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Delivering the Science Synthesis: FuelsTools

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ABSTRACT

To facilitate delivery and use of the Fuels Planning: Science Synthesis and Integration Project's (Project) products, the Project team engaged in a series of technology transfer activities throughout the life of the project. These included bringing land managers into the design and development phase, funding and staffing a specific delivery phase, and conducting an external evaluation to focus future activities. Our plans were informed by concepts central to the diffusion of the innovation theory; in turn, our activities deepened our understanding of the theory and its application to fuels management.

Keywords: wildland fire decision support tools, science delivery, technology transfer

The Fuels Planning: Science Synthesis and Integration Project (Project) was initiated by the USDA Forest Service to address manager's needs for improved access to the best available science. The Project targeted information useful for planning site-specific fuel (i.e., vegetation) treatment projects, particularly those under the National Fire Plan and the Healthy Forest Restoration Act, and, specifically, those planned to address fuels in the dry forests of the Interior West. Improved access was provided in the form of synthesized research information and computer software tools housed in a web-based "toolkit."

During the effort, scientists from three Forest Service Research Stations and several universities as well as participants from the National Forest Systems and the Department of Interior synthesized current research information pertinent to planning fuels treatment projects in four key areas: social science, wildland fire behavior and forest structure, environmental consequences, financial analysis and economic impacts (Table 1; please refer to related *JOF* articles for more in-depth information on each of these).

This article outlines science delivery efforts during both an initial Project development and a second phase focused on science delivery. We review the suite of products compiled during the project, our science delivery efforts, results of an evaluation, and present lessons learned.

Our Approach

The process by which a new technique or innovation moves through a population has long fascinated scholars and practitioners. In 1962, Rogers published his widely used "diffusion of innovation" theory after studying the movement of techniques and ideas in both agricultural and medical industries (Rogers 1962). His categorization of individuals based on their willingness to adopt new ideas has been supplemented over the years with additional insights into the characteristics and stages of diffusion (cf. Rogers [2003]). Although criticized for its simplicity, a generally accepted trajectory of diffusion begins—for both individuals and organizations—with awareness (knowledge), moving through interest (persuasion) to a decision to try (decision), to testing or using the innovation (implementation), and finally to acceptance and continued use (confirmation). The decision step may be considered the point of adoption; however, institutionalization of an innovation rests on actual implementation and confirmation of beneficial use. Graphically, this trajectory looks like an "S" curve, in which there is a significant lag time between adoption by the initial "innovators" and some indeterminate, but profound, inflection point at which adoption by the majority occurs rapidly, and then tapers off as the resistors come on board.

During development and delivery of the Project, we kept this trajectory in mind, using it to suggest tasks, set expectations,

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Table 1. Science synthesis and integration team and leads.

Team	Team leads
Project management	Russell Graham (RMRS); Sarah McCaffrey (NCS)
Fire behavior and forest structure	David Peterson (PNW); Morris Johnson (PNW)
Environmental consequences	Elaine Kennedy-Sutherland (RMRS); Anne Black (RMRS)
Economics	Jamie Barbour (PNW); Roger Fight (PNW)
Social science	Pam Jakes (NCS); Sue Barro (NCS)

Abbreviations refer to the various Forest Service research stations: RMRS, Rocky Mountain Research Station; NCS, North Central Research Station; PNW, Pacific Northwest Research Station.

and identify initial users and potential measures of success. A general rule of thumb holds that successful adoption takes 5 years. The Fuels Synthesis Project was initiated in October 2003 with prototype products launched in August 2004. Although ultimately the measures of success are likely to include the number of field projects using the Toolkit and the number of fuels treatment projects implemented, such measures are not appropriate for evaluating an effort in its early stages of diffusion. Here, we focus on activities during the first 2 years of the Fuels Synthesis Project after prototype launch (August 2004–August 2006). We use a variety metrics more appropriate to the early phases of diffusion—those related to awareness building, persuasion, and, to a very limited degree, decision to use.

Products—Our Innovations

Products are packaged as the "Science Synthesis: FuelsTools" a web-based toolkit (Toolkit) comprised of new, improved, and existing software tools; new peer-reviewed subject-matter syntheses; and annotated bibliographies and fact sheets, supplemented by training materials and web links to related materials (USDA Forest Service 2003). The Toolkit improves planning teams' access to existing research information by providing current information and knowledge gaps (uncertainties) for key management questions regarding implementation of fuel hazard reduction treatments. They represent the collective judgment of the most knowledgeable scientific experts in silviculture, fire behavior, fire ecology, social science, and other fields.

The Project provides access to a series of software tools, some of which are web-based while others run in a local environment (Table 2). Tools include, for economics and biomass use, My Fuel Treatment Planner (MyFTP); erosion and sedimentation, Watershed Erosion Protection Project–Fuels Management Erosion Analysis (WEPP-FuMe); understory plants and weeds, Understory Response Model (URM); overstory trees, First Order Fire Effects (FOFEM); terrestrial wildlife, Wildlife Habitat Response Model (WHRM); root disease, *Armillaria* Response Tool (*A*RT); and smoke production and short-distance dispersion, the Smoke Impact Spreadsheet (SIS). For the three preexisting programs MyFTP, WEPP, and FOFEM, the Project provided funding to complete or supplement existing functionality. URM, WHRM, and *A*RT are completely new software tools developed under this project that summarize and synthesize key scientific literature in their respective fields. MyFTP, WHRM, *A*RT, and URM currently are specified for use primarily in the dry, interior western forests. WEPP, FOFEM, SIS, and Forest Vegetation Simulator–Fire and Fuels Extension (FVS-FFE) can be used in forested areas nationwide. The Toolkit also provides links to other relevant information that preexisted the Project: tools such as FVS-FFE and search engines such as FRAMES.

Written materials will eventually include 13 peer-reviewed General Technical Reports (GTR) and numerous peer-reviewed articles. Currently, 11 GTRs and two articles are available, including a guidebook of the effects of fuels treatments on fire behavior, four syntheses of relevant social science literature, a synthesis of wildlife and invertebrate responses to fuels treatments, and several user's guides for the software (Table 3).

In addition, members of the Project team also produced four series of fact sheets—short, two-page overviews of the key issues and software tools in each subject area (Table 4).

Science Delivery

Successful tools or techniques are those that meet a need, are appropriate to the culture, knowledge, and technology available, and acceptable to the end user. Throughout the initial development phase researchers sought to involve managers to begin developing awareness and interest in the products and to ensure product usefulness. We did so by inviting field managers and regional staff to sit on synthesis teams and review draft documents. We also organized two beta-tests of proposed products to identify major bugs, user interface problems, and information gaps in prototype versions of the software. During tests, Forest Service and Bureau of Land Management (BLM) staff from a variety of areas—planning, fuels, wildlife, fisheries, hydrology, and silviculture—were introduced to the Toolkit.

Although these activities helped raise awareness of and build interest in the products, previous research and experience suggested that adoption of new tools and innovations would require additional effort (cf. Rogers [1962, 2003]). Therefore, the team developed and obtained funding for a more intensive science delivery phase. These efforts were based on the premises of the diffusion of innovation theory, viz., that successful transfer and delivery depends on people hearing about the technology, having access to the technology and training (if necessary), hearing positive assessments of the information or technology from their peers, and that the technology is usable and useful (Rogers 1962, Hall and Hord 1987).

Specific Science Delivery Efforts. Our intensive science delivery phase (January 2005–August 2006) took a multipronged approach (Table 5). Outreach was accomplished by individual and group efforts by all members of the Project team and was facilitated by a part-time science delivery lead (first author).

To ensure that people heard about and had access to the Toolkit, we sought to participate in a broad spectrum of opportunities. Activities were intended to raise awareness of the tools, help persuade potential users of their usefulness, and in the longer training sessions, use real-life examples to train managers in their use. Outreach activities covered the gamut from posting a website to 30- to 60-minute awareness-building presentations to 8- to 21-hour workshop-format intensive trainings to online and hard copy published user's guides, articles, fact sheets, and online video trainings. We developed a poster for meetings at which we could not make oral presentations and included Project information in numerous regional Forest Service newsletters.

Table 2. Science Synthesis: FuelsTools software and tools.

Acronym	Full name	Subject area and functionality
MyFTP	My Fuel Treatment Planner	Predicts cost/revenue and surface fuel loadings per acre for user-identified treatments.
*A*RT	*Armillaria* Response Tool	Predicts change in presence and risk of *Armillaria* root disease.
SIS	Smoke Impact Spreadsheet	Excel model predicting smoke emissions and downwind dispersion.
WEPP-FuMe	Watershed Erosion Prediction Project–Fuels Management	Predicts erosion and sedimentation through batch runs of WEPP for a set fire and mechanical treatments; accesses WEPP for custom treatments.
URM	Understory Response Model	Qualitative predictions of changes in biomass of understory plants and weeds 1, 5, 10 yr posttreatment.
WHRM	Wildlife Habitat Response Model	Qualitative predictions of impact to habitat 1 and 10 yr posttreatment.
Fuels Treatment Guidebook	Fuels Treatment Guidebook	Displays results of FVS-FFE runs for four stand densities and three surface treatments for 50 yr posttreatment.

Table 3. Peer-reviewed articles and GTRs.

Subject area	Publication number	Title
Overview	RMRS-GTR-120	Science basis for changing forest structure to modify wildfire behavior and severity
Fire hazard	PNW-GTR-628	Forest structure and fire hazard in dry forests of the western United States
	PNW-GTR-686	Guide to fuel treatments in the western United States: Assessing forest structure and fire hazard
Economics	PNW-GTR-662	Financial analysis of fuel treatments
	PNW-GTR-663	My fuel treatment planner: A users guide
Environmental consequences	RMRS-GTR-141	Root diseases in coniferous forests of the Inland West: Potential implications of fuels treatments
	RMRS-GTR-173	Wildlife and invertebrate response to fuel reduction treatments in dry coniferous forests of the western United States: A synthesis
	J. Am. Water Resources 40(2):299–309	WEPP internet interfaces for forest erosion prediction
	Wildfire online and http://leopold.wilderness.net/pubs/526.pdf	Tongue-tied: Understanding intensity and severity in the fire disturbance continuum
Social science	NC-GTR-257	Social science to improve fuels management: A synthesis of research on collaboration
	NC-GTR-259	Social science to improve fuels management: A synthesis of research on assessing social acceptability of fuels treatments
	NC-GTR-261	Social science to improve fuels management: A synthesis of research on aesthetics and fuels treatments
	NC-GTR-267	Social science to improve fuels management: A synthesis of research relevant to communicating with homeowners about fuels management

Through these direct efforts, we reached over 600 people, holding more than 30 presentations and workshops ranging from the International Union of Forestry Research Organisations Congress to the 2005 National Silviculture Workshop to the local Butte North Hazardous Fuels Treatment Interdisciplinary Team; and from federal forest managers (R6/SORO joint BLM/Forest Service meetings) to commercial forest managers (Inland Northwest Intermountain Tree Nutrition Cooperative) to private landowners (Landowner Assistance Team Leaders). Students of the National Advanced Fire Resource Institute's Rx 510 Advanced Fire Effects course and the University of Idaho's ecology accreditation series also have been exposed to the ToolKit. We have provided more than 80 hours of training to Forest Service and BLM employees in all of the Forest Service western regions.

We assumed that hearing good things about an innovation depends on that innovation being useable and useful; therefore, we solicited field-test partners with whom we could work to further understand uses and utility and from which to build case studies and examples.

To improve training materials, techniques, and the tools themselves, the team contracted for an external evaluation of the Toolkit and our delivery efforts while continuing to make software improvements requested by initial beta-testers.

Finally, because this level of effort is not sustainable for researchers over the long run, we sought to develop stand-alone training materials that may be integrated easily into existing communication and training opportunities and provide continuing support after completion of this project. This suite of short videos explaining each tool and subject area (3–5 minutes) and the overall project (23 minutes) can be viewed online or downloaded to provide either an initial overview or a brief refresher.

Evidence of Use. During the first 18 months that the prototype website was posted, users visited more than 18,000 times (main page count only). Between January 2005 and August 2006, users made more

Table 4. Fact sheets by subject area.

Subject area	Number	Title
Overview	RMRS-RN-19–1	The fuels synthesis project overview
Economics	RMRS-RN-20–1	Mastication treatments and costs
	RMRS-RN-20–2	Log hauling cost
	RMRS-RN-20–3	Economic impacts of fuel treatments
	RMRS-RN-20–4	My fuel treatment planner—overview
	RMRS-RN-20–5	NEPA and economics
	RMRS-RN-20–6	Selection criteria analysis
	RMRS-RN-20–7	Markets and log prices
	RMRS-RN-20–8	Prescribed fire costs
	RMRS-RN-20–9	My fuel treatment planner—the tool
Social science	RMRS-RN-21–1	Developing personal responsibility for fuels reduction: Building a successful program to engage property owners
	RMRS-RN-21–2	Developing personal responsibility for fuels reduction: Types of information to encourage proactive behavior
	RMRS-RN-21–3	Developing personal responsibility for fuels reduction: More ways to catch and hold people's attention
	RMRS-RN-21–4	Three critical topics to cover when talking about hazards
	RMRS-RN-21–5	The importance of working locally
	RMRS-RN-21–6	Important considerations for communicating about hazards
	RMRS-RN-21–7	The "laws" of effective public education about fire hazards
	RMRS-RN-21–8	The "golden rule" and other lessons on communicating about hazards
	RMRS-RN-21-9	Benefits of collaboration
	RMRS-RN-21-10	Stages of collaboration
	RMRS-RN-21-11	Challenges to collaboration
	RMRS-RN-21-12	Keys to successful collaboration
	RMRS-RN-21-13	Strategies for managing fuels and visual quality
	RMRS-RN-21-14	Landscape preference in forested ecosystems
	RMRS-RN-21-15	Landscape change and aesthetics
	RMRS-RN-21-16	Prescribed fire and visual quality
	RMRS-RN-21-17	Considering social acceptability of fuels treatments
	RMRS-RN-21-18	Issues affecting social acceptability of fuels treatments
Forest structure and fire hazard	RMRS-RN-22–1	Forest structure and fire hazard overview
	RMRS-RN-22–2	Fire hazard
	RMRS-RN-22–3	Visualizing forest structure and fuels
	RMRS-RN-22–4	Role of silviculture in fuel treatments
	RMRS-RN-22–5	Fuel treatment principles for complex landscapes
	RMRS-RN-22–6	Guide to fuel treatments in dry forests of the western United States: Assessing forest structure and fire hazard
Environmental consequences	RMRS-RN-23–1	Fire effects information system (FEIS)
	RMRS-RN-23–2	First order fire effects model (FOFEM)
	RMRS-RN-23–3	Structure fires in the wildland–urban interface
	RMRS-RN-23–4	Wildlife responses to fuels treatments: key considerations
	RMRS-RN-23–5	Prescriptions and fire effects
	RMRS-RN-23–6	Wildland fire use: The "other" treatment option
	RMRS-RN-23–7	Fire and weeds
	RMRS-RN-23–8	Evaluating sedimentation risks associated with fuels management
	RMRS-RN-23–9	Fire and fuels extension to the forest vegetation simulator (FFE-FVS)
	RMRS-RN-23–10	The understory response model (URM)
	RMRS-RN-23–11	Smoke impact spreadsheet (SIS) model
	RMRS-RN-23–12	Water erosion prediction project (WEPP) fuel management (FuMe) tool
	RMRS-RN-23–13	Root disease analyzer—*Armillaria* response tool (*A*RT)
	RMRS-RN-23–14	Fuels reduction and compaction
	RMRS-RN-23–15	The wildlife habitat response model (WHRM)

than 2,000 runs of the WEPP-FuMe model, 750 runs of the WHRM, 485 runs of the URM, and hit the *Armillaria* response tool's site (*A*RT) over 500 times. Model runs are being made by the Forest Service, BLM, and other federal agencies, through universities, and from the private sector.

In the first 6 months of 2005, visitors viewed the publication, "Social Science to Improve Fuels Management: A Synthesis of Research on Collaboration," (Sturtevant et al. 2005) 705 times and requested 335 downloads, making this the most frequently downloaded document on the North Central Research Station's website in June 2005.

Such evidence suggests that there is interest in the tools and by a wide variety of people, but such statistics provide little insight into which tools or venues are most effective and they do not indicate whether these efforts are successfully reaching the intended audience or persuading them to try the tools for actual planning efforts.

Evaluation

Overview and Methods. To assist us in understanding the most effective delivery mechanisms, identifying early uses of the products, and capturing initial success stories, in September 2005 we contracted with a third party (second author) to conduct an evaluation of initial outreach efforts. At this stage in the diffusion process, an evaluation can provide only information about the effectiveness (content, length, and venue) of our awareness building and training efforts, an impression of the breadth of people reached, and the level of interest and intent to use these efforts are generating. Results will help guide future science delivery efforts.

The evaluation was conducted 12 months after initial posting of the Project website and the first beta-test. Conducted using qualitative interviews administered

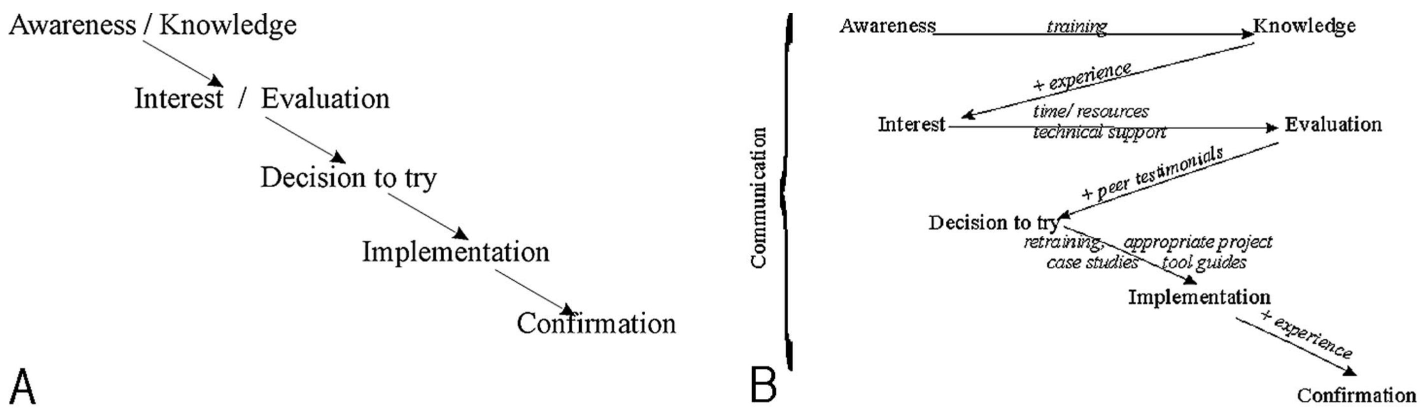

Figure 1. Stages in the diffusion of innovation.

over the telephone (10–60 minutes each), the evaluation targeted the 117 National Forest System (NFS) staff who participated in one of several outreach and training formats: two 8-hour beta-tests of the Science Synthesis: FuelsTools, one 8-hour and one 21-hour training, two 30- to 40-minute Project overviews provided at a national and a regional workshop, and word of mouth. This was a convenience sample drawn from attendance lists at conferences, trainings, and including several who heard of the tools through word of mouth. At the time the survey was conducted (fall 2005) six new or updated tools had been released: MyFTP, URM, WHRM, SIS, *A*RT, and WEPP-FuMe.

Evaluation Results. Although our target population for the Science Synthesis: FuelsTools was fuels planners—those with primary responsibility for fuels reduction project planning–those attending workshop and symposia sessions represent a wide variety of backgrounds (more than 30 job titles). We obtained responses from 60 workshop participants. Based on these responses, many attendees came not to learn about tools they could or would use themselves, but to obtain an overview of "what was out there." Thirty percent of these respondents do not have responsibility for project planning (e.g., appeals and litigation staff and regional staff). Nevertheless, they view themselves—or may be approached to serve as—conduits for information. Audience diversity may also account for the relatively small number of respondents who were already using or expected to use the tools at the time of the survey ($n = 13$). Still, these users represent 21% of the 37 respondents who provided detailed answers about the trainings and Toolkit.

The tools in the Toolkit are being used for large and small projects, from supporting Environmental Impact Statements to Categorical Exclusions, and for salvage, fuels, and Healthy Forest Restoration Act (HFRA) projects. They are being used in all phases of planning, from pre-National Environmental Policy Act (NEPA), during analysis, to assist in developing an understanding on Inter-Disciplinary planning teams and with the public. To our knowledge, thus far, no project has used the *all* tools in the Toolkit. Most of those who indicated they were already or expected to use the tools attended an 8-hour training. This represents 20% of all respondents who had attended an extended training (8–21 hours). Somewhat surprisingly, 35% of those expecting to use the tools in the near future learned about them through word of mouth, although the nature of the sample also must be kept in mind. One-half of those already using the tools in project planning did so at the behest of forest or regional staff who was aware of the tools and encouraged field units to take advantage of the Toolkit. In line with the diffusion of innovation theory, tools that had been in existence longer—SIS, WEPP, and MyFTP—had more users than the newer tools—WHRM and URM.

The evaluation uncovered a number of barriers to the use of the tools, from lack of time to learn new tools to the geographic specificity of many tools in the toolkit (dry interior forests), to the lag time between training and the initiation of a new project. In fact, 30% of respondents who do work on projects (8 of 27) indicated that a main reason for not having already used the tools was lack of an appropriate project. Others were reluctant to learn a new technique, favoring known methods under time and production pressures that make it difficult to learn new tools. By the time they did have time to learn a new tool, a number of participants had forgotten about the tools or had become rusty in their knowledge of the tools.

Lessons Learned

In a typical diagram of the diffusion of innovation process, the path from awareness to institutionalized use is fairly straightforward (Figure 1a). We found the process quite a bit messier (Figure 1b). Awareness must be matched with training to build knowledge, which is often preliminary to anyone showing much interest. But interest and knowledge alone are rarely sufficient for someone to decide to use a new technique; there is a need to evaluate the tool, which requires time . . . and often computer resources, data, and access to technical support. Often, a positive evaluation leads to a decision to use, but this may be further encouraged by the positive evaluation of peers. However, the step to implementation—or initial use—must be accompanied by an appropriate project (scale, data, team agreement, and time), often by a refresher course, and may be assisted by examples and user's guides. Finally, the move from implementation to adoption—or continued use—rests on having a positive experience during the first actual use and is assisted by support from supervisors.

There are several implications to this revised flow chart: (1) Each and every one of these facilitators can become a barrier—and is a barrier for some one. (2) Adoption takes time. The well-known "S" curve in the diffusion of innovation literature (Figure 2) suggests that there is a conceptually predictable trajectory for each innovation. However, introduction and takeoff do not occur in the absence of outside influence. There needs to be a net input of energy to get up to and through the "takeoff" stage. This leads directly to the third implication: (3) Adoption takes an input of energy, exogenous en-

Table 5. Project activities addressing each phase in the diffusion of an innovation.

Phase	Activities
Creating awareness	National and regional workshop overview presentations Mass media: e-mails, newsletters, website, popular articles Word of mouth within target groups Fact sheets Website Posters for local, regional, and national meetings Online 3- to 5-min tool overview videos
Building interest (persuasion)	Overview presentations Beta-test workshops Intensive training sessions Fact sheets Website Peer-reviewed articles Meetings with regional staff and leadership Using tools in national rollouts (Fireshed)
Supporting a decision to use	Website Onsite training sessions and assistance Easy access to and availability of tool developers Online users manuals Peer-reviewed publications and tool guides
Supporting implementation	Intensive and onsite training sessions Website Online refreshers, training, user's guides, and peer-reviewed literature GTRs and user's guides Establishing ongoing Help Desk/training and tool maintenance
Supporting confirmation	Website Encouraging and posting feedback Revising tools based on feedback and requests Collecting and posting testimonials Developing case study examples—success stories

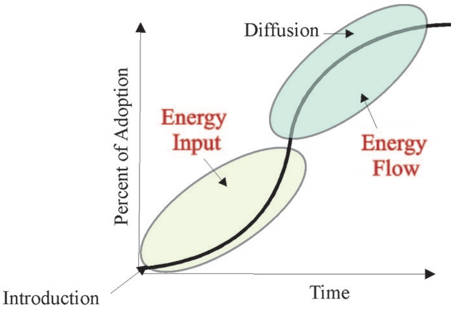

Figure 2. Trajectory of diffusion, showing energy flow.

ergy, at first. A net input of energy is necessary to get up to and through the "takeoff" stage. At an organizational level, such as in the Forest Service, where research is separate from management, this suggests that a partnership in which initial delivery efforts from research are paired with building of and commitment to internal support from management is necessary. An organizationally feasible definition of "takeoff" may be the point at which internal support for the new technology is such that further diffusion will occur naturally without further exogenous "push" from research.

Recommendations and Take-Home Messages. We attempted to track awareness and use of a new set of products through a variety of ad hoc measures: website statistics, number of people exposed to the Toolkit through various oral presentation venues, and a telephone survey of presentation attendees. Through this latter we also hoped to obtain information on level of initial application and use. Our purpose was to help guide future delivery efforts and was not intended as a comprehensive assessment. We were able to obtain much useful information from these sources; however, future science delivery evaluation efforts would be facilitated by more rigorous up-front planning. For instance, not all websites hosting our publications could provide information on number of downloads. Not all presentations collected attendance sheets. Conducting an evaluation barely 2 years into a delivery effort provided little information on ultimate use and application. Additional insights and recommendations follow.

Large meetings with short presentations offer exposure and boost awareness of new tools, but they are not venues for learning; longer training sessions are necessary, but not sufficient. Ultimately, learning occurs during the implementation stage when people actually put the tools to use on a real issue. By this time, however, potential users may have forgotten about the tools or become rusty in their recollection of use and usefulness. Developers and science delivery efforts must be able to maintain a stream of communication with potential users (through updates and other reminders) and provide easily accessible refresher training courses and opportunities.

In the current environment, where because of priorities and workforce there is limited energy to devote to adopting new tools, it is important to build a solid user network of support. This involves clearly identifying the benefits of using the new innovation, providing consistent and predictable support, and, if possible, online examples of on-the-ground use. It can also involve identifying and supporting a user-champion for the innovation.

Using real-time planning efforts to debut tools can seem both efficient and effective, but integrating management and research timelines is difficult. In our case, we were able to fully implement less than one-half of our partnership commitments because of timeline challenges outside either party's control. For this reason, it is important to develop more potential case studies than ultimately desired. It is also important to gain the commitment of supervisors and line officers to help ensure project completion. Hiring a dedicated delivery staff, in addition to project researchers, provides a deeper "bench" of potential trainers to draw on—a necessary feature for delivering products over an extensive area.

Multiple training and communication methods and venues are necessary to cover not only the range of interests and backgrounds, but also learning styles and communication options. Short, punchy fact sheets and communiqué's are useful to build awareness and interest and can lead to "test runs." However, peer-reviewed (citable) publications are essential for implementation and continued use.

Online refreshers and trainings are useful for some people, quite probably enough to make it worth the effort to develop, but are not useful for many people. Our experience shows that one-on-one contact and personal references of credibility are important.

The Forest Service and Department of Agriculture are just now developing guidelines for websites. We began with multiple websites, which can add significant complexity for maintenance and updates. Housing website maintenance under one "roof" would facilitate ease and cost of maintenance.

Users tolerate different levels of beta-testing. Although some seek brand new tools and are comfortable encountering glitches and small bugs, others are completely turned off. A fine line exists between getting the word out early, building momentum for new products, and remaining open to feedback that may necessitate changes and discouraging users who may expect glitch-free tools. Market demographic research to identify early adopters and innovators could help researchers target appropriate groups for the messier work of product development, saving other users the frustration of encountering beta-version software.

Because of lack of a central location for key contacts and notification/distribution venues (e-mail communication, notification, and distribution protocols vary by Forest Service region and there is no standard position or distribution list), it was difficult to determine whether we were accessing the most appropriate and key communication venues and contacts. A market demographic project, discussed previously, also could assist by providing a resource for all agency science delivery efforts.

Conclusions

Delivering new science tools is neither straightforward nor quick. It takes concerted and coordinated energy from both developer/researchers and users/managers. Efforts may be hampered by disconnects in timelines and accountability for research and management, particularly when funding mechanisms are ad hoc and delivery plans developed after development planning. Efforts are facilitated by integrating delivery and evaluation plans into project development plans.

Regardless of how delivery is planned or funded, patience and persistence are required to meld research and management cycles. Working with regional staff and supervisors who are in positions to encourage and/or require use of new information is critical, as is the necessity for communication, communication, communication. E-mail is widely considered to be an effective media for notifications (reminders and updates) in the Forest Service, but one notification is not enough. In an era in which managers are virtually inundated with new information and tools, it is easy for them to continue to use what is known, familiar, and proven. Periodic notices of updates, new uses, training opportunities, and more help remind potential users of the tools and how to access training and support. Hearing about something once at a conference is not enough!

Development and delivery of science to managers is not a one-step function, and attempting to use a single measure of success can obscure much important information on the strengths and weaknesses of an effort. There are multiple tasks and audiences across the gamut from discovery to delivery. Developing and describing various markers or measures of success along this gamut would seem to hold promise for further improving future science delivery efforts.

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