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Media representation of hemlock woolly adelgid management risks: a case study of science communication and invasive species control

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Abstract Public support can aid invasive species control and thus reduce negative impacts. Scientific communication can help or hinder efforts when associated risk and uncertainty are exaggerated or neglected, creating fear or distrust. Review of 104 media articles about managing a devastating forest insect, the hemlock woolly adelgid (*Adelges tsugae*), revealed that uncertainties and value judgments associated with claims of success were usually obscured or omitted, legitimate disagreement among experts about efficacy was omitted, and risks to non-targets were usually unaddressed. Discussion of chemical control in 83 articles included mention of non-target effects (e.g., to water quality, pollinators, and other native taxa) in only 11 articles and specificity was mentioned in only five instances. Biocontrol non-target impacts were mentioned in 11 of 83 cases and agent specificity was not mentioned in 71 of those cases. Ironically, while the value of the native ecosystem is used to justify management, possible non-target impacts of management on native ecosystems are largely ignored, notably hybridization between an introduced non-native biocontrol agent (*Laricobius nigrinus*) and a native beetle (*L. rubidus*) and ongoing releases of two non-native beetles, *L. osaskensis* colonies contaminated with a poorly understood, newly described species (*L. naganoensis*). To increase the public's ability to make informed decisions, benefits of

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management techniques should be discussed along with risks, scientific disagreement, and uncertainty.

Keywords *Adelges tsugae* · Eastern hemlock · Hemlock woolly adelgid · Invasive species · Media representation · Non-target effects · *Tsuga* spp. · Uncertainty

Introduction

Support from the public and legislators can aid invasive species control and prevention and thus reduce subsequent negative impacts to human health and ecological systems. Governmental and NGO funding and public engagement can help detect incipient populations and reduce established populations. Scientists and managers concerned with impacts of invasive species must enlist the support of the broader society to influence adoption of laws, regulations, and policies and to inculcate social norms that affect behavior, e.g., laws preventing firewood movement to limit pest movement. Scientific communication, whether through the media or otherwise, can help these mobilization efforts.

Scientific communication about invasive species issues presents significant challenges. Scientific experts often intuitively hold what science communication scholars have called the "deficit model" of science communication, which depicts science communication as a simple process of "transmission" of scientific facts to a naïve but receptive public (Nisbet and Scheufele 2009). Indeed, presenting technical information through popular media can potentially inform diverse audiences, from supporters, customers, collaborators, and contributors to skeptics or more hostile audiences. This simple deficit model has been challenged on multiple grounds. Empirical science communication research suggests that science literacy is often less important than other social and cultural factors in predicting individuals' views on controversial scientific issues (Allum et al. 2008; Kahan 2010, 2013). As in other complex areas of science, scientific communication about risks of invasive species and management options is inherently value-laden (Delfosse 2005; Larson 2007), and public perceptions of risks more generally are strongly influenced by political and cultural values (Simberloff 2005; Kasperson et al. 1988; Kahan 2010, 2013). Despite these limitations of the deficit model and the inevitability of narrative "framing" of technical information (Nisbet and Scheufele 2009), science communication should still strive for accuracy in representing the state of scientific knowledge to inform public decision-making. This effort can go awry when information is intentionally or unintentionally omitted or distorted, whether by scientists, journalists, or other actors. For example, Warner and Kinslow (2013) show how activists in Hawaii manipulated risk communications of government scientists by appealing to local values in an attempt to thwart release of a biocontrol agent intended to control invasive strawberry guava.

Here we use the hemlock woolly adelgid, *Adelges tsugae* Annand (Hemiptera: Adelgidae) or HWA, as a case study to evaluate media representation of risk associated with invasive species management. HWA is a sap-feeding Asian insect that devastates native eastern and Carolina hemlock populations, *Tsuga canadensis* (L.) Carriére (Pinaceae) and *T. caroliniana* Engelm., respectively, where it is introduced in eastern North America (Orwig and Foster 1998; Orwig et al. 2002; Eschtruth et al. 2006, 2013; Krapfl et al. 2011; Crabtree 2014). Its introduction was discovered in 1951, but it was not recognized as invasive until the 1980s, and management has largely occurred since online news has become commonplace, providing an opportunity to access information about its management easily. The unique combination of search terms "hemlock woolly adelgid" also makes relevant digital media easy to isolate. We report representation of risk associated with all management options mentioned in media and focus discussion on two methods commonly used in invasive species management that are represented the most, chemical and biological control ("biocontrol"). Both types of methods have controversial histories owing to non-target effects, which might affect public perception of associated risk and thus subsequent support of efforts to reduce impacts.

Effectiveness of chemical and biological control relies on a relationship with a target pest that limits its negative impacts, e.g., by killing the pest or altering its behavior. This effect on the target comes with concerns about consequences to receptors other than the target of control. Non-target impacts of chemical control have long been extensively reviewed (e.g., Newsom 1967; Pimentel 1971; Rodriguez-Kabana and Curl 1980; Desneuz et al. 2007), and infamous cases are well known, e.g., disruption of food webs owing to bioaccumulation of chlorinated pesticides. Biological control uses natural enemies, which are often not native to the area where they are introduced and are often advertised as a “safe” or “natural” alternative to chemical control (e.g., DeBach and Rosen 1991). Non-target impacts of some biocontrol agents have also been documented, e.g., native silk moth declines in northeastern North America linked to a parasitoid *Compsilura concinnata* introduced for gypsy moth control (Boettner et al. 2000); impacts to native North American thistles by the Eurasian weevil *Larinus planus* introduced to control non-native Canada thistle (Louda and O’Brien 2002); and the multicolored Asian lady beetle *Harmonia axyridis*, now a significant pest throughout Europe and North America (Koch and Galvan 2008; Roy and Wajnberg 2008). Older prominent examples of devastating impacts owing to generalist predators include declines of native predators caused by the cane toad *Rhinella marina* introduced to Australia in 1935 to control sugar cane pests (Shine 2010) and the extirpation of native Fijian birds by small Indian mongoose *Herpestes auropunctatus*, introduced for rat control (Hays and Conant 2007) (see also Simberloff and Stiling 1996a, b; Simberloff 2012).

In our study system, the target of control is HWA; direct or indirect effects to any other biotic or abiotic resources are considered non-target effects. While non-target effects will forever be of legitimate concern to any invasive species management program, biased association with extreme cases such as those just listed might unnecessarily impede management, e.g., as described above, if public support for management is negatively affected. On the other hand, bias that neglects appropriate mention of risk may lose public support by creating an atmosphere of distrust. By analyzing digital news media reports about HWA management, we sought to understand how such reports might “amplify” (intensify or attenuate) public perception of HWA management risks, following the “social amplification of risk” model introduced by risk and communication scholars (Kasperson et al. 1988). In this model, technical risk assessments by scientific experts can diverge widely from public perceptions of risk owing to many social processes of amplification, mediated through news, government communication, opinion leaders, social and cultural groups, individual experience and heuristics, etc. (Kasperson et al. 1988, Fig. 2). Other things equal, an exaggerated representation of risk associated with chemical use and introductions of biocontrol agents for HWA management in news media will tend to intensify public perceptions of such management risks, whereas omitting or downplaying relevant risks will tend to attenuate public risk perceptions.

Methods

We used Google search engine with the search term “hemlock woolly adelgid” to identify news articles through 15 August 2017 that discussed hemlock woolly adelgid management. We filtered results to include only news articles by choosing the “News” tab. Then, using the Google Chrome Web Scraper Extension (http://webscraper.io/), we retrieved information for each of the 674 articles returned: web address, heading, news source, publication date, and short description. We reviewed short descriptions and articles to eliminate articles that include no mention of HWA, e.g., unrelated articles that were returned in our search because the associated webpage includes links to articles about HWA.

We eliminated redundant occurrences of the same articles, despite the additional influence of redundant dissemination, and focused our analysis on articles that mention management, i.e., any activity or approach intended to prevent, mitigate, or eliminate HWA populations or associated negative impacts. From those articles, we recorded each mention of management method specificity, direct impacts to native species or native systems, any consideration of native species or other non-target receptors (e.g., economics and water quality), as well as of effects considered non-target but not explicitly designated as such (e.g., predation, competition). We also compiled information communicating the clarity of each approach, e.g., particular chemical or biocontrol agents used and associated efficacy.

We extracted content from the 390 remaining articles using an approach adapted from content analysis in the social sciences (Krippendorf 2004). First, a primary reviewer scanned 35 articles and developed a preliminary categorized list of terms included in articles related to HWA management, e.g., about management type, specificity, and effectiveness. An iterative process between the primary reviewer and a group of secondary reviewers who analyzed the entire group of articles was then performed to expand the list until no new terms were added and, with information from refereed and gray literature about HWA management and relevant to considerations of non-target impacts of invasive species management, to develop explicit questions related to HWA management risk communication. Finally, three different reviewers performed content analysis for each article using the final categorized list of questions (Table 1) and terms (see Online Resource 1). We used Fleiss' Kappa, calculated to be ≥ 0.71 for each question (Table 1), to confirm a high level of reliability among the three reviewers.

We then revisited articles to determine reasons for lacking consensus, correcting inaccurate responses. We identified some consistencies in disagreement among reviewers. Precision was sometimes inaccurately depicted in management type (e.g., "insecticide" was used instead of the more descriptive term "imidacloprid"), specificity (e.g., "HWA" was used instead of the less descriptive term "adelgid"), and effectiveness (e.g., "possibly successful" was used instead of "successful"). Similarly, biocontrol agent descriptions by reviewers sometimes did not reflect precision in articles; most frequently, "beetle" or "predator" was recorded when particular species or genera were specified in articles. In one instance, "*Laricobius rubidus*" was recorded as having been mentioned in an article that described beetles only as "*Laricobius*." On several occasions, reviewers omitted non-target effects (e.g., to water quality) that were mentioned and indicated native species when they were not in articles, e.g., owing to confusion when mention of *L. nigrinus*' native status in western North America was interpreted as native in eastern North America, as well. Other inconsistencies in responses were attributed to media format mischaracterizations, e.g., of radio or television transcripts as newspaper, and omissions of host resistance and quarantine from a designation of management. In some cases, agreement was likely facilitated by "yes" or "no" responses, responses chosen from explicit language included in articles, or queried information that was not mentioned (e.g., descriptions of specificity, mention of *L. rubidus*), leaving little room for differing interpretations of language.

Results

The majority of the 104 articles that discuss HWA management (see Online Resource 2) are in newspapers (66), followed by science or news magazines (10), radio (10) and television/cable news (9), press releases (6), newsletters (2), and other public media (1). Control is mentioned 221 times: biocontrol (83*), chemical control (83*), hemlock resistance (13), quarantine (12), tree removal and other silvicultural techniques (9), restricting movement of firewood/wood products (9), avoiding use of bird feeders (5), and in one instance each, buying trees from a reputable source, inspecting trees before planting, maintaining health of trees, spraying trees with a hose,

Table 1 Information collected and agreement among reviewers (Fleiss' Kappa) performing content analysis of articles about HWA management

Query	Response	Kappa
What is the format of the publication?	Select from list	0.86
Is HWA management mentioned?	Yes or no	1.00
If so, what type of management?	Select from list	0.92
How is specificity of this method described?	Select from list	0.85
Are non-target effects of this method mentioned?	Yes or no	0.91
If so, what type of non-target?	Input text	NA
Are native species as non-targets mentioned?	Yes or no	0.72
How is effectiveness of this method described?	Select from list	0.93
If this method is biocontrol, how is the agent described?	Select from list	0.90
Is "*Laricobius rubidus*" mentioned?	Yes or no	1.00
Are other native natural enemies mentioned?	Yes or no	0.71

and avoiding fertilizer. In two instances, the particular control method is unspecified.

Chemical use for HWA control (83 cases) is described generally as an insecticide or pesticide (29), a chemical (25), or a product (1), and in some cases more specifically as imidacloprid or products with imidacloprid as the primary active ingredient (e.g., CoreTect) (15), horticultural oil (6), insecticidal soap (6), or dinotefuran (1). One or more non-target effects of chemical use are mentioned in 11* articles and vary from economic impacts (1), to rerouting visitors around application sites (1), to stream (4) and drinking (2) water quality, impacts to other trees (1), pollinators (1) and other insects (3), birds (1), and residual effects to the environment, such as soil (1). In one article, insecticide use is simply described as "safe."

Chemical control specificity is mentioned in only five instances, as specific to HWA (1) and nonspecific (3) and affecting other important species (1). Effectiveness of chemical control (Fig. 1) is described as successful (31), good (1), likely successful (5), helping/reducing damage HWA levels (3), promising (1), limited (3), mixed or contradictory (13), and unsuccessful (1). The lack of confidence in efficacy, when noted, is attributed to logistics and cost associated with single-tree application across large stands, not chemical performance. Effectiveness is not mentioned in the remaining 25 of 83 cases.

Particular biocontrol agents discussed (83 cases) are beetles *Laricobius nigrinus* (11), *Sasajiscymnus tsugae* (8), *Laricobius* spp. or "Lari" beetles (5), *Laricobius osakensis* (2), and *Scymnus coniferarum* (1), silverflies *Leucopis argenticollis* and *L. piniperda*

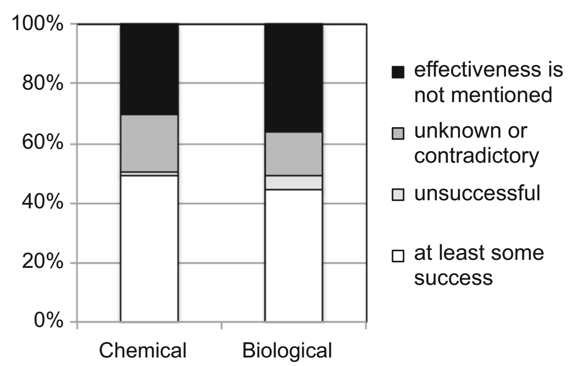

Fig. 1 Media representation of effectiveness of HWA chemical (n = 83) and biological (n = 83) control

(6), and the fungus *Lecanicillium muscarium* (1). Otherwise, agents are described only as beetles (19), predatory beetles (17), predators (7), fungi (2), biocontrol (2), or insects (2). Natural enemies native to eastern North America are mentioned in seven articles; one article reports that native predators do not control HWA; the other six articles state that there are no native natural enemies. *Laricobius rubidus*, an HWA predator native to eastern North America, is never mentioned. Effectiveness of biocontrol (Fig. 1) is variably described as successful (15), likely successful (6), helping/reducing damage levels (5), possibly successful (1), promising (8), limited (3), with mixed or contradictory results (3), hopeful (2), likely unsuccessful (1), unsuccessful (3), unknown (5), and pending because current activities are experimental (1). Agent effectiveness is not mentioned in 30 cases. Agent specificity is described as specific to HWA (6) or adelgids (6), with no mention of specificity in 71 cases.

Non-target impacts are mentioned in 11* of 83 cases that consider biocontrol. In four instances, agents are described as "no risk," as "no threat to non-target species," to have "no apparent effect on other creatures," and indicating that measures were satisfied "making sure it wouldn't cause problems in its territory." In one case, a tradeoff is described: "As always, adding a new species into the ecosystem comes with risks, but…that's why ecologists test them in the lab to rule out the most obvious risks" and "…the potential benefit of the fly being [sic] to control the adelgid population outweighs some of those unknown risks." Concern is communicated in six instances about agents with "unintended consequences," that "spread or eat anything besides the invasive adelgids," that affect "anything other than the woolly adelgid" or "other native species," and finally, posing then answering, "Are there risks in introducing a predator into the environment? Of course there are."

*Reference to discussion of chemical control (83 times) and biocontrol (83 times) is not in the same 83 articles, although many articles mention both approaches. Likewise, discussion of non-target effects 11 times in each case is also a coincidence.

Discussion and conclusions

Surprisingly, concern addressed in the scientific literature about risks associated with HWA chemical (e.g., Raupp et al. 2004; Reynolds 2008; Cowles 2009; Dilling et al. 2009; Eisenback et al. 2010) and biological (e.g., Zilahi-Balogh et al. 2002; Butin et al. 2004; Flowers et al. 2005; Vieira et al. 2011) control is usually not mentioned in media, likely attenuating any public perception of such management risks. Additionally, clarity about types and effectiveness of control is usually lacking. On occasions where risk is communicated, language associated with chemical control consistently and clearly indicates concern about negative impacts to the environment and/or human health. In only one instance is chemical control characterized as safe. And indeed, all chemical HWA control methods (e.g., neo-nicotinoids imidacloprid and dinotefuran, horticultural oil, and insecticidal soap) (Silcox 2002; Havill et al. 2016) are non-specific, broad-spectrum insecticides that kill HWA as well as native insects, triggering possible subsequent negative cascading effects in ecosystems (e.g., Raupp et al. 2004; Hakeem 2008; Reynolds 2008; Dilling et al. 2009; Eisenback et al. 2010; de Lima e Silva et al. 2017). On the other hand, language associated with biocontrol is contradictory, indicating either concern or no risk. Host-specificity testing consistently indicates HWA biocontrol agents feed on species other than HWA and adelgids (e.g., Zilahi-Balogh et al. 2002; Butin et al. 2004; Flowers et al. 2005; Vieira et al. 2011) in testing that includes a limited number (usually fewer than six) of non-target species and usually does not test other indirect or direct interactions such as hybridization or resource competition. So there is noteworthy uncertainty in non-target risk associated with HWA biocontrol. The contrast between risks associated with chemical and biological control might reflect an inaccurate risk heuristic that, because biocontrol agents are "natural," little risk is associated with their use. (It is important to note that there are also "natural" chemicals used as pesticides and in biological warfare, e.g., ricin, and that disease-vectoring species like mosquitoes are natural as well.)

Debate among scientists and scientific uncertainty associated with effectiveness and non-target impacts of biocontrol agents are not addressed in media articles. The role of natural enemies in HWA population control has not been evaluated to the extent that it is understood in HWA's native or introduced ranges. Non-native biocontrol agents have been released in eastern North America with evidence of success pending (Jubb et al. 2018); however, the majority of media articles that address effectiveness indicate some success (Fig. 1). These species do eat HWA, but that does not necessarily entail a population-level effect indicating control (Van Driesche and Hoddle 2017). Studies in enclosures (e.g., McClure et al. 2000; Lamb et al. 2005; Mausel et al. 2008; Vieira et al. 2013) often cited as proof of control in the field suggest only potential for control. Reports citing success in refereed literature (e.g., McClure 1995a, b, 1996, 1997; Cheah and McClure 1996, 1998; Sasaji and McClure 1997; McClure and Cheah 1999; McClure et al. 2000) are correlative and lack data indicating population-level effects in the field. The only field evaluation in the introduced range demonstrated tree health did not differ between untreated trees and those with biocontrol; and HWA numbers differed at only one site, where they were greater where biocontrol agents had been released (Sumpter et al. 2018). More of these evaluations are needed to assess HWA biocontrol efficacy.

Only seven articles mention natural enemies native to eastern North America. One article reports that native predators do not control HWA, which is likely true. However, the other six articles inaccurately state that there are no native natural enemies. A predator imported from northwestern North America, *Laricobius nigrinus* hybridized with the eastern North American endemic *L. rubidus* that feeds on HWA. Wiggins et al. (2016) documented hybridization in 10.75% of *Laricobius* specimens collected in 2010 and 2011. Fischer et al. (2015) report hybridization in 12.9% and 15.5% of specimens (2010 to 2012) from eastern hemlocks and white pine (*Pinus strobus* (L.), Pinaceae), respectively, documented increasing *L. nigrinus* populations and decreasing *L. rubidus* populations (2007 to 2012), and conclude that it is not known if native *L. rubidus* will be displaced by hybrids. Hybridization with non-native species is a well-recognized threat to native species, ecosystems, and biodiversity because it can lead to extinction or to hybrids themselves becoming pests (Rhymer and Simberloff 1996; Mooney and Cleland 2001), yet there is no mention of the native *L. rubidus* or hybridization in the 104 articles reviewed. Effectiveness and specificity of purebred *L. nigrinus* (e.g., Zilahi-Balogh et al. 2002; Lamb et al. 2005, 2006) reported in media after this discovery may no longer apply owing to hybridization with *L. rubidus*. Another unreported newsworthy discovery is that of a new species, *Laricobius naganoensis*, which was inadvertently imported into the United States from Japan as a contaminant of another biocontrol agent, *Laricobius osakensis* (Fischer et al. 2014; USDA 2017). Additionally, the same rationale sometimes used to justify waiting for biocontrol release outcomes, that impacts may take time to become apparent (Van Driesche and Bellows 1996), might be applied to reconsider some role in HWA control by other natural enemies already present, native (e.g., *L. rubidus*, *Chilocorus stigma*) and non-native (e.g., *Scymnus suturalis*, *Harmonia axyridis*) (Montgomery and Lyon 1995; personal observation).

These results are puzzling. The rationale for HWA management provided—in almost every article—is the aesthetic value of native hemlocks and their role as a foundation species, hosting native communities important to recreation such as sport fishing and influencing resources such as water quality. So it is surprising that possible impacts of HWA management on these same native species and resources are largely omitted and associated uncertainty is ignored or misrepresented. Recognition and consideration of non-target effects of any control method should be not only the norm (Van Driesche et al. 2016) but a priority in resource management. These risks were infrequently or inaccurately described in the majority of media representations of HWA management, likely attenuating risk perceptions of public consumers of these reports.

HWA management is challenging. Insecticides kill HWA, but use is not feasible long-term or in large areas. Expensive, labor-intensive applications must be repeated because these are often systemic insecticides, introduced into the tree's circulatory system to reach all HWA feeding on the tree, e.g., by injection into the trunk or painting bark. Insecticides used for HWA are broad-spectrum, meaning action is not specific to HWA, also killing beneficial insects such as pollinators. Biocontrol agents feed on HWA, but evidence is pending about their ability to control HWA populations. Host-specificity testing provides information about how agents perform under controlled conditions but cannot predict how agents will perform under natural conditions in the field or when interacting with species other than those tested. So non-target impacts are also a concern for biocontrol management. Other methods (e.g., silvicultural techniques) do not eliminate but may reduce HWA populations, and it will be many years before potential promise associated with host resistance is realized. In the meantime, negative impacts can be reduced by preventing spread using methods limiting dispersal (e.g., quarantine, chemical treatment, and inspection of nursery stock) and early discovery and eradication of HWA populations small and localized enough to treat completely with insecticide.

Journalists cannot be expected to sift through all relevant studies or to perform a comprehensive review of the scientific literature, because understandably they usually lack the time and relevant expertise. Additionally, media representation might be skewed because more accessible summary reports and management plans created for public consumption (e.g., Havill et al. 2016) often lack the scientific rigor and discourse associated with refereed literature that is more difficult to digest. For instance, Havill et al. (2016) discuss some risks associated with chemical control and hybridization but do not mention ongoing contamination of *L. osakensis* colonies by *L. naganoensis* (USDA 2017) and do not discuss uncertainties or risks associated with biocontrol host-specificity testing and establishment. So while journalists are obliged to accurately portray information provided by scientific and other experts, the obligations associated with responsible science communication fall largely on scientists and managers who engage the media. Guided by the principle of informed consent from biomedical ethics, Elliott's (2010) discussion of the "ethics of expertise" in scientific communication with the public and policymakers appeals to a duty of scientific experts to disclose information that a "reasonable person" would want to know. Depending on the context, this may include uncertainties and value judgments associated with the scientific information, any relevant disagreements within the expert community, and possible conflicts of interest. Information provided about benefits, risks, and alternatives ought to be aimed at increasing, as opposed to diminishing, the public's ability to make informed decisions. Information should be clearly presented to avoid common misunderstandings, as well as "information overload," "misleading framing," and "false beliefs that result in unjustified inferences" (Elliott 2010, p. 383).

We do not intend to downplay the significant challenges of science communication surrounding a topic as complex and contested as invasive species management. Further, while we assume the myriad of management strategies in practice likely suffer from the same unknowns, uncertainties, and omissions, we cannot assume media representation of risk that we documented extends beyond HWA management without validation. Nonetheless, benefits of management techniques should be discussed along with risks, and the extent of expert disagreement and scientific uncertainty about benefits and risks should be responsibly communicated. But scientists and other experts studying management techniques may feel pressure to provide solutions to invasive species and pest problems and thus to represent their techniques as successful even when evidence for efficacy is limited or uncertainties are significant. On the other hand, overemphasizing uncertainty may also obscure scientific consensus. Other problems that may arise on the journalistic end of science communication, for example framing stories based on previously published articles, recycling old information that may be outdated, or inaccurately presenting information from expert sources, also contribute to miscommunication (Harvey et al. 2018).

Media representations of risks of HWA management may reflect a failure of responsible science communication, whether on the part of scientists, managers, or journalists, insofar as: (1) uncertainties and value judgments associated with claims of management "success" were usually obscured or omitted; (2) legitimate debate and disagreement among experts about the efficacy of management techniques were omitted; and (3) non-target effects of chemical or biological management techniques were usually not addressed. The paucity of discussion of non-target effects is particularly problematic given that a reasonable person interested in HWA management would likely want to know about associated risks, especially those that have been thoroughly documented in other cases. Additionally, when disagreements arise in value judgments about what should count as an environmental risk, ideally these would also be reported; e.g. in this case, whether the hybridization of a non-native biocontrol beetle with a native species should be considered an environmental risk of HWA biocontrol. While some form of risk "amplification," whether intensification or attenuation, is arguably difficult to avoid, as long as such risk information can be presented in a way that does not lead to an exaggerated perception of management risks, or to "information overload," scientists and managers have an obligation to ensure such risks are not completely obscured in science communication.

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