



How do plants respond to fire? Seeking knowledge on hundreds of species in dozens of ecosystems can be overwhelming. When the species are not native to the U.S., knowledge is even harder to find and apply. Credit: Mandy Tu, ©The Nature Conservancy, Garon Smith, and Matt Brooks, U.S. Geological Survey, Biological Resource Division.

The Fire Effects Information System: How a Superhero Database Comes to Save the Day

Summary

Land managers must make fire management decisions considering place, history, and species, an undertaking that requires a vast amount of information that tends to be spread through many publications. The Fire Effects Information System ([FEIS] at www.fs.fed.us/database/feis) provides a single source for managers, where knowledge available in the scientific literature has been analyzed, discussed, and synthesized into reviews of plant and animal species. As managers formulate plans for prescribed fires, fuel management, and post-fire revegetation, they can see at a glance, without having to perform their own literature search, what the results of past research have been, where studies were located geographically, and where knowledge gaps exist. Available to managers since 1986, FEIS has recently been updated and expanded with reviews of 60 nonnative plant species. In these reviews, the scientists located extensive information on the basic ecology of weeds, but found little information on heat tolerance, post-fire establishment, effects of varying fire regimes (severities, seasons, and intervals between burns), or long-term effects of fire.

Key Findings

- FEIS provides users with a single source to consult for reviews of the scientific literature on plant and animal species.
- The FEIS team has synthesized the available knowledge into each review and analyzed the information source to indicate how generally information can be applied.
- FEIS reviews point out gaps in scientific knowledge so managers can identify areas of uncertainty in planning and information needed from monitoring.

Introduction

We all have different ways of reacting to things. And we've probably all known someone who runs a little hot, whose flashpoint is quick, or who seems as cool as a cucumber. These clichéd phrases serve as familiar shortcuts to describing personalities—patterns in human behavior that people recognize. They also provide tacit guidelines for the best way to work with a particular type. While we've memorized some shortcuts for the way our own species behaves, it would take a Herculean effort to do the same for the dizzying array of organisms that occupy this world with us. For example how would each of the plant and animal species in a northwestern lowland forest react to even one type of disturbance, such as a severe wildland fire? How would those in a southeastern swamp react to prescribed burning? Change the variables, and maybe you are faced with anticipating reactions to different kinds of fires, or fires in places that now include newcomer species—weeds that might increase fire severity or change the fire return interval.

Land managers must make fire management decisions considering place and histories—an undertaking that requires a vast amount of knowledge most likely spread among many publications. While wide gaps in scientific knowledge exist, Jane Kapler Smith, Ecologist in the USDA Forest Service's Fire Sciences Laboratory at the Rocky Mountain Research Station, along with her team in the Fire Modeling Institute, have provided land managers with a resource that offers Herculean help—reviews of the scientific literature that recognize the life history, seasonal features, reactions to fire, and patterns of succession for more than 1,100 plant and animal species—collected in a single database.

FEIS—Doer of great labors

As anyone who has ever looked through published literature to collect information knows, it's easy to get bogged down in the labors of the search. Booklists, listservs, and search engines help. But to enlist the FEIS database is to find a powerful ally that has performed most of this difficult labor for you. Developed at the Forest Service's Fire Sciences Laboratory of the Rocky Mountain Research Station, the database's planners periodically gather input from land managers on which species to review. Through the continued efforts of Smith and her team, the scientists search their on-site literature collection and other literature databases, analyze the knowledge

available, assess general patterns, discuss conflicting information, and identify knowledge gaps—and synthesize all of this into each species review. Within a review, Smith indicates, they try to document every assertion so readers know “who said so.” “This also makes it relatively easy for readers to follow up on our synthesis and analysis,” Smith offers, “by looking the information up for themselves.”

Available to managers since 1986, the database boasts literature reviews of about 1,000 plant species, including 111 nonnative plants, and 120 animal species found in the United States. As its name suggests, reviews in the Fire Effects Information System emphasize how fire affects species, but they also include information on biology, ecology, taxonomy and distribution of each species. Because the information is gathered into one database, FEIS allows managers to quickly see the information available, where research was conducted, and what information is still lacking in regard to fire, without having to perform their own literature searches. Managers can use this collected information to help them plan prescribed fires, fuel management, and post-fire revegetation. FEIS species reviews integrate detailed fire regime information from the LANDFIRE Rapid Assessment, and the FEIS team supplements the knowledge available through FEIS reviews by linking them to other websites such as NatureServ and www.plants.usda.gov.

Available to managers since 1986, the database boasts literature reviews of about 1,000 plant species

With invasive plant species spreading throughout the U.S., managers must understand the potential influence of these species on ecosystem functions and responses to fire. To assist Smith and her team in creating a more powerful ally for managers, the Joint Fire Science Program supported the team's work on reviews of 60 nonnative species. Ecologists Kristin Zouhar and Gregory T. Munger were enlisted to adapt FEIS methodology, search the scientific literature, and write the majority of these species reviews.

FEIS flexes some muscle

Those who manage our wildlands know that the ability of weeds to change ecosystems depends on species traits, characteristics of the ecosystem, and the opportunities that disturbances such as fire can bring. Exploring the literature on fire and weeds led scientists to question some common beliefs. Are nonnative plants always more hearty than native plants or have we just




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Two examples from FEIS

FEIS Review section	Topics included
Introduction	Authorship and citation
	Scientific and common names, abbreviations, synonyms, code names
	Taxonomy description
	Life form (tree, shrub, herb, etc.)
	Legal status (threatened, endangered, etc.)
Distribution and Occurrence	Current known distribution
Botanical and Ecological Characteristics	General characteristics
	Raunkiaer life form
	Reproduction (includes breeding system, pollination, seed production, seed dispersal, seed banking, germination/establishment/seedbed requirements , growth, and asexual reproduction and regeneration)
	Site characteristics (includes topography, elevation, climate, and soils)
	Successional information (includes longevity, response to disturbance, and competitive interactions)
	Seasonal patterns (aboveground phenology, belowground phenology)
Fire Ecology	Fire adaptations (including heat tolerance of tissues and seed), fire regimes
	Postfire regeneration strategies
Fire Effects	Immediate fire effect on plant
	Species response to fire (includes postfire establishment and postfire vegetative response)
	Fire management considerations (includes fire as a control agent)
Management Considerations	Importance to livestock and wildlife
	Other uses
	Impacts and control
Literature cited	

Contents of a FEIS plant species review. Topics in bold print are considered crucial for understanding relationships between plant species and fire.

- [AUTHORSHIP AND CITATION](#)
- [FEIS ABBREVIATION](#)
- [SYNONYMS](#)
- [NRCS PLANT CODE](#)
- [COMMON NAMES](#)
- [TAXONOMY](#)
- [LIFE FORM](#)
- [FEDERAL LEGAL STATUS](#)
- [OTHER STATUS](#)

All photos ©John M. Randall/The Nature Conservancy

AUTHORSHIP AND CITATION:
Zouhar, Kris. 2003. Bromus tectorum. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2007, August 25].

Opening page of the cheatgrass review in FEIS. Cheatgrass is one of the few weed species for which most information considered crucial by the scientists is available in the scientific literature.

focused on the ones that have been harmful in some ecosystems, and has their “success” skewed our opinions? Zouhar and Munger found that the answer is dependent on many factors, such as the nature of the plant community and disturbance and the availability of propagules or subsequent weather.

Winnowing a list of species down to 60 from the 156 nominated by botanists and invasive plant specialists from every region of the United States required some help. To finalize selections, Smith’s team consulted with the Wildland Invasive Species Team of The Nature Conservancy, who helped provide informal knowledge from managers on a number of species and recommended ways to group similar species. The team placed six bush honeysuckle species into a single review, and two reviews were used to cover three broom species. Then Zouhar and Munger went to work, with assistance from Smith and other members of the FEIS team. The final product was a series of 43 reviews covering 60 weed species, 35 of which were entirely new to FEIS.



Fire in Old World climbing fern, a nonnative species in the Southeast that can act as a ladder fuel. Credit: Amy Ferriter, South Florida Water Management District, www.bugwood.org.

FIRE MANAGEMENT CONSIDERATIONS:

As of this writing (2005) there is very little published information about fire management and climbing ferns. Roberts [31] indicated that “fire alone will not control” Old World Climbing fern, but no further details were provided. Stocker and others [37] burned Old World climbing fern with a propane torch and indicated that “recovery” was imminent. Citing a personal communication, Ferriter [5] reported that prescribed fire, alone and in combination with 2,4-D herbicide application, was not effective at controlling Japanese climbing fern in northern Florida Pine plantations. More detailed research is needed to determine how climbing ferns might respond to broadcast burning or wildfire under varying burn conditions, intervals, seasons, etc.

Climbing fern presence may instigate changes in fire behavior. Old World climbing fern presence in southern Florida forests has been associated with greater incidence of crown fire, due to an increase in ladder fuels. Also, burning mats of Old World climbing fern may be lofted by convection and ignite spot fires downwind from the main fire (reviewed by [21]). There are also suggestions that climbing fern presence in forest canopies may carry fire through wet areas that would otherwise present a boundary to fire spread (reviewed by [16]).

What a FEIS review says about fire management and climbing fern species in the Southeastern U.S.

Some new talents for a steadfast hero

Making a good thing better, Smith and her team recently changed the file structure throughout FEIS so all 1,100-plus species reviews begin with a table of contents that links to the various sections. “This is not rocket science,” Smith says, “but it makes FEIS much simpler for new users to navigate and easier for ‘old’ users to download from. Easier to teach, too.” The team has also added 16 “Research Project Summaries” to FEIS. These summarize fire effects studies that contain fairly complete information on fuels, burning conditions, fire behavior, and fire effects on multiple species. Research Project Summaries are linked to and from every FEIS species included in the study, thus supplementing species reviews written some time ago with new information. Research Project Summaries also provide “tidbits” of fire effects information on more than 200 species not yet reviewed in FEIS.

Smith related the feedback she has received on the database. One user commented he had attended a national class on applied fire effects, and all of the participants, 72 of them, said they go to FEIS for help in solving management-related questions and want it to be enhanced.



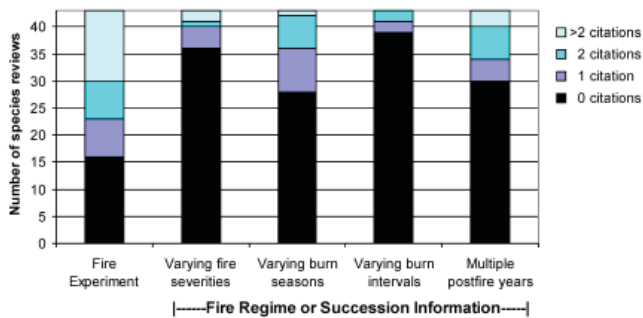
Flowers of scotch broom, a nonnative shrub that can regenerate profusely from sprouts and seeds after fire. With more detailed information about weeds, managers can more effectively plan to limit or prevent the spread of invasive plants. Credit: Barry Rice©, The Nature Conservancy.

What we don’t know can hurt us

In reviewing 60 weed species for FEIS, Zouhar, Munger, and Smith identified topics considered crucial for understanding each plant’s relationship to fire. Results of their analysis are available at www.fs.fed.us/rm/pubs/rmrs_gtr042_6.pdf (Chapter 12). The scientists found that fewer than half of the 60 species examined had high-quality information on heat tolerance, post-fire establishment, effects of varying fire regimes (severities, seasons, and intervals between burns), or long-term effects of fire. Quantitative information describing nonnative plants’ impacts on native plant communities and long-term effects on ecosystems was sparse. While some knowledge gaps were owing to lack of information, others occurred because

the information covered only a narrow range of conditions or a small geographic area, or was anecdotal rather than substantiated by data.

For most species reviews, the scientists found sufficient information on biology and ecology—not necessarily related to fire—to allow managers to make a limited assessment about an invasive plant’s potential to establish, persist and spread in a particular area after fire. Nevertheless, the scientists feel managers could make better decisions with information that tells them how those plants respond specifically to fire, as well as the potential for the species to alter fuels and fire regimes. The scientists caution managers to pay attention to the scope of research, since information from one or two studies conducted in one ecosystem may not provide a reliable picture of what will happen in a different ecosystem, at a different season, or under different conditions.



Number of fire experiment studies with information on fire regime characteristics that were used for recent weed species reviews in FEIS. The black portion of each bar indicates the proportion of FEIS weed species reviews for which no research could be found on the topic.

“Researchers can improve the knowledge available on nonnative invasive plants for managers by applying rigorous scientific methods and reporting the scope of the research, in both scientific papers and literature reviews,” the FEIS team suggests. “Managers can use this knowledge most effectively by applying scientific findings with caution appropriate to the scope of the research, monitoring treatment results over long periods of time, and adapting management techniques as new information becomes available.”

The FEIS team is currently working on reviews of 80 existing nonnative species with delivery expected in 2011.

Further Information: Publications and Web Resources

FEIS online at: www.fs.fed.us/database/feis

Smith, Jane Kapler, Janet Howard, and Jack McWilliams. 2004. Focus on invasive plants in the Fire Effects Information System. In: Engstrom, R.T.; K.E.M. Galley, and W.J. de Groot eds. Proceedings of the 22nd Tall Timbers Fire Ecology Conference: fire in temperate, boreal, and montane ecosystems; 2001

Management Implications

- FEIS literature reviews provide a head start for managers seeking information on fire effects for fire management, fuel management, and post-fire revegetation programs.
- The information provided in the new “weed reviews” in FEIS is sufficient to allow managers to make limited assessments of the ability of 60 nonnative invasive plant species to establish, persist, and spread in a particular area after fire.
- More knowledge is needed to confidently predict how invasive plants will respond to fire and how they may alter fuels and fire regimes. Managers should use caution when employing information from one or two studies, from studies that were limited in scope, and from studies limited to a short time after fire such as a single year or a few years. Monitoring over many years and decades is needed.
- A literature review is only as good as the scientific information that went into it, and knowledge about fire effects is often very limited. When this happens, there is no substitute for local knowledge, monitoring, and management that is adapted to use what is learned.

October 15-18; Kananaskis Village, Alberta, Canada. Tallahassee, FL: Tall Timbers Research Station: 137-140.

Zouhar, Kristin; Gregory T. Munger, and Jane Kapler Smith. 2008. Gaps in Scientific Knowledge about Fire and Nonnative Invasive Plants. Wildland fire in ecosystems: fire and nonnative invasive plants. Gen. Tech. Rep. RMRS-GTR-42- vol. 6. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 243-259.

Zouhar, Kristin; Jane Kapler Smith, Steve Sutherland, and Matthew L. Brooks, eds. Wildland fire in ecosystems: fire and nonnative invasive plants. Gen. Tech. Rep. RMRS-GTR-42- vol. 6. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 243-259:

www.fs.fed.us/rm/pubs/rmrs_gtr042_6.pdf

Scientist Profiles

Jane Kapler Smith is Leader for the Information Team of the Fire Modeling Institute (FMI), which includes management of the Fire Effects Information System. The FMI Information Team specializes in synthesizing scientific information about fire for use by managers and the public. Jane co-developed the educational program "FireWorks."



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