Gaps in Knowledge About Fire and Invasive Plants in the Eastern United States

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Introduction

This analysis identifies gaps in the science- and observation-based knowledge about the relationships between fire and 69 nonnative invasive plant species covered in 57 species reviews in the Fire Effects Information System (FEIS, online at www.fs.fed.us/database/feis) and identified as problems in the eastern United States. A similar analysis on knowledge gaps regarding fire and 60 nonnative invasive species was published in 2008 (Zouhar and others 2008). In that analysis, a numerical scale was developed to rank the "quality" of the sources cited on topics relevant to fire ecology. Quality rankings were based on the source's evident rigor and the clarity of its scope of inference. The highest quality rank was "high", describing peer-reviewed articles. The lowest rank was "no information". Intermediate rankings included non-reviewed articles and other gray literature as well as anecdotal information. The authors recognized that this source-quality scale was subjective and had the potential to misrepresent the quality of the information, but it nevertheless provided some insights about knowledge gaps and limitations. The analysis presented here used a similar approach, but instead of focusing on the nature of the information *source* (e.g., peer-reviewed journals versus gray literature), it focused on the *type* of information – primarily to distinguish between actual field measurements or observations and inferences or claims not clearly substantiated by field observations.

Methods

In October 2008, we began a project for the Joint Fire Science Program to synthesize knowledge on fire and plant species considered invasive in the eastern United States and publish the syntheses in FEIS. Our task was to produce literature reviews covering 70 to 80 invasive species identified by eastern land managers as problematic in their area. The 69 species reviewed[1] and included in this analysis are listed in Appendix 1. This list is neither a random nor systematic sample of nonnative plant species in eastern North America but represents many of the species about which managers are concerned and for which some published scientific research exists. Most of the FEIS reviews published for this project cover only 1 species, but a few cover 2 or more species in the same genus (see Appendix 1). Species were grouped if they had similarities such as life form, mode of reproduction, and habitat preferences, suggesting that ecological characteristics and fire responses might be similar. In this analysis, we focus on species reviews as a whole (57 total) rather than on the individual taxa within reviews.

For each species review, a FEIS writer (trained ecologist) gathered, reviewed, and synthesized the information from available published literature. The review was edited by two ecologists and a bibliographic specialist, then published on the FEIS website. Species reviews surveyed all relevant English-language literature available on a species at the time of writing. For each review, we first searched the Fire Effects Library for literature with information pertaining to the species (citations searchable at feis-crs.org, though documents are not downloadable from this source). The Fire Effects Library contains more than 60,000 documents that have been assigned keywords according to species, location, and other content. FEIS staff regularly check current contents of several scientific journals for literature on fire-related topics and add useful literature to the Library, so the Fire Effects Library is likely to have peer-reviewed literature covering fire and the species being reviewed if such literature is available. Several other scientific literature databases were then searched, including some combination of the following: JSTOR, ISI Web of Knowledge, Ovid, DigiTop, Tall Timbers Fire Ecology Database, Agricola, ProQuest, and WorldCat. These searches yielded journal articles, theses, dissertations, proceedings articles, and some gray literature. When search results were sparse, we also searched the periodical database in DigiTop and explored the Internet for clues and contact information of managers. As we wrote, if information on fire was sparse or gaps in understanding were identified, we attempted

1. A total of 74 species were reviewed for this project, but 5 were incomplete at the time of this analysis so only 69 were included.

to contact managers who had some experience with that species and included in our reviews whatever pertinent information they provided.

Table 1. Descriptions of fire topics covered by this analysis	
Topic	**Definition/description**
Fire experiment	Research providing quantitative information on the prefire and postfire or burned and unburned plant community (including the species under review), burning conditions, and fire behavior
Immediate fire effects on plant	Primarily observations of survival or mortality after fire. Survival was inferred if postfire sprouting was observed.
Heat tolerance of seed	Typically observations or measurements from laboratory experiments where seeds were exposed to heat from ovens, boiling water, or open flames and their subsequent survival were evaluated. Field observations and experiments addressing seed viability before and after fire were rare.
Postfire seedling establishment	Observations or measurements of seedling establishment after fire, typically within 1-2 growing seasons
Postfire abundance	Observations or measurements of abundance (e.g., cover, frequency, density) made either before and after fire or after fire on similar burned and unburned sites
Postfire occurrence (no additional information)	Observations of the plant on a burned site. Prefire or unburned comparisons were not made, and typically time of establishment was not documented nor was abundance described. Time since fire was variable. This was the weakest type of observation-based fire information, as very little could be inferred from it.
Postfire vegetative response	Observations or measurements of postfire sprouting
Fuels	Information on fuel characteristics of the invasive plant and information regarding changes in fuel characteristics in plant communities where the nonnative species was invasive. For example, observations or measurements indicating that an invasive tree or shrub shades out native grasses and forbs, or observations of shrubs growing in dense thickets where native shrubs are typically sparse.
Fire regimes	Information on the frequency or severity of fire tolerated by an invasive species. Information about fire regimes in invaded habitats was not included, except in those rare cases when available information suggested the potential for invasive populations to alter the presettlement fire regimes of invaded areas.

For this report, each completed species review was analyzed to determine the source and type of information on topics important for understanding the species' relationship to fire. We focused our analysis on each of 9 fire topics (described in Table 1) and on several botanical and ecological topics as well (described in Table 2). The botanical/ecological topics were selected because they cover characteristics that help explain observed fire responses or can be used to infer fire responses. In the rare cases where substantial fire information was available, botanical/ecological information was usually

also abundant and our analysis of it was abbreviated. To quantify knowledge quality and knowledge gaps, we listed all citations on each topic and then categorized the *source* and *type* of information provided by each of the sources cited on each topic.

Table 2. Relationship of botanical and ecological topics covered in this analysis to fire

Topic	Relationship to fire
Seed production	Information on these topics may indicate whether a species has potential for establishment from on- or off-site seed after fire.
Seed dispersal	
Seed banking	
Seedling establishment	
Asexual reproduction	Information on this topic often indicates the potential for a species to survive and sprout following top-kill by fire.
Shade tolerance	Information on these topics may indicate whether a species is likely to establish and thrive in the postfire environment, where shade is typically reduced, and whether a species is likely to persist as succession proceeds.
Response to nonfire disturbance	
Other succession information	
Belowground phenology*	Information on seasonal changes in underground carbohydrate reserves may indicate when fire will have the greatest impact on perennial species.

* Information on aboveground phenology that was relevant to postfire regeneration potential was included within other topics in this analysis. For example, information on timing of seed production or dispersal was included within those topics.

Information source, as used here, is determined by the publication where the information is found (for example, peer-reviewed articles, dissertations, floras, weed management guides); *information type* describes the basis for assertions within a source. Thus *information type* distinguishes assertions based on experimental measurements and field observations from assertions for which no observational basis is given. Many sources contain more than one *information type*. A peer-reviewed article describing a field experiment, for example, contains mainly observation-based information, but its introduction and conclusions may contain generalizations or speculation that reach beyond the experimental evidence but have no observational basis described. The analysis of knowledge gaps presented in Zouhar and others (2008) ranked information based mainly on *source*, which did not account for the different bases of information used. This shortcoming seems especially pertinent to discussions of invasive species, for which the role within native communities may be in flux and poorly understood. In this case, it seems critical to avoid relying on assertions for which the basis is unknown or the scope of inference is not described. In this study, therefore, we recorded both information *source* (Table 3) and *type* (Table 4) but focused the analysis on *information type* only.

We considered experiments and direct observations or measurements, which sometimes came from unpublished data, the highest quality information types. These were categorized as “Type 1” information in our analysis (Table 4). “Type 1” information could be traced back to primary references or observations (for example, site-specific studies published in journals, proceedings, theses, or dissertations, observations made in floras, personal communications from land managers). “Type 2” was used for information that lacked in-text citations or specific descriptions of the observational basis, but that was prepared by land managers or weed researchers familiar with the species and was therefore assumed to reflect direct observations by the author. The species review for octopus tree provides an example: Most of the information on this species came from gray literature and fact sheets that lacked citations. However, because these were written mostly by horticulturalists, botanists, and land

managers from areas where octopus tree is invasive, they were assumed to represent observations. "Type 3" was used for all other information, including inferences, assertions within syntheses that had no clear basis in observations, assertions based on unknown sources or foreign-language sources (which we could not verify), and unsubstantiated claims.

In addition to categorizing information sources and types, we conducted a coarse spatial analysis of Type 1 information for each species review. On distribution maps for each species or group of species, we recorded areas in North America where Type 1 fire and botanical and ecological information was available.

Table 3. Categories of sources cited in FEIS reviews

Source category	Description/examples
Journal article	Anonymously peer-reviewed documents
Government publication, proceedings, or similar	Usually peer-reviewed, but not anonymously
Thesis or dissertation	Publications approved by colleges and universities to meet requirements for advanced degrees
Flora	Typically regional publications, but also included floras of small areas published in journals
Personal communication to author of FEIS species review	Comments solicited by FEIS writers from land managers, botanists, and/or horticulturalists who had observed or managed the species
Personal communication or observation cited in another article	Comments or observations that represented first-hand account about the species and were cited as personal communications in another publication
Horticultural reference	Landscaping manuals or horticultural journals, which often provided substantial information on nonnative species introduced for horticultural purposes, including site preferences and guidelines for propagation
Weed book	Typically identification or management guides for nonnative invasive species in particular areas. Often written by scientists or managers and rarely included in-text citations, making it difficult to determine the source of the information or the scope of inference. Some of these sources included bibliographies; however, these did not allow the reader to determine the source of specific pieces of information within the text.
"Other" book	Books on topics other than horticulture and invasive species
Fact sheet or similar (with or without citations)	Similar to weed books. Often written about nonnative invasive species in a particular area. Usually available on the Internet. Rarely included in-text citations, although some included bibliographies.
Annual report, newsletter, progress report, unpublished report, etc	Typically internal publications for an organization, probably not rigorously peer reviewed. Also included articles written for non-professional audiences.

Table 4. Categories of information cited in FEIS reviews		
Information type	**Description/examples**	**Qualitative ranking**
Experimental evidence	Systematic observations and measurements analyzed to test hypotheses	Type 1: Observation based
Direct observations or measurements made by researcher or manager	Descriptive observations or measurements that were not compared statistically with another group (e.g., plant height, growth rates)	
Unpublished data	Observation-based information cited in other published sources or obtained from unpublished reports	
Assumed observations or measurements	Information from publications written by managers or researchers familiar with the species; however, the actual basis was not described	Type 2: May be observation based
Synthesis not clearly based on observations	Information given in a literature review or synthesis where the source of the information was not clear or not verifiable	Type 3: Basis not described or not verifiable
Inference	Conclusions or assumptions typically found in introduction or conclusion section of paper. Occasionally used to indicate FEIS writer's inference based on collected data.	
Basis of information attributed to foreign-language literature	Information from sources outside North America that the writer could not obtain and verify. Typically from articles written in a language other than English.	
Unknown	Information from fact sheets (or similar) with bibliographies but without in-text citation(s) for the information in question	
Unsubstantiated claim	Unverifiable statement without citations, typically from literature lacking both in-text citations and bibliographies	

Results and discussion

General findings indicated that less than half of the species reviews had Type 1 information for the majority of fire topics (Table 5). Fire information for widely distributed species often came from a small fraction of their North American range (data not shown). Most species reviews had Type 1 information on most botanical/ecological topics (data not shown). More than half of the species reviews that lacked Type 1 fire information had Type 1 information on most botanical/ecological topics (Table 6). Because the quality and credibility of Type 2 and Type 3 information was uncertain due to a lack of

documentation of the source or the nature of the information, this analysis focused on Type 1 information.

Fire topics: Of the 57 species reviews analyzed, 25 (44%) contained Type 1 information on fewer than 3 fire topics, and 8 (14%) had no Type 1 information at all on any fire topic (Appendix 2). Among the species reviews with no Type 1 fire information, 6 reviews (those covering winged euonymus, moneywort, wineberry, octopus tree, common tansy, and wisteria) had some Type 2 or Type 3 information on fire topics. However, these information types generally come from fact sheets and weed books that fail to report the basis for assertions. Thus the scope of inference is rarely described and difficult, if not impossible, to infer. This type of information is difficult for managers to apply with confidence. Type 2 and Type 3 information are not elaborated on further in this report.

The most common fire topics addressed with Type 1 information were Fuels, Occurrence on a burned site, and Postfire seedling establishment. About half of the species reviews included Type 1 information on these topics (Table 5). Among the 17 reviews (30%) with Type 1 information on only 1 or 2 fire topics, the most common topics covered were Fuels (4 reviews) and Occurrence on a burned site (8 reviews) (Appendix 2). This type of information was probably most abundant because it is easily detected by casual observation. Unfortunately, these topics may also represent the least useful information for fire managers to apply in the field.

Table 5. Summary of Type 1 information on fire topics covered in FEIS species reviews

	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response
Number of reviews with Type 1 information	12	19	29	14	24	28	25	28	22
Percent of reviews with Type 1 information	21	33	51	25	42	49	44	49	39

Much of the information included in the Fuels topic was only indirectly related to fuels and rarely included measurements specifically characterizing fuels. It included observations such as a species' tendency to form dense stands, produce abundant litter, or shade out understory herbs, and was often inadequate for determining whether an invasive population had altered or could alter fuel characteristics on an invaded site. Potential for an invasive species to alter fuel characteristics and therefore possibly alter fire behavior was often asserted, but rarely was this speculation supported by measurements or comparisons of fuel characteristics between invaded and uninvaded sites.

Information categorized as Occurrence on a burned site lacked comparisons between prefire and postfire or burned and unburned conditions and typically lacked information on abundance. Generally there was no indication of when the plant established relative to the fire—whether it was an adult unharmed by fire, a sprout that emerged after top-kill by fire, or a seedling that established sometime (possibly years) after fire. These observations do not provide enough information to conclude that the plant is likely to establish, persist, or change in abundance on burned sites. Similarly, information on

Postfire seedling establishment was often limited to observations of seedlings on a burned site but lacked details on time of establishment, distance to the nearest seed source, and seed bank composition.

The fire topics for which the least Type 1 information was available were Fire experiment (just 21% of reviews had Type 1 information), Heat tolerance of seed (25%), and Fire regimes (33%). Additionally, less than half the reviews had Type 1 information on Immediate fire effect on plant (42%) and Postfire abundance (44%) (Table 5, Appendix 2). This lack of information is especially troubling when our literature search found publications giving fire management recommendations. For example, 2 publications noted that moneywort may be controlled by frequent prescribed fire (Czarapata 2005, Kennay and Fell 1992), yet no observation-based information was available regarding Immediate fire effect, Postfire vegetative response, or the species' likely response to Fire regimes characterized by frequent burning.

Among the 57 species reviews, 7 had more than 20 recorded instances of Type 1 information on fire topics: black locust, Brazilian pepper, sweetclover, weeping lovegrass, common velvetgrass, reed canarygrass, and Chinese silvergrass (Appendix 2). Several of these taxa may have substantial fire information because they often occur in areas or ecosystems that are managed with frequent prescribed fire (black locust (e.g., Dooley 2003), Brazilian pepper (e.g., Doren and others 1991, Gunderson 1983, Loope and Dunevitz 1981), and Chinese silvergrass (e.g., Golchin and others 1997, Mutoh and others 1985, Nakamura and others 1971)) and therefore are more likely to be included in fire studies. Many of these well studied taxa are desirable forage or occur in valuable wildlife habitat (e.g., sweetclover (Autenrieth and others 1982, Duebbert and others 1981), weeping lovegrass (Hoover and others 1948, Humphrey 1960), and Chinese silvergrass (Hirata and others 2007)). For some species, experiments were conducted to determine if prescribed fire could be used to increase their productivity (e.g., sweetclover (Olson 1975), weeping lovegrass (Klett and others 1971, McIlvain and Shoop 1970)). Fire information may be more abundant for common velvetgrass and weeping lovegrass because they occur in US deserts (Gucker 2008, 2009b), where research suggests that increased fine fuel loading and continuity have the potential to alter fire regimes, with likely detrimental effects on native plant communities (e.g., see Brooks 2008, Rice and others 2008). Black locust may be well studied because it is native to North America, so information is not limited to research on its impacts or control (Stone 2009c).

Although the information for the 7 species reviews noted above would appear to be sufficient for making management decisions with regard to fire, critical information may still be lacking. For example, reed canarygrass often occurs in areas managed with prescribed fire (e.g., Clotfelter and others 1999, Foster and Wetzel 2005,), and prescribed fire is often recommended as a potential control agent for reed canarygrass (e.g., Antieau, Clayton J. 2000, Anzinger and Radosevich 2008, Heutte and others 2003, Hoffman and Kearns 1997, Hutchison 1992, Solecki 1997). However, there was little information on the effects of prescribed fire alone on reed canarygrass; observations were limited to a series of small-plot studies on experimentally planted prairie species (Smith 2010). Similarly, while Brazilian pepper had abundant Type 1 information on fire topics, most of it concerned fuel characteristics; none was available on postfire seedling establishment, vegetative response, or changes in abundance (Meyer 2011, in review). Information on fuels and fire regimes was lacking for the sweetclovers, and no fire experiments were published on Chinese silvergrass. Thus, fire information was lacking even for the best studied invasive species.

For the species reviews analyzed in this project, information about the responses to fire was typically available from studies conducted in only a fraction of each species' North American range. White

mulberry, for example, occurs in 48 states but fire information comes from only 1 state (Stone 2009b). Teasels (Gucker 2009a) and cypress spurge (Gucker 2010a) both occur in 42 states, but neither had Type 1 fire information from more than 1 state. Even for species reviews with more than 9 site-specific fire studies or observations from North America, it was rare to have studies covering more than 15% of states within its North American range. For example, the 15 site-specific fire observations or studies of weeping lovegrass came from only 3 states, whereas its North American range includes 32 states (Gucker 2009b). For common velvetgrass, there were 17 site-specific fire observations or studies, but these came from only 5 of the 45 states within its North American range (Gucker 2008).

Of the 57 species reviews analyzed, just 7 had fire information from 25% or more of states within their North American range. Of these 7 reviews, 3 covered species with limited US distributions (fewer than 8 states). However, 4 covered widely distributed species: clovers (*Kummerowia* spp. (Gucker 2010b) and *Melilotus* spp. (Gucker 2009d)), sericea lespedeza (Gucker 2010c), and Japanese stiltgrass (Fryer 2011).

In some cases, North American fire studies were lacking entirely. For giant hogweed (Gucker 2009c) and Chinese silvergrass (Waggy 2011), all fire information came from these species' native range. How well fire behavior and postfire responses from plant communities in their native range might approximate those of their nonnative range is unknown without more fire information from invaded habitats.

Botanical and ecological topics: When information was lacking on fire topics for FEIS species reviews, we often inferred fire adaptations or potential fire responses from known botanical and ecological traits such as asexual regeneration, response to nonfire disturbance, seed bank persistence, or seedling establishment patterns. For example, several perennial species are noted to sprout following top-kill from disturbances other than fire; we usually considered these species likely to sprout following top-kill from fire as well. For example, although immediate fire effects on common tansy were not reported in the literature, its rhizomes were described as robust, sturdy, and stout, suggesting they would likely survive fire (Gucker 2009e). Because teasel sprouted after being cut, but meristematic tissue occurred just below the surface, the species review reported that low-severity fires would likely only top-kill teasel, but high-severity fires could result in death (Gucker 2009a). Species with wind-dispersed seed and successful seedling establishment in high-light environments (e.g., swallow-worts (Stone 2009a)) were described as having high potential for establishment in the postfire environment.

Among the 25 reviews with little or no information on any fire topics, only 12% had Type 1 information on Belowground phenology, while 64% to 60% had Type 1 information on Seed production, Seedling establishment, and Succession (Table 6, Appendix 3). Although 76% of these reviews had some Type 1 information on Seed banking, it rarely proved adequate for evaluating potential postfire establishment from the soil seed bank. Type 1 information on Seed banking was often limited to reports of seed longevity under optimal storage conditions in a laboratory and lacked field experiments, observations, or measurements. Similarly, 92% of these reviews included Type 1 information on Response to nonfire disturbance. However, this information was often limited to observations of establishment or persistence in anthropogenically disturbed environments (e.g., timber harvest sites, roadsides, mine spoils, ditch banks) that are typically occupied by weedy species, and therefore the information is insufficient for inferring a disturbance response in wildlands. One topic fairly well covered for these species reviews was Shade tolerance (Table 6). Type 1 information on this topic was available for 88% of the species reviews for which fire information was lacking, and in several cases, the information was based on experimental studies. Thus we could sometimes infer the species' response to increased light in the postfire environment, or to increased shade as tree canopies regrow in the years after a fire.

Table 6. Summary of Type 1 information on botanical/ecological topics covered in FEIS species reviews having fewer than 3 fire topics with Type 1 information

	Asexual reproduction	Belowground phenology	Other (nonfire) succession information	Response to nonfire disturbance	Seed banking	Seed dispersal	Seed production	Seedling establishment	Shade tolerance
Number of reviews with Type 1 information	20	3	15	23	19	23	16	16	22
Percent of reviews with Type 1 information	80	12	60	92	76	92	64	64	88

Conclusions

Managers need knowledge from scientific studies, monitoring programs, and other sources to make informed decisions, and they need to know the nature of this knowledge and its scope of inference to determine how to apply it to their management issues. Current experiment- and observation-based information about relationships between fire and invasive plants in the eastern United States is limited. More experiments and observations are needed, and this information must be presented in a way that helps readers assess its nature, quality, and applicability.

Wildland managers dealing with fire and invasive plants require detailed information about complex issues that would be best addressed by Fire experiments that include several years of data in a particular ecosystem under various burning conditions, at varying times of year, with varying fire severities and intervals between burns. What is usually available is some information about the biology of the invasive plants and possibly a smattering of information regarding the species' occurrence on burned sites, postfire seedling establishment or sprouting, or short-term changes in abundance after fire. Often information relevant to fire is anecdotal and the source of the information is not described (Type 2 or Type 3 information in this analysis), making it difficult for managers to apply that information with confidence.

This analysis highlights the importance of careful, complete, direct communication about results in scientific and technical publications. When the source of information and the basis for inference (e.g., location and nature of personal observations, years of management experience, synthesis of other literature) are not well described in the published literature, managers cannot assess its applicability to their locations and issues. We took a conservative approach to assessing information quality for this analysis by describing information as Type 1 only if it was clearly based on observations. It is likely that other assertions in the literature would have qualified as Type 1, but because their basis was not clearly described, we classified them instead as Type 2 or Type 3. Writers can improve the credibility and usefulness of their work by describing the basis of the information they are sharing, thus communicating its nature, reliability, and scope of inference.

Most nonnative invasive species included in the reviews investigated in this analysis lacked sufficient fire studies and observations for managers to make informed decisions about their response to various fire management decisions. Even for species that have good information on most fire topics, fire information is rarely available throughout their North American range, making it difficult to predict fire relationships outside the primary areas of study. While botanical and ecological information was available for the majority of species reviewed, the validity of inferences about fire responses made from these characteristics are impossible to assess without actual postfire observations and fire studies.

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Appendix 1. Nonnative invasive plant species used for this analysis.			
FEIS code	**Scientific name**	**Common name**	**Date completed**
AEGPOD	Aegopodium podagraria	goutweed	January-10
AILALT	Ailanthus altissima	tree-of-heaven	November-10
ALBJUL	Albizia julibrissin	mimosa	May-09
AMPBRE	Ampelopsis brevipedunculata	porcelainberry	January-10
BERVUL	Berberis vulgaris	common barberry	September-09
CIRPAL	Cirsium palustre	marsh thistle	July-09
CORVAR	Coronilla varia	crownvetch	January-10
CYNSPP	Cynanchum louiseae, C. rossicum	black and pale swallow-wort	January-09
DIOSPP	Dioscorea alata, D. bulbifera, D. pentaphylla, D. polystachya, D. sansibarensis	water, air, fiveleaf, Chinese, and Zanzibar yam	November-09
DIPSPP	Dipsacus fullonum, D. laciniatus	common and cut-leaved teasel	May-09
ERACUR	Eragrostis curvula	weeping lovegrass	June-09
EUOALA	Euonymus alatus	winged burning bush	February-09
EUOFOR	Euonymus fortunei	wintercreeper	July-09
EUPCYP	Euphorbia cyparissias	cypress spurge	May-10
EUPESU	Euphorbia esula	leafy spurge	December-10
FRAALN	Frangula alnus	glossy buckthorn	December-08
GLEHED	Glechoma hederacea	ground-ivy	April-09
HEDHEL	Hedera helix	English ivy	September-10
HERMAN	Heracleum mantegazzianum	giant hogweed	March-09
HIEAUR	Hieracium aurantiacum	orange hawkweed	November-10
HIECAE	Hieracium caespitosum	meadow hawkweed	January-11
HIEPIL	Hieracium piloselloides	tall hawkweed	January-11
HOLLAN	Holcus lanatus	common velvetgrass	March-09
IRIPSE	Iris pseudacorus	pale-yellow iris	June-09
KUMSPP	Kummerowia stipulacea, K. striata	Korean and Japanese clover	August-10
LESBIC	Lespedeza bicolor	bicolor lespedeza	August-10
LESCUN	Lespedeza cuneata	sericea lespedeza	November-10
LYSNUM	Lysimachia nummularia	moneywort	January-11
MELAZE	Melia azedarach	chinaberry	November-09
MELSPP	Melilotus alba, M. officinalis	white and yellow sweetclover	April-10
MICVIM	Microstegium vimineum	Japanese stiltgrass	January-11
MISSIN	Miscanthus sinensis	Chinese silvergrass	January-11
MORALB	Morus alba	white mulberry	November-09
NANDOM	Nandina domestica	sacred bamboo	December-09
NEYREY	Neyraudia reynaudiana	silk reed	July-10
PAEFOE	Paederia foetida	skunkvine	November-09
PAUTOM	Paulownia tomentosa	princesstree	May-09
PERLON	Persicaria longiseta	Oriental lady's thumb	July-10
PHAARU	Phalaris arundinacea	reed canarygrass	August-10

PHYAUR	Phyllostachys aurea	golden bamboo	November-09
POLAVI	Polygonum aviculare	prostrate knotweed	June-10
POLPEF	Polygonum perfoliatum	mile-a-minute	May-10
POLSPP	Polygonum sachalinense, P. cuspidatum, P. × bohemicum	giant, Japanese, and Bohemian knotweed	April-10
POPALB	Populus alba	white poplar	July-10
ROBPSE	Robinia pseudoacacia	black locust	June-09
RUBPHO	Rubus phoenicolasius	wineberry	April-09
SCHACT	Schefflera actinophylla	octopus tree	January-11
SCHPRA	Schedonorus pratensis	meadow fescue	October-10
SOLDUL	Solanum dulcamara	bittersweet nightshade	September-09
SOLVIA	Solanum viarum	tropical soda apple	October-09
TANVUL	Tanacetum vulgare	common tansy	September-09
TRISEB	Triadica sebifera	Chinese tallow	January-11
TUSFAR	Tussilago farfara	coltsfoot	January-11
UROMUT	Urochloa mutica	para grass	September-10
VINSPP	Vinca major, V. minor	bigleaf and common periwinkle	July-09
WISSPP	Wisteria floribunda, W. sinensis	Japanese and Chinese wisteria	January-09

Appendix 2. Abundance of each type of information on fire topics in each review

	Information Type 1									Information Type 2									Information Type 3										
Species review	**Fire experiment**	**Fire regimes**	**Fuels**	**Heat tolerance of seed**	**Immediate fire effect on plant**	**Occurrence on burned site**	**Postfire abundance**	**Postfire seedling establishment**	**Postfire vegetative response**	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response	**Number of topics covered with Type 1 information**	**Total number of Type 1 references in this review for fire**
AEGPOD	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
AILALT	**2**	**0**	**3**	**0**	**2**	**1**	**0**	**4**	**3**	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	2	**6**	**15**
ALBJUL	**0**	**6**	**1**	**2**	**0**	**3**	**1**	**1**	**0**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**6**	**14**
AMPBRE	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	**0**	**0**
BERVUL	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**	**3**
CIRPAL	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**
CORVAR	**0**	**0**	**0**	**2**	**0**	**2**	**0**	**0**	**0**	0	0	2	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	**2**	**4**
CYNSPP	**0**	**0**	**2**	**0**	**0**	**1**	**1**	**0**	**1**	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	**4**	**5**
DIOSPP	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	**2**	**3**
DIPSPP	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	**4**	**4**
ERACUR	**3**	**1**	**4**	**3**	**6**	**1**	**5**	**6**	**3**	0	0	1	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	**9**	**32**
EUOALA	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
EUOFOR	**0**	**2**	**2**	**0**	**2**	**0**	**1**	**0**	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**	**9**
EUPCYP	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	**2**
EUPESU	**0**	**0**	**0**	**3**	**5**	**3**	**3**	**1**	**1**	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	**6**	**16**
FRAALN	**3**	**1**	**1**	**0**	**1**	**0**	**3**	**1**	**2**	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	**7**	**12**
GLEHED	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	**2**
HEDHEL	**0**	**3**	**4**	**0**	**0**	**0**	**0**	**1**	**0**	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	**3**	**8**
HERMAN	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	**1**	**1**
HIEAUR	**1**	**0**	**0**	**0**	**0**	**4**	**1**	**2**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**	**8**
HIECAE	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**1**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**2**	**4**

Appendix 2. Abundance of each type of information on fire topics in each review

	Information Type 1									Information Type 2									Information Type 3										
Species review	**Fire experiment**	**Fire regimes**	**Fuels**	**Heat tolerance of seed**	**Immediate fire effect on plant**	**Occurrence on burned site**	**Postfire abundance**	**Postfire seedling establishment**	**Postfire vegetative response**	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response	**Number of topics covered with Type 1 information**	**Total number of Type 1 references in this review for fire**
HIEPIL	**0**	**0**	**0**	**0**	**1**	**4**	**0**	**1**	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**	**7**
HOLLAN	**2**	**0**	**2**	**1**	**0**	**9**	**8**	**3**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	**6**	**25**
IRIPSE	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	1	1	**1**	**1**
KUMSPP	**0**	**0**	**1**	**1**	**1**	**3**	**2**	**4**	**0**	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	**6**	**12**
LESBIC	**1**	**1**	**1**	**3**	**4**	**0**	**4**	**2**	**3**	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	2	2	0	**8**	**19**
LESCUN	**3**	**1**	**0**	**3**	**4**	**0**	**1**	**4**	**1**	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	2	2	0	**7**	**17**
LYSNUM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	**0**	**0**
MELAZE	**0**	**2**	**0**	**0**	**0**	**1**	**1**	**2**	**2**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**5**	**8**
MELSPP	**1**	**0**	**0**	**6**	**4**	**9**	**11**	**12**	**3**	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**7**	**46**
MICVIM	**0**	**0**	**9**	**0**	**0**	**0**	**2**	**5**	**0**	0	0	0	0	0	0	0	1	0	0	0	2	0	1	0	0	1	0	**3**	**16**
MISSIN	**0**	**5**	**3**	**0**	**4**	**5**	**4**	**1**	**4**	0	0	2	0	0	0	0	1	0	0	2	1	0	0	0	0	0	0	**7**	**26**
MORALB	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	**4**
NANDOM	**0**	**0**	**4**	**0**	**1**	**0**	**0**	**1**	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**	**7**
NEYREY	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**	**3**
PAEFOE	**1**	**1**	**2**	**0**	**2**	**0**	**0**	**1**	**3**	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	**6**	**10**
PAUTOM	**0**	**0**	**5**	**1**	**0**	**0**	**0**	**4**	**0**	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	1	0	**3**	**10**
PERLON	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**
PHAARU	**1**	**2**	**5**	**2**	**1**	**2**	**5**	**2**	**4**	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	2	1	0	**9**	**24**
PHYAUR	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**	**4**
POLAVI	**0**	**1**	**0**	**0**	**0**	**6**	**2**	**5**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**4**	**14**
POLPEF	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**

Appendix 2. Abundance of each type of information on fire topics in each review

	Information Type 1									Information Type 2									Information Type 3										
Species review	**Fire experiment**	**Fire regimes**	**Fuels**	**Heat tolerance of seed**	**Immediate fire effect on plant**	**Occurrence on burned site**	**Postfire abundance**	**Postfire seedling establishment**	**Postfire vegetative response**	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response	**Number of topics covered with Type 1 information**	**Total number of Type 1 references in this review for fire**
POLSPP	**0**	**0**	**8**	**0**	**1**	**0**	**0**	**0**	**0**	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	**9**
POPALB	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	**2**	**3**
ROBPSE	**5**	**6**	**5**	**1**	**7**	**1**	**8**	**6**	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**9**	**55**
RUBPHO	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**1**
SCHACT	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	**0**	**0**
SCHPRA	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**3**
SCHTER	**0**	**4**	**10**	**1**	**7**	**9**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	**5**	**31**
SOLDUL	**0**	**0**	**1**	**0**	**0**	**3**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	**4**
SOLVIA	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
TANVUL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	**0**	**0**
TRISEB	**0**	**2**	**7**	**0**	**3**	**3**	**2**	**2**	**0**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**6**	**19**
TUSFAR	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**1**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	**5**
UROMUT	**0**	**2**	**4**	**0**	**2**	**1**	**2**	**2**	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**7**	**15**
VINSPP	**0**	**0**	**3**	**0**	**2**	**1**	**1**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**4**	**7**
WISSPP	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**0**	**0**
Total citations for this information type and topic	24	43	94	30	65	84	73	77	60	0	0	8	1	2	0	0	2	0	0	29	25	4	17	2	9	10	11		

Appendix 2. Abundance of each type of information on fire topics in each review

	Information Type 1									Information Type 2									Information Type 3										
Species review	**Fire experiment**	**Fire regimes**	**Fuels**	**Heat tolerance of seed**	**Immediate fire effect on plant**	**Occurrence on burned site**	**Postfire abundance**	**Postfire seedling establishment**	**Postfire vegetative response**	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response	Fire experiment	Fire regimes	Fuels	Heat tolerance of seed	Immediate fire effect on plant	Occurrence on burned site	Postfire abundance	Postfire seedling establishment	Postfire vegetative response	**Number of topics covered with Type 1 information**	**Total number of Type 1 references in this review for fire**
Number of reviews with this information type for this topic	12	19	29	14	24	28	25	28	22	0	0	6	1	2	0	0	2	0	0	13	19	4	13	2	5	8	6		
Percent of reviews with no Type 1 information for this topic	79	67	49	75	58	51	56	51	61																				

Appendix 3. Abundance of each type of information on biology and ecology topics in each review with fewer than 3 fire topics with Type 1 information. Data are presented in order of increasing fire information.

	Information Type 1									Information Type 2									Information Type 3									
Species review	**Asexual reproduction**	**Belowground phenology**	**Other (nonfire) succession information**	**Response to nonfire disturbance**	**Seed banking**	**Seed dispersal**	**Seed production**	**Seedling establishment**	**Shade tolerance**	Asexual reproduction	Belowground phenology	Other (nonfire) succession information	Response to nonfire disturbance	Seed banking	Seed dispersal	Seed production	Seedling establishment	Shade tolerance	Asexual reproduction	Belowground phenology	Other (nonfire) succession information	Response to nonfire disturbance	Seed banking	Seed dispersal	Seed production	Seedling establishment	Shade tolerance	**How many Type 1 references in this review for fire?**
AEGPOD	**7**	**0**	**3**	**1**	**2**	**1**	**4**	**0**	**3**	1	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	1	0	**0**
AMPBRE	**1**	**0**	**6**	**0**	**0**	**1**	**1**	**2**	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
EUOALA	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	1	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	**0**
LYSNUM	**5**	**0**	**5**	**6**	**7**	**4**	**5**	**0**	**14**	1	0	0	0	0	0	1	0	1	3	0	0	0	1	1	0	0	3	**0**
SCHACT	**2**	**0**	**0**	**3**	**1**	**4**	**0**	**4**	**1**	0	0	0	4	0	2	3	0	2	0	0	0	2	1	1	2	1	2	**0**
TANVUL	**4**	**0**	**7**	**6**	**0**	**3**	**0**	**2**	**6**	6	0	0	0	0	1	0	0	0	1	0	0	2	0	1	0	0	3	**0**
TRISEB	**0**	**0**	**4**	**6**	**4**	**0**	**10**	**8**	**18**	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**0**
CIRPAL	**0**	**0**	**2**	**3**	**0**	**5**	**0**	**5**	**8**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
HERMAN	**5**	**0**	**4**	**8**	**0**	**9**	**0**	**2**	**5**	0	0	1	0	0	2	0	0	1	0	0	1	0	0	4	0	0	0	**1**
IRIPSE	**4**	**0**	**0**	**1**	**3**	**3**	**2**	**1**	**2**	0	0	1	0	0	1	0	0	1	3	0	1	2	0	1	0	0	3	**1**
PERLON	**1**	**0**	**0**	**11**	**5**	**2**	**4**	**1**	**0**	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
POLPEF	**0**	**0**	**0**	**6**	**2**	**3**	**3**	**0**	**7**	0	0	0	0	0	0	0	0	1	0	0	1	4	1	5	5	0	4	**1**
RUBPHO	**2**	**0**	**2**	**3**	**1**	**2**	**0**	**0**	**3**	1	0	0	0	0	0	0	0	0	0	0	5	1	2	1	0	0	1	**1**
SCHPRA	**4**	**0**	**0**	**13**	**5**	**3**	**0**	**2**	**0**	0	0	0	0	0	0	0	0	0	3	0	0	1	2	1	0	1	0	**1**
CORVAR	**4**	**2**	**4**	**11**	**6**	**4**	**0**	**0**	**3**	2	0	0	0	0	1	0	0	0	1	0	0	3	3	1	0	0	6	**2**
DIOSPP*	**0**	**0**	**0**	**2**	**1**	**4**	**4**	**0**	**3**	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4	1	0	3	**2**
EUPCYP*	**6**	**2**	**8**	**3**	**3**	**8**	**0**	**4**	**4**	0	0	2	2	0	0	0	0	1	1	1	0	0	2	2	0	0	1	**2**
GLEHED	**4**	**0**	**2**	**11**	**6**	**3**	**3**	**0**	**14**	0	0	0	0	0	0	0	0	1	0	0	0	0	3	2	0	1	0	**2**
HIECAE	**7**	**0**	**6**	**13**	**4**	**2**	**1**	**2**	**9**	1	0	0	0	0	0	1	0	0	1	0	1	2	0	0	0	1	0	**2**
MORALB	**1**	**1**	**0**	**12**	**3**	**9**	**0**	**0**	**0**	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	**2**
POLSPP	**9**	**0**	**0**	**1**	**3**	**4**	**2**	**5**	**10**	0	0	0	0	0	1	0	1	0	4	0	2	2	0	0	3	0	1	**2**

Appendix 3. Abundance of each type of information on biology and ecology topics in each review with fewer than 3 fire topics with Type 1 information. Data are presented in order of increasing fire information.

	Information Type 1									Information Type 2									Information Type 3									
Species review	**Asexual reproduction**	**Belowground phenology**	**Other (nonfire) succession information**	**Response to nonfire disturbance**	**Seed banking**	**Seed dispersal**	**Seed production**	**Seedling establishment**	**Shade tolerance**	Asexual reproduction	Belowground phenology	Other (nonfire) succession information	Response to nonfire disturbance	Seed banking	Seed dispersal	Seed production	Seedling establishment	Shade tolerance	Asexual reproduction	Belowground phenology	Other (nonfire) succession information	Response to nonfire disturbance	Seed banking	Seed dispersal	Seed production	Seedling establishment	Shade tolerance	**How many Type 1 references in this review for fire?**
POPALB*	**10**	**0**	**5**	**3**	**0**	**3**	**2**	**2**	**3**	7	0	0	0	0	0	0	0	1	4	0	0	0	0	1	2	0	0	**2**
SOLDUL	**6**	**0**	**9**	**5**	**13**	**9**	**3**	**2**	**8**	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	1	0	2	**2**
SOLVIA	**5**	**0**	**0**	**2**	**4**	**6**	**5**	**3**	**1**	1	0	0	3	1	5	2	0	0	0	0	1	0	1	1	1	1	1	**2**
UROMUT	**0**	**0**	**3**	**7**	**1**	**0**	**1**	**1**	**1**	0	0	3	1	0	0	3	0	1	0	0	0	0	0	0	0	0	0	**2**
Total citations for this information type and topic	**88**	**5**	**70**	**137**	**74**	**93**	**51**	**46**	**129**	21	0	8	11	1	15	10	1	12	28	1	12	22	20	27	15	6	31	
Number of reviews with this information type for this topic	**20**	**3**	**15**	**23**	**19**	**23**	**16**	**16**	**22**	9	0	5	5	1	9	5	1	11	13	1	7	11	11	15	7	6	13	
Percent of reviews with no Type 1 information for this topic	**20**	**88**	**40**	**8**	**24**	**8**	**36**	**36**	**12**																			

***Asexual reproduction by propagules (e.g. rhizome, root, or stem fragments) was included in the seed production, seed dispersal, and seedling establishment topics for these reviews because sexual reproduction by these taxa occurs under only certain conditions in North America.**