on how to implement projects. The Joint Fire Science Program's success can ultimately be measured by how well critical information from research efforts is conveyed to resource managers and other end users, and whether it affects and influences management decisions.

Environmental analyses are performed for three primary purposes: To comply with environmental laws and regulations; to inform and engage those who have a stake in the decision; and to support sound decision making (Page 2006). In order to meet these objectives the analyses needs to be well grounded in quality science and reflect evidential experiences of those familiar with the issues surrounding project implementation. The land management agencies within the Joint Fire Science Program produce thousands of documents every year. Several hundred which are in support of fire related activities.

This study investigates to what extent existing JFSP sponsored research is currently being incorporated into environmental analyses for fuels management related projects within Federal land management agencies. We also explore whether fire sciences in general are being utilized in local planning efforts.

Science, Knowledge, and Planning

An environmental planning process is often where science and policy interact. The growing body of scientific information and knowledge interacts with tactical experiences to improve our overall management of natural environment. This is the corpus of NEPA itself that Federal activities will lessen their impact on the environment over time and provide for productive harmony between man and nature (Section 101).

Today there is a tremendous amount of scientific information available to land managers. As one individual stated at a workshop with fire managers and researchers – "We get a fire hose of information, and it's often delivered with the fog-nozzle on" (White 2004). Scientific information that agencies consider is in itself the product of a process, the scientific process, which if followed is given deference among scientists as reliable knowledge (Clarke 2006). Effective dissemination of scientific knowledge to stakeholders and decision makers contributes to forest policy and on-the-ground management. The JFSP has contributed significantly to this effort for the past decade. Over 1,500 publications including books, dissertations/thesis, and both referred and non-referred articles, along with approximately 300 websites and 100 computer models and software have been generated as a result of this work. So what makes certain scientific information become transformed into knowledge to be used within a decision making process?

The rationale decision model on which the NEPA regulations were built around assumes that the decision maker has access to complete information, that preferences are known, and external conditions dictate choice in an accepted protocol (March 1991). However this quite often is not the case and yet managers need to make decisions without clear preferences and even without complete information (Kleindorfer et al. 1993).

Sampling Frame

To help determine the extent that JFSP related science and other general fire science appears to be used at the planning level a statistical sample of projects with fuel management activities was derived from the National Fire Plan Operations and Reporting System (NFPORS) for three JFSP sponsoring agencies (FS, BLM, NPS). The total number of environmental assessments and environmental impact statements that were identified in NFPORS as having a signature date in 2004 to early 2007 were used to define the population size.

Strata samples were selected for each agency and there was significant variation in the stata depending upon the population size. The original sample size included 39 Forest Service projects, 30 Bureau of Land Management projects, and 6 National Park Service projects. A population sample was extracted using the project name, as entered into NFPORS, as the key identifier.

Based upon inaccuracies in data input within NFPORS the original sample populations had several non-applicable projects. The general cause of this was incorrect signature date entered into the database, thus the environmental document was completed prior to a time period when even some of the initially JFSP sponsored research could have effectively disseminated to the field. The final sample size was adjusted to 35, 28, and 5 respectively for a total of 68 projects for review. This included projects from 20 different states with the majority of projects (78%) coming from11 western states.

Queries and Inferences

In order to conduct a very thorough search for the use of fire science related material a variety of search methods were employed. The first approach included empirical research on the direct occurrences of cited JFSP publications and seminal products. The second approaches involved using anecdotal evidence on use of the science in planning documents. For the first two approaches over 160 documents (including EAs, supplements, reference sections, and attached specialists reports) totaling more than 5,800 pages were searched for results. A third approach which was added more recently will utilize qualitative research to examine how information is obtained and incorporated into project planning at the local level. This latter effort was outside the scope of the original proposal and is still on going.

Direct Occurrences: Environmental documents from each of the projects were queried to determine whether JFSP research was cited in the document and whether seminal products are being referenced in the planning documents. This required two separate cross data base comparisons. A "perl script" was written for a list of 34 seminal

products that were identified by JFSP. A standardized and a "sloppy" search were then performed base on this perl script to capture direct occurrences or uses of the products. Environmental documents that support the project planning were electronically scanned using the "perl script" for the names and variations of names of the seminal products. As expected the "sloppy" search generated a large number of false positive occurrences that required manual cleaning of the data.

A second query for direct occurrences involved a cross comparison of the JFSP deliverables database with references cited in planning documents. Due to considerable variation in how deliverables are cited in the planning documents, a 3 step protocol was developed to ensure more accurate results were capture. The initial step involved both a standardized and sloppy "perl script" search for lead author's last name. Once again the sloppy search produced a large number of false positives which required a manual search to verify. The second step involved a standardized "perl script" search for internet addresses that were cited in the documents. The third step required a separate manual search for references that were poorly defined in the documents.

Indirect Occurrences and Inferences: A qualitative analysis was performed to ascertain whether JFSP research and/or other fire science were being incorporated into the project planning documents. This process involved coding sections of the document that pertained to the application of fire sciences. The application of the science was basically coded as inference or use of a JFSP publication or related science; inference or use of a JFSP sponsored product; and inference or use of a non-JFSP fire related science. Sections of the document that didn't pertain to fire related science or didn't demonstrate a causational relationship with fire sciences were coded as non-applicable. Qualitative coding required an extensive knowledge of the work performed by JFSP in order to ensure consistency of coding through the various documents.

Key Findings

Direct Occurrences

- JFSP findings were represented in the sample. A total of 38 out of the 68 sample projects – or 56 percent – used at least one piece of science that could be directly attributed to JFSP. However there was considerable discrepancy between agencies and geographical location in how they currently use or at least attribute the use of JFSP related science (Tables 1 and 2). The Fire Effects Information System, Wildland Fire in Ecosystems (Rainbow Series), First Order Fire Effects Model, and BehavePlus were the most commonly used seminal products.

Table 1: Percent of Projects that used JFSP Science by Agency for all Projects

Agency	Number of Projects	Projects that used JFSP	Percentage
BLM	28	5	18%
FS	35	28	80%
NPS	5	5	100%
Total	68	38	56%

Table 2: Percent of Projects that used JFSP Science by Geographical Regions for all Projects

Region	Number of Projects	Projects that used JFSP	Percentage
East	12	8	67%
NW	10	5	50%
PSW	9	6	67%
Rockies 1	15	11	73%
Rockies 2	22	8	36%
Total	68	38	56%

Rockies 1 includes: ID, MT, SD, UT, NV. Rockies 2 includes: AZ, CO, NM, and WY.
PSW includes CA. NW includes: AK, OR, WA. East includes: AR, LA, MI, NH, PA, TX

- Variation exists as to what extent JFSP science is incorporated at the planning level. Thirty three distinct JFSP projects were referenced at least once in our sample population with one sample including science from 10 distinct JFSP studies. The Forest Service documents had the highest occurrence of JFSP science with an average of 1.25 seminal products and 1.6 references per project. The National Park Service was very similar to these averages at 1.2 and 1.4 respectively. The Bureau of Land Management had fair fewer occurrences at .2 seminal products and references per project (Table 3). Notably the BLM also had fewer occurrences of other fire science references as well. There were also significantly different levels of use geographically, which likely reflect the percentage of the agencies represented in each of the sample sets.

Table 3: Average Number of JFSP Products used by Project.		
Agency	Avg. # of Seminal Products	Avg. # of JFSP References
Forest Service	1.25	1.6
BLM	.21	.21
Park Service	1.2	1.4
Geographic Region		
East	.58	.92
Northwest	1.1	1.5
Pacific Southwest	.63	.63
Rockies 1	1.4	1.7
Rockies 2	.52	.57

Indirect Occurrences and Inferences

- Fire science is widely used on most fuels related planning projects. All but one of our samples – almost 99 percent of projects for the three agencies studied – used at least some form of fire science. In some cases (7%) the association or inference of the base science was not distinguishable.

- The use of fire science varied greatly from a vague use of it in a very general form to very detailed inclusion of it in the analysis, to the integration of several different disciplines to robustly describe the existing condition and the associated impacts of the project. In total we found reference to almost 500 unique sources of fire science. Science related to the use and application of Fire Regime Condition Classes was the most prominently referenced material.

- There exists considerable variation in the application and in particular the documentation of fire sciences. One project used over 90 different fire science sources. Fifteen projects (22%) did not cite any fire science related publications of which 5 of these projects didn't include any citations of science publications. However based upon the qualitative assessment only one of these projects didn't apply any principles of fire science within their planning documents. The project in question is a vegetative management biomass project that included pile burning as the only fire related activity.

Qualitative Analysis and Inferences

- Management units vary in their capacity to stay current with much of the science. There are several management resource issue areas where fire related science exists to help address the resource concern; however in some cases the science is either not known or incorporated into the planning process. In particular recent information on birds and invasive plant species would have benefited many of the projects as some struggled with providing a causational relationship of fire and impacts on these species. Other units did a very good job of describing these relationships and utilized multiple sources for their conclusions.

The Fire Effects Information System and papers from the Rainbow Series were often contributing agents to this knowledge.
    - The more recent issue surrounding insect infestations and changes in fuel loading and thus impacts associated with fire appears to be another area where several units are lacking information that may exist.

- Science/Management interaction is valued at the project level. In several projects (at least 6 occurrences) there was direct reference to a JFSP project's deliverable prior to the deliverable being completed and delivered or published indicating direct science and management interaction in science delivery. There were also instances where the author of the environmental document indicated personal communications with one of the JFSP investigators.

- Information gathered and research conducted at the local level is an important source for land managers. Projects that involved the application of fire as a treatment method often had extensive information about local fire history and examples of observed past fire behavior. Several projects used non-traditional forms of fire science such as unpublished reports and local administrative studies. Traditional Ecological Knowledge was incorporated on a few products generally involving the use of fire by Native Americans and the benefits of this use on plant species.

- Familiarity with the science is an important contributing factor when considering what science to use. Most projects rely heavily upon traditionally used sources of information/knowledge. Specialists tended to adopt new applications that have some connection to existing applications that they currently use. Examples of this include the "Finney Suite" and applications that appear to have a basis in FARSITE. This was even demonstrated in a negative sense where the application of a new tool was applied incorrectly to narrow the scope of the analysis.

- Individuals and organizations quite often accumulate information in event oriented time periods. Based upon the set of environmental documents reviewed it appears that knowledge is gained in lumps generally surrounding some type of event such as a conference, a large focused planning effort, or an individuals educational experience (trainings, school). It was very apparent in a few documents that different individuals authored different sections of the document and there appears to be a correlation between their life experiences and the time they acquired the knowledge based upon the age of the science.

Discussion

A tremendous amount of variability existed in both how projects were entered into the NFPORS database and how fire science was applied in the NEPA analysis. The data entry in NFPORS likely depends upon the skills of the data input person as well as the value the agency places on this process and the understanding of the various data fields. This variation affected our final sample population, but didn't affect the flow and migration of information and knowledge.

The variability of the application of fire science in NEPA documents once again likely depends upon the skills of the writer and the value the agency places on the process, as well as several other factors such as accessibility to data, and the accumulation, aggregation and integration of the science. These factors can influence the development, flow and transfer of knowledge and the application of science in the decision making process (MacGregor et al, In Preparation).

In previous work we identified several critical periods for when incorporating new research becomes an ideal time for science delivery. Included in this were routine planning efforts such as NEPA. However; not every unit invests similar amount of effort at this stage. Conflict is essential for learning as it encourages seeking out and assimilating new information to reduce the conflict. However; there is considerable variation in whether and how conflict is expressed at the unit level and within the planning process. Those units that are more insulated from conflict posed by various interest groups have less incentive to acquire and use new knowledge. Those units that are constantly being bombarded by conflict will seek out higher level of knowledge to combat or resolve the conflict. Additionally not every agency official has similar informational needs. Rather each has a minimum information threshold below which they are less willing to make a policy decision (Reenock et al, 2007).

Transfer of knowledge and technology is not complete until the receiver accepts and applies the material, or rejects it as inappropriate or inaccurate (Johnson & Dixon 2007). One characteristic that generally seems to greatly affect the rate of adoption for new science is that of compatibility (Rogers, 2003). JFSP products that were consistent with existing products or science being used by natural resource managers appear to have been applied in a very timely fashion. An example of this is the Fire and Fuel Extension to Forest Vegetation Simulator (FVS) which is commonly used in the Forest Service, especially on those units that have institutionalized the use of FVS for a variety of resource areas. Another example of this is the use of BehavePlus which appears to have been readily adopted by those units that had previously been using earlier versions of the model.

Complexity also seems to influence the rate of adoption of various JFSP products. Rogers (2003) defines complexity as the degree to which an innovation is perceived as difficult to understand and use. This probably goes hand in hand with compatibility and is reflected in products such as SPOTS which build upon established fire sciences and thus readily comprehended by many natural resource managers, including fire behavior analysts and fuel specialists, and presents the information that is fairly transparent to others. On the other hand land managers may reject a possible superior scientific product because it is difficult to use and understand than what they are currently doing (Johnson & Dixon 2007).

Another aspect that tends to influence the application and use of the science is the structure or format of delivery. Two of the most commonly used JFSP seminal products were Fire Effects Information System and "The Rainbow Series". Both of these delivery systems involve a collection of information around a pertinent management issue and

the electronic delivery of this information in some structure manner. Further investments in these types of systems may prove valuable from a science delivery standpoint provided the functionality of the system can meet the existing demand for this type of knowledge.

Implications for Research

NEPA requires a systematic interdisciplinary approach [42 USC 4321; Section 102 (A)] which generally means several different specialists will collaborate on the environmental document. This was designed to integrate the use of natural and social sciences, but also may influence how information is gathered, exchanged, and used by individuals, thus ultimately affected what science delivery techniques will be most successful for natural resource managers. Harmom (2006) presents a schematic about how information flow could be improved among resource specialists and others (Figure 1). Considering this information with those findings of MacGregor et al (In Preparation) and one can see that current science delivery methods may not be as effective in today's culture.

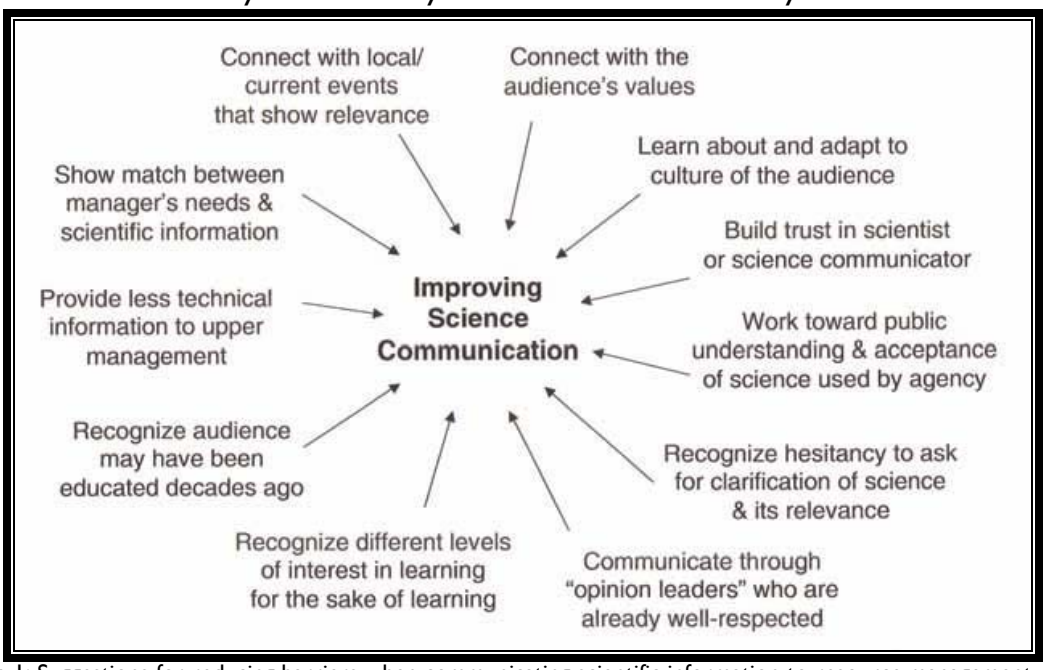

Figure 1: Suggestions for reducing barriers when communicating scientific information to resource management specialists and others. (Harmon 2006)

People perceive and process information in different ways. Understanding these differences and incorporating learning style methodologies enhances knowledge transfer (Simmon-Brown & Reed 2007). Managers can obtain information that increases their awareness of and ability to evaluate innovations by communicating with researchers, technology transfer or application specialists hired to communicate results, and other managers (Wright 2007). The most traditional methods of transferring knowledge and technology are publication in journals, symposia, and field trips. MacGregor finds that research papers alone may not provide sufficient direction for use of science in resource management decision making. Natural resource managers want science to be presented in a relevant manner in the form of "core science frameworks" that reflect managerial issues of field units. This idea suggests organizing science findings in a new manner that

draws upon meta data or the corpus of the science to reach managers in a more effective manner.

Based upon information from a recent survey completed within the Forest Service (USDA Forest Service, 2007) up to 70 percent of the workforce that currently does NEPA for a significant part of their jobs are eligible to retire in less than 10 years. This means a tremendous amount of knowledge is likely to "walk out the door" in the near future presenting an even greater need for effective science delivery. Combine this with the fact that most natural resource specialists have very limited time to invest in acquiring and deciphering the ever growing accumulation of fire related sciences will challenge the research world. Questions that need to be addressed include:

- How do natural resource specialists and managers learn and share information?
- What science delivery techniques are effective from both a nurturing and cost perspective?
- What type opportunities exist to improve the rate of adoption of new science?
- How can science be made more "compatible" to future natural resource managers?

Deliverable Crosswalk

Our initial proposal basically contained two products to help decipher the use of JFSP related research in project planning: Direct occurrence citations of JFSP sponsored publications and a qualitative assessment of the usefulness of the research. Based upon a meeting with representatives for JFSP in January 2008, the study was expanded to include greater emphasis on whether fire related science was being used, including JFSP and other sources, even if the science was not being referenced or cited in the document; and more emphasis on how knowledge is gained and transferred within natural resource land management personnel. The qualitative assessment aspect is not completed yet as it has to follow in sequential order to knowledge gained from the direct and indirect occurrences and use of fire science. However we did gather quite of bit of evidence from the qualitative analysis coding that was completed on 168 documents.

Table A-1: Crosswalk between proposed and delivered products.

Proposed	Delivered	Status
Determination of whether JFSP research is cited in agency's environmental documents	Database of direct occurrences for JFSP publications and seminal products.	Completed
	Database of indirect occurrences or inferences to JFSP research	Completed
Analysis of use of fire science related material in local planning efforts.	Database of indirect occurrences to non JFSP research.	Completed
	Database of Fire Science References used in sample population.	Completed
Qualitative assessment of the usefulness of JFSP related work	In depth interviews with various subsections of the sample population to determine their information acquisition methods.	Ongoing
	Testimonies related to relevance of JFSP research.	Ongoing

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