Doubling Knowledge on Fire and Eastern Invasive Plants in the Fire Effects Information System (FEIS)

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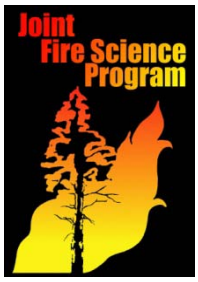

I. **Abstract:** Managers have been coming to the Fire Effects Information System (FEIS) for reviews of scientific knowledge about fire effects since 1986. Prior to this project, FEIS provided relatively little coverage of invasive plant species in the eastern United States: In 2008, the system contained 52 species reviews of eastern invasive plants covering 69 taxa. The system now contains 105 reviews of eastern invasive plants covering 139 taxa. Thus the project has doubled the information in FEIS on eastern invasive plants. In fact, the information has more than doubled, since the numbers above do not include updates of 5 reviews, addition of 2 Research Project Summaries, and addition of 1 Management Project Summary. This project has also described and quantified knowledge gaps regarding eastern invasive species and fire, and has delivered information on fire and eastern invasive plants to managers through presentations and training sessions in the eastern United States and at national venues.

The 58 species reviews and 3 Research/Management summaries published in FEIS for this project gather and synthesize information on individual plant species, especially regarding

- how invasive plant species may respond to fire and thus influence native plant communities
- how wildfire, fire suppression activities, and fire exclusion may influence plant invasions and site invasibility
- how invasive plants may alter fuels and fire regime characteristics
- how fire may increase invasions and invasibility or be used to reduce them
- knowledge gaps and limitations of existing knowledge on these topics

II. **Background and purpose:** In its 2008 call for proposals, the Joint Fire Science Program requested projects to increase understanding of relationships between fire and plant invasions in the eastern United States (RFA 2008-1 Task 2). One way to increase understanding is to accumulate and synthesize existing information. FEIS is known as a "go-to place" for knowledge about fire effects, so it provides a logical, easily accessible location for hosting fire effects syntheses. While knowledge syntheses do not create new field data, they do create new understandings of existing data by bringing the results of all studies on a topic together in one location, summarizing them, comparing results, and analyzing differences.

This project had 3 objectives:

1. In FEIS, publish syntheses of available information on plant species considered invasive in the eastern United States. Focus on:
   - evidence of invasiveness and conditions/locations where the species is invasive
   - effects of fire and fire management practices on the species
   - effects of plant invasions on fuels, fire behavior, and fire regime characteristics
   - potential for use of prescribed fire to control the species
2. Develop a quantitative analysis of knowledge gaps regarding fire and invasive plant species in the eastern states
3. Provide training and increase FEIS use in the eastern United States among both federal and nonfederal wildland managers

III. **Study description:** The main vehicle for completing this project was a series of FEIS species reviews following the standard FEIS format for invasive plants (Figure 1).

Figure 1. Outline of Invasive Plant Species Review for FEIS

Introductory
- AUTHORSHIP AND CITATION
- COMMON NAMES
- TAXONOMY
- SYNONYMS
- LIFE FORM

Distribution and Occurrence
- GENERAL DISTRIBUTION
- HABITAT TYPES AND PLANT COMMUNITIES

Botanical and Ecological Characteristics
- GENERAL BOTANICAL CHARACTERISTICS
- SEASONAL DEVELOPMENT
- REGENERATION PROCESSES
- SITE CHARACTERISTICS
- SUCCESSIONAL STATUS

Fire Effects and Management
- FIRE EFFECTS
- FUELS AND FIRE REGIMES
- FIRE MANAGEMENT CONSIDERATIONS

Management Considerations
- FEDERAL LEGAL STATUS
- OTHER STATUS
- IMPORTANCE TO WILDLIFE AND LIVESTOCK
- OTHER USES
- IMPACTS AND CONTROL

Appendix: Fire Regime Table
References

Before writing species reviews, we needed to identify the species to be covered. We used 3 sources to develop a list of species to consider:

- We compiled a list of nonnative invasive species in the eastern United States that emerged as important when we worked on *Fire and Nonnative Invasive Plants* (Zouhar and others 2008, completed in JFSP task 04-4-1-08). We sent this list to eastern wildland managers in the Forest Service, National Park Service, Fish and Wildlife Service, and The Nature Conservancy with a request for help in prioritizing; one replied.
- Jan Schultz, coordinator of the Forest Service Region 9 (eastern) non-native invasive species program, provided a list of problem invasive plants in Region 9 and the forests in which each occurred.
- Beth Buchanan, Fire Ecologist in Forest Service Region 8 (southern), and Alix Cleveland, coordinator of the Region's invasive species programs, provided a list of priority species from Region 9. This list was compiled from information provided by managers working on individual forests.

We selected species for review by focusing on species that were specifically identified as priorities, those occurring in several Forests, and those common to both the Eastern and Southern Regions. We attempted to cover approximately the same number of species from each Region. We excluded aquatic species, species for which an initial literature search yielded few citations, and most of the invasive species reviews published in FEIS since 2000 (JFSP tasks 00-1-2-09 and 03-4-2-03). For a few of the species reviewed since 2000, however, we found substantial new literature, so we updated them. After completing reviews of 2 major forage grasses, we decided to exclude other forage grasses from this project; this decision and related recommendations are discussed in Section VII.

How well does this project respond to needs identified by eastern managers? This project has updated or added to FEIS:

- Reviews of 25 of the 32 species prioritized by managers in the Southern Region. Of the 7 that were not added, one was updated in 2008, several lacked sufficient literature to review, and another was a forage grass.
- Reviews of 23 of the 46 species on the Eastern Region list that occurred in 4 or more forests. Eighteen of the remaining 23 species were already in FEIS, had been written since 2001, and/or did not have substantial new literature. Two were aquatics, and 1 was a forage grass.

FEIS contains many reviews that cover multiple species or infrataxa. We prepared such "multi-taxa reviews" for this project if the taxa being considered had similar life-forms and reproductive strategies and thus seemed likely to have similar responses to fire. In multi-taxa reviews, the majority of knowledge often applies to one taxon (and is identified as such) but is probably relevant to others as well.

Table 1 in Section VIII lists the species reviews completed for this project and the taxa covered in each.

Preparation of FEIS reviews: FEIS species reviews of invasive plants cover all relevant English-language literature that is available at the time of writing by using the following procedure: For each review, we first use the Citation Retrieval System (feis-crs.org) to search the FEIS Library for articles with information on that species. The Library contains more than 60,000 documents that have been keyworded according to species, location, and other content. FEIS staff regularly check current contents of several scientific journals for literature on fire-related topics and routinely add useful literature to the FEIS Library. Several other databases are then searched, including some combination of the following: JSTOR, ISI Web of Knowledge, Ovid, DigiTop, Tall Timbers Fire Ecology Database, Agricola, ProQuest, and WorldCat. When searches produce very sparse results, we search the periodical database in DigiTop and sometimes search the Internet looking for clues and contact information. As we write reviews where information on fire is sparse or unavailable, we attempt to contact managers who have experience with that species; with their permission, we include any pertinent information from these sources in the review.

Species reviews are written, reviewed, and edited according to the FEIS Quality Assessment/Quality Control Plan (available on request). Writers identify the nature of information sources and indicate the scope of inference for most information given, so readers can apply the knowledge appropriately. Lack of knowledge on specific issues is identified. Citations are linked to a complete bibliography. Each review is edited by an ecologist-editor, a fire ecologist, and a bibliographic specialist. Upon approval, each is uploaded to the FEIS website.

Research Project Summaries (RPSs) are written to supplement FEIS reviews by presenting studies that have relatively complete descriptions of burned and unburned vegetation, burning conditions, fire behavior, and fire effects on invasive plants. Each RPS is linked to relevant FEIS species reviews, and the species reviews are linked back to the RPS.

IV. **Key findings** are described within species reviews and Research Project/Management Summaries (see Section VIII, Tables 1 and 2). Key findings regarding knowledge gaps are described in the Knowledge Gap Analysis (Section VIII, Objective 2).

V. **Management implications** are described within species reviews and Research Project/Management Summaries (see Section VIII, Tables 1 and 2).

VI. **Relationships among recent findings** are described within species reviews and Research Project/Management Summaries (see Section VIII, Tables 1 and 2).

VII. **Future work needed:** As mentioned in Section III, species nominations for this project included several nonnative forage grasses. After completing 2 of these, however (*Schedonorus pratensis* and *Eragrostis curvula*), and drawing on our past experience in reviewing forage species for FEIS, we noted that this kind of review poses 2 unique challenges: First, the literature is abundant but often focused mainly on productivity, so applying these findings to fire management is complex and time-consuming. Second, forage species are often considered desirable in at least some wildland habitats, at least more desirable than other nonnative species—again making the literature difficult to interpret and apply. Given these complexities, we chose to focus on other invasive species for the remainder of this project. However, the nonnative forage grasses remain a concern for wildland managers in the eastern states and may warrant a series of species reviews focused solely on this group of species.

The Knowledge Gap Analysis (Section VIII, Objective 2) illustrates a severe lack of observation-based knowledge regarding fire and invasive plants in the eastern United States. This analysis could be used to focus future field research on specific knowledge gaps regarding particular species. Better yet, analysis of the report could yield a suite of species that might be addressed together in field studies. The report could also be used to assess the adequacy of proposed field methods for providing information on topics most needed for management. Finally, the Knowledge Gap Analysis can be used to guide scientists and managers who write about invasive species, encouraging them to describe the observations or logic behind their assertions so managers can apply their insights appropriately.

VIII. Deliverables

Objective I—comprehensive knowledge syntheses—is met by 58 FEIS species reviews that cover 75 invasive plant taxa in the eastern United States (Table 1). These reviews comprise 1,725 published pages and cite more than 7,000 references. By covering the topics in the Invasive Plant Template (Figure 1), each review addresses evidence of the species' invasiveness and conditions/locations where the species is invasive; effects of fire and fire management practices on the species; effects of the species on fuels and fire regimes; and potential use of prescribed fire for managing the species.

Table 1. FEIS Species reviews produced for this task

FEIS code	No. taxa	Taxa included		Author	Status	FEIS publ. date
		Scientific name(s)	Common name(s)			
AEGPOD	1	*Aegopodium podagraria*	goutweed	Melissa Waggy	published	1/31/2010
AILALT#	1	*Ailanthus altissima*	tree-of-heaven	Janet Fryer	published	12/6/2010
ALBJUL	1	*Albizia julibrissin*	mimosa	Rachelle Meyer	published	5/28/2009
AMPBRE	1	*Ampelopsis brevipedunculata*	porcelainberry	Melissa Waggy	published	1/31/2010
BERVUL	1	*Berberis vulgaris*	common barberry	Corey Gucker	published	10/9/2009
CELORB		*Celastrus orbiculatus*	Oriental bittersweet	Janet Fryer	published	2/28/2011
CIRPAL	1	*Cirsium palustre*	marsh thistle	Corey Gucker	published	7/7/2009
CORVAR	1	*Coronilla varia (Securigera varia)*	crownvetch	Corey Gucker	published	2/4/2010
CYNSPP	2	*Cynanchum spp.: C. louisiae, C. rossicum*	swallow-worts: Louis' swallowwort (black swallowwort), European swallowwort (swallowwort)	Kate Stone	published	3/17/2009
DIOSPP	5	*Dioscorea spp.: D. alata, D. bulbifera, D. pentaphylla, D. polystachya, D. sansibarensis*	yams: water yam, air yam (air potato), five-leaf yam, Chinese yam, Zanzibar yam	Corey Gucker	published	11/18/2009
DIPSPP	2	*Dipsacus spp.: D.fullonum, D. laciniatus*	teasels: common teasel, cut-leaved teasel	Corey Gucker	published	7/7/2009
ELAPUN	1	*Elaeagnus pungens*	thorny-olive	Corey Gucker	published	2/28/2011
ERACUR	1	*Eragrostis curvula*	weeping lovegrass	Corey Gucker	published	7/7/2009
EUOALA	1	*Euonymus alatus*	winged burning bush	Janet Fryer	published	3/17/2009
EUOFOR	1	*Euonymus fortunei*	wintercreeper	Kris Zouhar	published	7/7/2009
EUPCYP	1	*Euphorbia cyparissias*	cypress spurge	Corey Gucker	published	5/28/2010
EUPESU	1	*Euphorbia esula*	leafy spurge	Corey Gucker	published	12/30/2010
FRAALN	1	*Frangula alnus (Rhamnus frangula)*	glossy buckthorn	Corey Gucker	published	1/7/2009
GLEHED	1	*Glechoma hederacea*	ground-ivy	Melissa Waggy	published	4/24/2009
HEDHEL	1	*Hedera helix*	English ivy	Melissa Waggy	published	9/7/2010
HERMAN	1	*Heracleum mantegazzianum*	giant hogweed	Corey Gucker	published	4/2/2009

HIEAUR	1	*Hieracium aurantiacum*	orange hawkweed	Kate Stone	published	11/9/2010
HIECAE	1	*Hieracium caespitosum*	meadow hawkweed	Kate Stone	published	1/31/2011
HIEPIO	1	*Hieracium piloselloides*	tall hawkweed	Kate Stone	published	1/24/2011
HOLLAN	1	*Holcus lanatus*	common velvetgrass	Corey Gucker	published	3/18/2009
IRIPSE	1	*Iris pseudacorus*	pale-yellow iris	Kate Stone	published	7/7/2009
KUMSPP	2	*Kummerowia spp.: K. stipulacea, K. striata*	clovers: Korean clover, Japanese clover	Corey Gucker	published	8/2/2010
LESBIC	1	*Lespedeza bicolor*	bicolor lespedeza (Japanese bushclover)	Corey Gucker	published	8/31/2010
LESCUN#	1	*Lespedeza cuneata*	sericea lespedeza	Corey Gucker	published	11/15/2010
LYSNUM	1	*Lysimachia nummularia*	moneywort	Robin Innes	published	1/24/2011
MELAZE	1	*Melia azedarach*	chinaberry	Melissa Waggy	published	11/11/2009
MELSPP	2	*Melilotus spp.: M. alba, M. officinalis*	sweetclovers: white sweetclover, yellow sweetclover	Corey Gucker	published	4/12/2010
MICVIM#	1	*Microstegium vimineum*	Japanese stiltgrass	Janet Fryer	published	1/25/2011
MISSIN	1	*Miscanthus sinensis*	Chinese silvergrass	Melissa Waggy	published	1/26/2011
MORALB	1	*Morus alba*	white mulberry	Kate Stone	published	11/24/2009
NANDOM	1	*Nandina domestica*	sacred bamboo	Kate Stone	published	12/17/2009
NEYREY	1	*Neyraudia reynaudiana*	silk reed	Kate Stone	published	7/30/2010
PAEFOE	1	*Paederia foetida*	skunkvine	Corey Gucker	published	11/19/2009
PANREP	1	*Panicum repens*	torpedograss	Kate Stone	published	3/10/2011
PAUTOM	1	*Paulownia tomentosa*	princesstree	Robin Innes	published	7/7/2009
PERLON	1	*Persicaria longiseta (Polygonum cespitosum var. longisetum)*	Oriental lady's thumb	Kate Stone	published	7/15/2010
PHAARU	1	*Phalaris arundinacea*	reed canarygrass	Melissa Waggy	published	8/6/2010
PHYAUR	1	*Phyllostachys aurea*	golden bamboo	Corey Gucker	published	12/3/2009
POLAVI	1	*Polygonum aviculare*	prostrate knotweed	Kate Stone	published	6/23/2010
POLPEF	1	*Polygonum perfoliatum*	mile-a-minute	Kate Stone	published	4/7/2010
POLSPP	3	*Polygonum spp.: P. sachalinense, P. cuspidatum, P. × bohemicum*	knotweeds: giant knotweed, Japanese knotweed, Bohemian	Kate Stone	published	4/12/2010

			knotweed			
POPSPP	5	*Populus alba, Populus X canescens, Populus X heimburgeri, Populus X rouleauiana, Populus X tomentosa*	white poplar	Corey Gucker	published	7/20/2010
RHASPP	2	*Rhamnus spp.: R. cathartica, R. davurica*	buckthorns: common buckthorn, Dahurian buckthorn	Kris Zouhar	published	3/14/2011
ROBPSE	1	*Robinia pseudoacacia*	black locust	Kate Stone	published	7/7/2009
RUBPHO	1	*Rubus phoenicolasius*	wineberry	Robin Innes	published	5/1/2009
SCHACT	1	*Schefflera actinophylla*	octopus tree	Corey Gucker	published	1/26/2011
SCHPRA	1	*Schedonorus pratensis (Festuca pratensis)*	meadow fescue	Kate Stone	published	11/1/2010
SCHTER#	1	*Schinus terebinthifolius*	Brazilian pepper	Rachelle Meyer	published	2/28/2011
SOLDUL	1	*Solanum dulcamara*	bittersweet nightshade	Melissa Waggy	published	9/9/2009
SOLVIA	1	*Solanum viarum*	tropical soda apple	Melissa Waggy	published	10/10/2009
TANVUL	1	*Tanacetum vulgare*	common tansy	Corey Gucker	published	8/8/2009
TRISEB#	1	*Triadica sebifera*	Chinese tallow	Rachelle Meyer	published	1/27/2011
TUSFAR	1	*Tussilago farfara*	colts foot	Robin Innes	published	2/28/2011
UROMUT	1	*Urochloa mutica*	para grass	Kate Stone	published	9/10/2010
VINSPP	2	*Vinca spp.: V. major, V. minor*	periwinkles: bigleaf periwinkle, periwinkle	Kate Stone	published	6/6/2009
WISSPP	2	*Wisteria spp.: W. floribunda, W. sinensis*	wisterias: Japanese wisteria, Chinese wisteria	Kate Stone	published	3/17/2009
#These reviews are updates from previous versions.						
Total species reviews:			61			
Total taxa covered:			78			

In addition to the species reviews, 2 Research Project Summaries and 1 Management Project Summary (Table 2) address ***Objective 1***.

Table 2. FEIS Research Project and Management Summaries produced for this task

FEIS code	Title	FEIS taxa covered*	Non-FEIS taxa**	Author/ compiler	Status	Date
Howe94-02	Research Project Summary: Herbaceous responses to seasonal burning in experimental tallgrass prairie plots	9	7	Jane Kapler Smith	published	8/6/2010
Glasgow07	Research Project Summary: Response of herbaceous vegetation to winter burning in Texas oak savanna	8	7	Jane Kapler Smith	published	8/6/2010
FILN11	Management Project Summary: Fire effects on 3 subtropical invasives-- common bamboo, Natal grass, and white leadtree	0	3	Jane Kapler Smith	published	1/24/2011
**Acer rubrum, Acer saccharum, Andropogon gerardii, Elymus canadensis, Elymus repens, Elymus trachycaulus, Liriodendron tulipifera, Microstegium vimineum, Nyssa sylvatica, Panicum virgatum, Phalarus arundinacea, Rhus glabra, Rosa multiflora, Rudbeckia hirta, Sorghastrum nutans, Sporobolus heterolepis, Vaccinium pallidum*						
***Bambusa vulgaris, Conyza canadensis, Dioscorea quaternata, Elymus virginicus, Erechtites hieracifolia, Erigeron annuus, Leucaena leucocephala, Melinis repens, Onoclea sensibilis, Onoclea sensibilis, Phytolacca americana, Potentilla simplex, Solidago altissima, Symphyotrichum ericoides, Symphyotrichum lanceolatum, Uvularia perfoliata, Zizia aurea*						

When we began this project, we anticipated writing numerous Research Project Summaries (RPSs) to supplement the species reviews. However, we found few studies *on the selected species* that were complete enough to be useful in an RPS. Most were lacking information on at least one crucial component, such as prefire vegetation, burning conditions, or fire behavior.

Although only 2 RPSs were completed, they illustrate the usefulness of the RPS format in FEIS. Each provides detailed information on a prescribed fire study that can be linked to multiple species reviews (footnote to Table 2); in addition, each provides some coverage of multiple "non-FEIS" species (second footnote).

The Management Project Summary (MPS) completed for this project was an attempt to canvass managers in a particular region (southern Florida and Caribbean nations) for field-based knowledge and to share it via FEIS. Three species were covered in this MPS, and knowledge was generally quite limited. This format may be most useful if it can be updated frequently with new knowledge; it remains to be seen whether FEIS is an appropriate venue for such dynamic, management-driven information.

Objective 2—quantitative analysis of knowledge gaps—is met by the Knowledge Gap Analysis, posted 1/31/11 as a draft JFSP deliverable. The report will be updated to "complete" by 2/28/11 on the JFSP website and uploaded to the FEIS website. This report is also being prepared for submittal to *Fire Ecology* or *Ecological Applications.*

Objective 3—Provide training and increase use of FEIS in the eastern United States—is met by the 6 presentations and 3 poster displays listed in Table 3. The scope of these presentations was not limited to this project, but also covered FEIS in general, *Fire and Nonnative Invasive Plants* (Zouhar

and others 2008), information on additional invasive and native plant species covered in FEIS, and the need for critical thinking in applying information from a synthesis to management.

Table 3. Science delivery activities for this project

Date	Nature of activity	Title	Venue	Audience	Presenters
12/8/08-12/12/08	Poster	Fire Effects Information System (FEIS)	Forest Service Region 8 Prescribed Fire Workshop, Hot Springs, AR	~400 burn bosses and other fire staff, mainly from southern US	Non-hosted poster
11/19/09	1.5-hr workshop/ presentation	Fire and invasive plants	Prescribed fire for managers class at Prescribed Fire Training Center, Tallahassee, FL	~20 resource managers from throughout U.S., federal, state, NGO	Jane Kapler Smith
12/01/09	Poster presentation	Writing Syntheses for Managers: Lessons from the Rainbow Series & Fire Effects Information System	4th International Fire Ecology & Management Congress, Savanna GA	Scientists and managers, U.S. and international	Jane Kapler Smith, Kris Zouhar, Janet Fryer
12/10/09	1.5-hour workshop	Using FEIS to share information on fire and invasive plants	Florida & Caribbean Fire Invasives Learning Network workshop, San Juan, Puerto Rico	~20 managers plus TNC coordinators, southern FL and Caribbean	Jane Kapler Smith
01/28/10	1-hr presentation	Fire and invasive plants	Rx310, Northern Rockies Training Center, Missoula, MT	Fire managers from R1 FS, BLM, BIA, FWS, NPS; 46 students total.	Kris Zouhar, Jane Kapler Smith
02/22/10	50-min presentation	Fire and invasive plants	Rx510, NAFRI, Tucson, AZ	72 managers (FMOs, AFMOs, Fire Bosses, Fire Ecologists, & others)	Jane Kapler Smith, Kris Zouhar
11/15/10	1.5-hr workshop/ presentation	Fire and invasive plants	Prescribed fire for managers class for Prescribed Fire Training Center, Camp Blanding, FL	24 resource managers from throughout U.S., federal, state, NGO	Jane Kapler Smith

12/6/10-12/10/10	Poster	Fire Effects Information System (FEIS)	Interagency Prescribed Fire Workshop, Sandestin, FL	~400 burn bosses and other fire staff, mainly from southern US	Non-hosted poster (Kris Zouhar & Corey Gucker, authors)
Scheduled for 03/14/11	50-min presentation	Fire and invasive plants	Rx510, NAFRI, Tucson, AZ	estimated 70 managers (FMOs, AFMOs, Fire Bosses, Fire Ecologists, & others)	Jane Kapler Smith, Kris Zouhar

Literature cited:

Zouhar, Kristin; Smith, Jane Kapler; Sutherland, Steve; Brooks, Matthew L., eds. 2008. ***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. 355 p.