Invasive Plant Science and Management 2012 5:194–208

Assessing Stakeholder Perspectives on Invasive Plants to Inform Risk Analysis

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Conservation and land management decisions often are based primarily on natural science, but could be more successful if human influences were effectively integrated into decision making. This is especially true for efforts to manage invasive plants, whose arrival is usually the product of deliberate human introduction. Risk-assessment models that predict the probability that a nonnative plant will naturalize or invade are useful tools for managing invasive plants. However, decisions based on such models could affect stakeholders differently. Careful assessment of risk-analysis methodologies should consider the importance of stakeholder participation. We surveyed the perceptions of four stakeholder groups (conservation professionals, master gardeners, professional horticulturists, and woodland landowners) in Iowa about invasive plants, general management approaches, and risk-assessment models. We also examined whether or not a stakeholder's nature relatedness plays a role in shaping his or her responses. Stakeholder perceptions varied less than expected across all four groups. Eighty-seven percent of respondents agreed invasive plants are a problem, and 88.4% agreed that we have a responsibility to manage them to protect natural areas. Support for the use of risk-assessment models also was high, with 78.7% of respondents agreeing that their use has potential to prevent plant invasions. Nature relatedness scores for all groups were correlated with respondent perspectives on invasive plants. Respondents believed biologically significant error rates (errors that might introduce a new invasive plant) should not exceed 5 to 10%. Respondents were more tolerant of horticulturally limiting errors (errors that restrict sale/use of a plant that would not have become invasive), reporting rates of 10 to 20% as acceptable. Researchers developing risk-assessment models might wish to aim for error rates within these bounds. General agreement among these stakeholder groups suggests potential support for future risk-management efforts related to invasive plants.

Key words: Nature relatedness, invasive awareness, risk-assessment models, survey.

Invasive plants, or nonnative plants that spread aggressively into natural habitats and disrupt native communities, are commonly named as one of the most problematic conservation challenges today. In addition to $35 billion in annual economic costs that they incur (Pimentel et al. 2005), invasive species can reduce native biodiversity (Hejda et al. 2009) and alter ecosystem processes (Brooks et al. 2004; Ehrenfeld 2003). Many strategies have been suggested to confront this challenge, including preventing introduction of invasive plants, responding rapidly to their establishment with eradication efforts, containing their spread, and mitigating their impacts (Hulme 2006). Often, land managers responsible for maintaining natural areas operate in crisis-management mode and must contain invaders or mitigate their impacts in costly battles. It would be better to prevent the introduction of potentially invasive plants before they are released for use. This solution is especially appropriate, because the majority of nonnative plants arrive in new locations due to deliberate human introduction (Mack and Erneberg 2002). If effective systems are developed to screen nonnative plants for potential invasiveness, the frequency of new invaders could be significantly reduced.

Risk analysis, comprised of both risk assessment and risk management, is one strategy for screening potentially invasive plants. In this context, risk assessment scientifically quantifies the probability that a nonnative plant will naturalize or invade. Risk management involves actions taken based on risk-assessment outcomes. These actions are influenced by stakeholders' values and opinions of acceptable risk and the costs and benefits of implementation (National Research Council 2009). Researchers have

DOI: 10.1614/IPSM-D-11-00067.1

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Management Implications

Many conservation professionals and land managers have spent countless hours containing or eradicating invasive plants encroaching on natural areas. Given the costs and effort associated with their control, prohibiting the introduction of new nonnative plants that are likely to become invasive would be very beneficial. Risk-assessment models are statistical tools that can be used to screen new plant introductions for invasiveness, but implementing these models comes with challenges. Because most new plant introductions are deliberately initiated by humans, stakeholders' needs must be taken into consideration if these preemptive management efforts are to be successful. We identified and surveyed four stakeholder groups (conservation professionals, master gardeners, professional horticulturists, and woodland landowners) in Iowa, who are important voices in decision-making for invasive plants, about their perspectives on general management approaches, and risk-assessment models. We also examined whether or not nature relatedness (a person's sense of connection to the natural world) plays a role in shaping these perspectives. We found these stakeholder groups had relatively minor differences of opinion. Stakeholders agreed that invasive plants were a problem that we have a responsibility to manage, and were open to the idea of passing state laws or mandates to achieve that goal. This was true even of professional horticulturists and master gardeners, who would potentially incur more costs than benefits from such regulations. Stakeholders also displayed consistently high levels of nature relatedness, and concern these groups have about invasive plants might be influenced by their identification with nature. Overall, our findings suggest that risk analysis to limit introduction of potentially invasive plants is likely to be acceptable in Iowa. When selecting a risk-assessment model to adopt, stakeholders believe choosing models with a low chance of introducing potentially invasive plants is more important than choosing models with a low chance of prohibiting a plant unlikely to become invasive. Current risk-assessment models, which emphasize prevention of invasive plant introduction at the expense of preventing introduction of benign plants, appear to be aligned with stakeholder preferences.

developed many risk-assessment models to screen nonnative plants for invasiveness (Daehler et al. 2004; Gassó et al. 2010; Gordon and Gantz 2008; Pheloung et al. 1999; Reichard and Hamilton 1997; Widrlechner et al. 2004). None of these models is perfect; they are subject both to false positive and false negative errors. False positives have been referred to as horticulturally limiting errors, because they represent opportunity costs to horticultural production caused by the rejection of valuable plants that are not likely to become invasive (Widrlechner et al. 2004). False negatives have been referred to as biologically significant errors, because they represent the likely introduction of a new invasive plant, creating ecosystem costs and new challenges for natural resource managers and conservationists (Widrlechner et al. 2004). Risk-assessment models also could fail to classify a plant or require information that is difficult to find or unavailable in the scientific literature (Fox and Gordon 2009; Jefferson et al. 2004; Parker et al. 2007). Although risk-assessment models have limitations, they show promise for reducing introductions of new invasive plants, and some are already in use in Australia (Weber et al. 2008) and the United States (Jefferson et al. 2004).

A recent reassessment of risk-analysis methodologies (National Research Council 2009) emphasized the importance of stakeholder participation during all stages of risk analysis to increase its credibility and transparency. This aspect of risk analysis for invasive plants has received less attention than has risk-assessment model development. Some surveys have been conducted on attitudes towards invasive plants (e.g., Andreau et al. 2009; Bardsley and Edwards-Jones 2006; Bremer and Park 2007; Burt et al. 2007; Colton and Alpert 1998; Daab and Flint 2010; García-Llorente et al. 2008; Peters et al. 2006), but similar efforts are lacking with respect to risk-assessment modeling and determining what stakeholders deem as acceptable risk. These previous surveys suggest that there are differences of opinion about invasive plants that could present challenges for the effective application of risk-assessment models. If those developing risk-assessment models expect them to be accepted and adopted, stakeholder groups should not be viewed as passive recipients of the results, especially if their opinions differ. Our primary objective was to understand stakeholder perspectives on invasive plants, their management, and risk assessment to inform model development and communication during the risk-analysis process in Iowa.

In addition to evaluating stakeholder perspectives, understanding their biases can help explain stakeholder responses. Underlying mental constructs can inform an individual's attitudes. For environmental issues, researchers have proposed that a person's sense of relatedness with nature plays a role in shaping attitudes. Ecopsychologists suggest that our failure to address environmental problems is partly due to our failure to acknowledge the ecological context of human existence (Roszak 1992; Winter and Kroger 2004). A mental construct that disassociates humans from nature could be linked to environmentally destructive behavior (Worthy 2008). For example, neoclassical economic theory has been criticized for an anthropocentric slant that neglects adequate consideration of negative externalities that damage natural ecosystems (Hall et al. 2000; Magness 2003). We suggest that individuals holding a strong sense of connection to (and dependence on) nature in an ecological context would find it more difficult to dismiss the costs of plant invasions simply as a negative externality.

Several scales have been designed to examine individual attitudes towards nature. The New Environmental Paradigm (NEP) (Dunlap et al. 2000) has been used widely to measure proenvironmental orientation. Schultz (2000, 2001) created another scale to classify individuals' concern for the environment as egoistic, social–altruistic, or biospheric. Neither of these scales directly taps a person's sense of relatedness to (or connection with) nature, which is the mental construct we wished to evaluate. Two more

https://doi.org/10.1614/IPSM-D-11-00067.1 Published online by Cambridge University Press

recently developed scales do assess the construct we were interested in: Mayer and Frantz's (2004) Connectedness to Nature (CNS) scale and Nisbet et al.'s (2009) Nature Relatedness (NR) scale. The NR instrument includes three subscales that examine individuals' self-identification with nature (NR–Self, for which responses to statements elicit how closely respondents have intertwined their identity with nature), their overall orientation toward nature (NR–Perspective, including items that elicit the respondents' sense of human effects on nature), and respondents' physical relationship with nature (NR–Experience, including statements that examine respondents' degree of contact with and enjoyment of nature). We chose to use the NR scale because it included this last metric to assess physical relatedness to nature (NR–Experience).

We identified four key stakeholder groups who would be affected by risk analysis for nonnative plants. First, conservation professionals often advocate rigorous management of invasive plants as part of their vocational responsibility to preserve natural areas and native biodiversity. Second, master gardeners could be affected by decisions made from risk-assessment models that limit the selection of plants available for sale and act as leaders in the gardening community. Third, professional horticulturists invest significantly in the development and introduction of both native and nonnative plants and, as a group, are a significant source of naturalizing plants and invaders (Reichard and White 2001). Finally, woodland landowners, some of whom engage in timber production, must deal with the negative consequences of invasive species on their land.

We surveyed representatives of these four stakeholder groups to address four main objectives: (1) assessing stakeholder awareness of invasive plants, their perception of invasive plants, and their support for general management approaches; (2) determining stakeholder perspectives on risk-assessment models as a management tool for invasive plants, and the maximum acceptable error rates for these models; (3) evaluating relationships between a stakeholder's degree of nature relatedness and attitudes towards invasive plants and their management; and (4) considering differences in opinions among stakeholder groups because they might influence the risk-analysis process. We expected conservation professionals and woodland landowners to be more concerned about invasive plants, to favor laws and mandates as a management approach, and to be less concerned about horticulturally limiting errors than about biologically significant errors. We expected professional horticulturists and master gardeners to express relatively less concern about invasive plants and a greater acceptance of voluntary regulation as a management approach, and to give more consideration to horticulturally limiting errors than biologically significant errors.

Materials and Methods

We developed four online survey instruments to assess and compare the perspectives of each stakeholder group in Iowa (conservation professionals, master gardeners, professional horticulturists, and woodland landowners). We obtained e-mail addresses for representatives of each of these groups. Conservation professionals included Iowa Department of Natural Resources employees, County Conservation Board personnel from Iowa's 99 counties, and employees of Iowa-based nonprofit conservation organizations (including the Iowa Natural Heritage Foundation, Trees Forever, and the Nature Conservancy's Iowa Office) ($n = 281$). These were obtained from the State of Iowa employee directory, the Iowa County Conservation Board e-mail list, and employee directories from these nonprofit organizations, respectively. E-mail addresses for master gardeners in Iowa ($n = 405$) were provided by the Iowa State University Extension Master Gardener program. Professional horticulturists were represented by members of the Iowa Nursery and Landscape Association (INLA), whose e-mail list was provided by the INLA ($n = 182$). A list of e-mail addresses for woodland landowners who are members of the Iowa Woodland Owners Association was provided by Iowa State University Extension Forestry ($n = 137$). Lists were screened for duplicate e-mail addresses; seven conservation professionals who also appeared in the woodland landowner list were removed from the landowner list but were retained in the conservation professional group.

Survey Development and Administration. The four survey instruments contained questions about knowledge and familiarity with invasive plants, attitudes toward invasive plants and their management (including risk-assessment models), and a scale to measure the nature relatedness (NR) of stakeholders. The number of questions on a survey ranged from 57 to 61, with certain questions unique to each stakeholder group. Respondents first were asked to select their affiliation with a primary and secondary (if applicable) stakeholder group, to confirm their placement in the four groups. Following this, respondents were given 21 statements to rate using a Likert scale (1 "strongly disagree" to 5 "strongly agree") to evaluate their NR, including seven statements for each of three subscales: NR–Self (internalized identification with nature), NR–Perspective (external sense of human impacts on nature), and NR–Experience (physical familiarity with and enjoyment of nature). Statements about NR–Self included items such as "I am very aware of environmental issues," and "Even in the middle of the city, I notice nature around me." Statements about NR–Perspective included "Humans have the right to use natural resources any way we want." Statements about NR–Experience included "I enjoy being outdoors, even in unpleasant weather." Statements for each of the NR subscales were adapted from Nisbet et al. (2009).

Respondents were then asked to rate priorities for various environmental issues in Iowa on a Likert scale

https://doi.org/10.1614/IPSM-D-11-00067.1 Published online by Cambridge University Press

(1 "lowest priority" to 5 "highest priority"). We asked respondents whether they had heard of invasive plants before. If they had heard of invasive plants, they were then asked where they had heard about them. To evaluate their understanding of invasive plants, we asked respondents to provide their own definition of invasive plants. We scored responses on a pass–fail basis: if they mentioned that invasive plants are aggressive (e.g., fast growth/spread), disruptive (e.g., outcompeting natives), or a challenge to eradicate (e.g., few natural enemies, resilient), they were given a "pass." Responses that only defined invasive plants as broadly undesirable or nonnative were considered insufficient. A set of four additional questions to assess general attitudes about invasive plants was evaluated on a Likert scale (1 "strongly disagree" to 5 "strongly agree").

We then supplied a common definition of invasive plants before presenting questions on invasive-plant management. These questions also used a 1 to 5 Likert scale unless otherwise noted. We posed three questions on general management approaches inspired by Burt et al.'s (2007) study on the potential efficacy of voluntary initiatives to regulate invasive plants. Two questions were constructed for correlation with the NR scale; this pair contrasted an ecocentric management philosophy with an anthropocentric management philosophy for invasive plants. Respondents were asked four questions about risk assessment as a management tool for invasive plants, following a basic explanation of risk assessment and its possible outcomes. We also explained error rates and then asked two open-ended questions about the maximum levels of horticulturally limiting error and biologically significant error that respondents would find acceptable in risk-assessment models.

In addition to questions common to all four stakeholder groups, 19 questions were framed specifically for single groups (up to seven questions per group). Most of these were developed based on important additional considerations specific to their respective stakeholder groups. For example, given the challenge of managing invasive plants, we were curious if conservation professionals felt pessimistic about the prospect of invasive plant control. We also adapted items from an earlier survey (Peters et al. 2006) of the Minnesota horticultural industry for our professional horticulturist group.

All four surveys were reviewed by the Office for Responsible Research at Iowa State University prior to administration with SurveyMonkey™ (SurveyMonkey 2011). Unique survey links were sent to the respective stakeholder group lists via an e-mail cover letter in October 2010. We sent out a reminder to all groups after 2 wk, and, due to lower initial response rate for professional horticulturists, we e-mailed a second reminder to this group. We closed the surveys in December 2010.

Survey—Data Editing and Statistical Analysis. Returned surveys that were more than 50% complete were included in the data analysis. Respondents who did not report a primary or secondary group affiliation associated with the administered stakeholder e-mail list were excluded, as were duplicate respondents. If respondents skipped any NR scale items, missing values were imputed by the hot deck method (Ford 1983). Potential nonresponse bias was assessed by comparing early respondents (those who replied to the initial request) to late respondents (those who replied after the 2-wk reminder) with each group using ANOVA. We determined descriptive statistics for all survey data by using a combination of Excel® (Microsoft 2007) and JMP® 8 (SAS 2009). Other statistical procedures (one-way ANOVA, means comparisons using Tukey's HSD, *t*-tests, sign-ranked matched pairs, correlations, and calculations of Cronbach's α) were conducted using JMP 8.

Results

Response rates, Demographics, Interest in Plants. Our online surveys were e-mailed to 1,005 individuals representing the four stakeholder groups. We received 471 eligible responses (after excluding incomplete and duplicate surveys), for an overall response rate of 46.9% (Table 1). Fewer than 5% of questions within each stakeholder group showed differences between early and late respondents, suggesting minimal nonresponse bias. The proportion of men to women was nearly equal overall, but disproportionately allocated among stakeholder groups; women predominated among master gardeners and men among the other three groups (Table 2). Stakeholder respondents were primarily middle-aged, well-educated, middle to upper-middle class, and long-time residents of Iowa (Table 2).

When asked to select their primary three interests in plants, the top three overall selections were gardening/landscaping at home (66.2%), visiting natural areas with plants (52.6%), and cultivating plants for food (44.6%). The top selection varied by stakeholder group: conservation professionals selected visiting natural areas with plants (83.9%); master gardeners selected gardening/landscaping at home (92.8%); professional horticulturists selected gardening/landscaping as a profession (91.7%); and woodland landowners selected visiting natural areas with plants (62.1%).

Awareness and Knowledge of Invasive Plants. Respondents were aware of and typically understood the concept of invasive plants. Nearly all respondents had heard of the term "invasive plant" before; only one respondent in the master gardener group marked "unsure." The most common sources of information about invasive plants included newspapers, magazines, or books (82.3%), educators or workshops/lectures (81.7%), conservation professionals (74.8%), colleagues (63.8%), and the Internet (60.8%). The least-commonly reported information source was plant retailers or nurseries (28.4%).

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Table 1. Response rates for online surveys about invasive plants e-mailed to four stakeholder groups in Iowa.

Stakeholder group	Surveys administered (*n*)	Total respondents (*n*)	Response rate (%)
Conservation professionals	281	130	46.3
Master gardeners	405	207	51.1
Professional horticulturists	182	60	33.0
Woodland landowners	137	74	54.0

We used an open-ended question asking for a definition of ''invasive plant'' to evaluate respondents' understanding of the concept. The percentages of respondents who met our criteria for understanding in each group were 80.0% of conservation professionals, 96.5% of master gardeners, 92.6% of professional horticulturists, and 86.4% of woodland landowners. A notable number of conservation professionals simply defined ''invasive plant'' as any nonnative plant (11.5%) and were the most likely of the stakeholder groups to stipulate that an invasive plant is nonnative (76.0%). Only 36.0% of master gardeners and 38.9% of professional horticulturists made the distinction that invasive plants are nonnative; woodland landowners did so 58.3% of the time. Some respondents, particularly conservation professionals, indicated the possibility of an invasive plant being native (16.0% for conservation professionals, 6.9% or less for the other groups).

Perspectives on Invasive Plants. Respondents believed that invasive plants are a problem. Although not the highest priority relative to other environmental issues in Iowa (water quality, preserving natural areas, sustainable energy, solid waste, and soil erosion all rated more highly), 69.9% of respondents considered invasive species to be a high or the highest priority. When asked to respond to ''I don't see invasive plants as a problem,'' a strong majority in each stakeholder group disagreed or strongly disagreed (Table 3). A majority of stakeholders also indicated that invasive plants are not simply weeds (73.4% of all respondents), or plants growing where they are not wanted (73.2% of all respondents) (Table 3). Although stakeholders see invasive plants as a problem, slightly over half of all respondents agreed or strongly agreed that ''invasive plants aren't necessarily bad plants'' (Table 3). Conservation professionals and woodland landowners did not have strong opinions on this question, because their mean responses did not differ from ''unsure'' ($P > 0.23$ and $P > 0.11$, respectively).

When asked to respond to the statement ''I am concerned that we have used invasive plants for management projects,'' conservation professionals agreed or strongly agreed (79.3%, Table 4). Parallel, but not identical questions were asked of the other stakeholder groups. Only 31.7% of master gardeners agreed or strongly agreed that they were concerned they may have used invasive plants in their gardening (Table 4). A majority (56.6%) of professional horticulturists were concerned that they may have sold or cultivated invasive plants, and most (89.1%) woodland landowners were very concerned about the impact of invasive plants on their property (Table 4).

Perspectives on Invasive Plant Management. Respondents believed we have a responsibility to manage invasive plants and support the use of state laws or mandates for this purpose. A strong majority (92.9%) of respondents disagreed or strongly disagreed with a ''hands off'' approach to managing invasive plants or letting nature take its course (Table 5). Stakeholders also disagreed or strongly disagreed (87.4%) that ''we should only manage invasive plants if they cause trouble for people'' and instead favored taking responsibility to protect natural areas from invasive plants (88.5% agree or strongly agree, Table 5). Voluntary management was not deemed sufficient by stakeholders, with 59.6% disagreeing or strongly disagreeing that ''invasive plants should be managed on a voluntary basis'' (Table 5). Instead they favored state laws or mandates, with

Table 2. Demographics of four stakeholder groups from surveys on invasive plants in Iowa.

				Education		Annual income		
Stakeholder group	Male/female (*n*)	Median age (yr)	Average Iowa residence time (yr)	Associate's degree or less (%)	Bachelor's degree or more (%)	$49,999 or less (%)	$50,000 to $99,999 (%)	$100,000 or more (%)
Conservation professionals	94/32	44	39	6.3	93.7	11.3	62.1	17.7
Master gardeners	42/154	60	49	39.1	59.9	17.7	35.4	16.7
Professional horticulturists	36/21	49	48	35.1	63.2	20.0	38.2	27.3
Woodland landowners	56/12	60	58	26.8	73.2	12.9	41.4	28.6

https://doi.org/10.1614/IPSM-D-11-00067.1 Published online by Cambridge University Press

Table 3. Stakeholder responses to survey questions on invasive plants. Means and standard deviations (in parentheses following each mean) represent numerical coding of a five-point Likert scale: strongly disagree (1), disagree (2), unsure (3), agree (4), and strongly agree (5).

		Five-point Likert scale (%)				
Survey question and group	Mean (SD)[a]	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. Invasive plants are the same thing as weeds.						
Conservation professionals (n = 130)	2.3 (1.0)	13.1	64.6	3.8	13.8	4.6
Master gardeners (n = 206)	2.3 (1.0)	16.0	57.8	7.8	14.1	4.4
Professional horticulturists (n = 60)	2.5 (1.2)	18.3	45.0	8.3	23.3	5.0
Woodland landowners (n = 74)	2.3 (1.1)	21.6	51.4	8.1	13.5	5.4
2. If it grows where I don't want it, it is an invasive plant to me.						
Conservation professionals (n = 130)	2.0 (0.8) a	20.0	66.9	3.1	8.5	1.5
Master gardeners (n = 206)	2.5 (1.2) b	17.0	47.6	7.8	20.9	6.8
Professional horticulturists (n = 60)	2.2 (1.0) ab	23.3	55.0	5.0	15.0	1.7
Woodland landowners (n = 73)	2.4 (1.1) ab	19.2	49.3	8.2	19.2	4.1
3. Invasive plants aren't necessarily bad plants.						
Conservation professionals (n = 130)	2.9 (1.2) a	13.1	32.3	10.8	41.5	2.3
Master gardeners (n = 203)	3.4 (1.1) b	9.4	15.3	12.8	55.7	6.9
Professional horticulturists (n = 60)	3.4 (1.0) b	3.3	21.7	11.7	55.0	8.3
Woodland landowners (n = 74)	3.2 (1.2) ab	10.8	18.9	14.9	48.6	6.8
4. In general, I don't see invasive plants as a problem.						
Conservation professionals (n = 130)	1.5 (0.6) a	59.2	37.7	1.5	0.8	0.8
Master gardeners (n = 204)	1.9 (0.9) b	35.3	49.0	8.8	6.4	0.5
Professional horticulturists (n = 60)	2.1 (1.0) b	30.0	45.0	11.7	11.3	0.0
Woodland landowners (n = 74)	1.7 (1.0) ab	50.0	37.8	6.8	1.4	4.1

[a] Means followed by the same letter within a column for each question are not significantly different at $P \leq 0.05$ according to Tukey's HSD. Means are not different unless noted.

60.9% agreeing or strongly agreeing with this, although 26.3% were unsure (Table 5).

Attitudes Toward Risk Assessment. Respondents supported implementation of risk-assessment models as a management tool for invasive plants, but expressed concerns about the accuracy and effectiveness of such models. Most (78.7%) agreed or strongly agreed that risk assessment has the potential to prevent future plant invasions (Table 6). When asked how much they agreed or disagreed with the statement "I don't think we should use risk assessment," most (74.3%) disagreed or strongly disagreed (Table 6). Although in agreement about the potential benefits of risk assessment, respondents were divided on its effectiveness. Conservation professionals and professional horticulturists exhibited more skepticism about the effectiveness of risk assessment than did master gardeners, whereas woodland landowners were evenly divided (Table 6). A majority of conservation professionals (63.8%) and professional horticulturists (61.4%) also expressed concern about the accuracy of risk assessment. In contrast, master gardeners and woodland landowners were of mixed opinions (Table 6).

Slightly more than one-half of conservation professionals expressed willingness to use results from risk assessment to guide land-management decisions (Table 4). When professional horticulturists were asked a similar question, a majority agreed or strongly agreed that they would be willing to use risk assessment in their businesses decisions (Table 4). Most professional horticulturists also expressed a willingness to conduct field trials on plants classified as "further analysis" by the models (Table 4). If a risk-assessment model rejected a plant, professional horticulturists agreed or strongly agreed that they would discontinue sale of that plant (Table 4). Not surprisingly, a slightly smaller percentage would do so if the plant had a high profit margin (Table 4). Master gardeners indicated that they would rather buy plants from a retailer who used risk assessment, and most would be willing to pay more for such plants (Table 4).

Acceptable Error Rates for Risk-Assessment Models. After explaining the concept of error rates, we then asked

https://doi.org/10.1614/IPSM-D-11-00067.1 Published online by Cambridge University Press

Table 4. Stakeholder responses to survey questions unique to each group on invasive plants and their management. Means and standard deviations (in parentheses following each mean) represent numerical coding of a five-point Likert scale: strongly disagree (1), disagree (2), unsure (3), agree (4), and strongly agree (5).

Group and survey question	Mean (SD)	Five-point Likert scale (%)				
		Strongly disagree	Disagree	Unsure	Agree	Strongly agree
Conservation professionals						
1. I am concerned that we have used invasive plants for management projects. (n = 130)	3.9 (1.0)	2.3	12.3	6.2	56.2	23.1
2. Other conservation or land management issues should take a higher priority than invasive species. (n = 130)	2.8 (0.9)	5.4	33.8	33.1	26.2	1.5
3. Managing invasive species is fighting a losing battle. (n = 130)	2.4 (0.8)	10.0	54.6	24.6	9.2	1.5
4. I am willing to use results from risk assessment to guide land management. (n = 130)	3.5 (0.8)	0.0	11.5	33.1	46.9	8.5
Master gardeners						
5. I'm concerned that I may have used invasive plants in my gardening. (n = 205)	2.7 (1.1)	9.8	45.4	13.2	29.3	2.4
6. I would rather buy plants from a retailer who has used risk assessment. (n = 201)	4.1 (0.7)	0.0	3.5	9.0	63.2	24.4
7. I would be willing to pay more for a plant sold by a retailer who has used risk assessment. (n = 200)	3.6 (0.9)	0.5	11.0	27.0	47.0	14.5
Professional horticulturists						
8. I am concerned that we have sold or cultivated invasive plants. (n = 60)	3.3 (1.1)	5.0	25.0	13.3	48.3	8.3
9. Introducing new and interesting plants is more important than worrying about if these plants will become invasive. (n = 60)	2.1 (0.9)	25.0	53.3	13.3	8.3	0.0
10. I am willing to use results from risk assessment in my business decisions. (n = 57)	3.8 (0.6)	0.0	1.8	22.8	68.4	7.0
11. I am willing to conduct field trials on plants classified as "further analysis." (n = 56)	3.4 (0.9)	1.8	21.4	19.6	53.6	3.6
12. If the risk assessment model rejected a plant, I would discontinue sale of it. (n = 56)	3.6 (0.9)	1.8	7.1	30.4	48.2	12.5
13. I would discontinue sale of a plant even if it had a high profit margin. (n = 55)	3.6 (0.8)	0.0	5.5	38.2	43.6	12.7
Woodland landowners						
14. I'm concerned about the impact of invasive plants on my own property. (n = 73)	4.3 (0.9)	1.4	4.1	5.5	38.4	50.7
15. It's my responsibility to deal with invasive plants on my property. (n = 72)	4.3 (0.7)	0.0	2.8	6.9	51.4	38.9
16. It would concern me if a plant was invading on property close to my own. (n = 57)	4.3 (0.5)	0.0	0.0	4.2	61.1	34.7

our stakeholders an open-ended question about the maximum error rates they would be willing to accept for both biologically significant and horticulturally limiting errors. Based on median values, respondents believed that biologically significant errors (which would allow the use of nonnative plants that might become invasive) in risk-assessment models should not exceed 5 to 10% (Figure 1). Conservation professionals were the least likely to accept high biologically significant error rates, and master gardeners were the most likely. Median values revealed a

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Table 5. Stakeholder responses to survey questions on invasive plant management. Means and standard deviations (in parentheses following each mean) represent numerical coding of a five-point Likert scale: strongly disagree (1), disagree (2), unsure (3), agree (4), and strongly agree (5).

		Five-point Likert scale (%)				
Survey question and group	Mean (SD)[a]	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. If a plant is invasive we should just let nature take its course and not interfere.						
Conservation professionals (n = 130)	1.5 (0.6) a	57.7	37.7	3.1	1.5	0.0
Master gardeners (n = 205)	1.6 (0.7) a	52.7	40.5	5.4	1.0	0.5
Professional horticulturists (n = 60)	2.0 (0.7) b	20.0	68.3	8.3	1.7	1.7
Woodland landowners (n = 73)	1.6 (0.7) a	52.1	39.7	6.8	0.0	1.4
2. We should only manage invasive plants if they cause trouble for people.						
Conservation professionals (n = 130)	1.6 (0.8) a	50.0	14.5	3.1	4.6	0.8
Master gardeners (n = 205)	1.8 (0.9) a	40.5	47.3	5.9	5.4	1.0
Professional horticulturists (n = 60)	2.2 (1.0) b	25.0	46.7	11.7	15.0	1.7
Woodland landowners (n = 73)	1.7 (0.7) a	43.8	47.9	5.5	2.7	0.0
3. We have a responsibility to help protect our natural areas from invasive plants.						
Conservation professionals (n = 130)	4.3 (1.0)	5.4	1.5	1.5	36.9	54.6
Master gardeners (n = 203)	4.1 (1.0)	6.9	1.5	4.9	46.1	40.7
Professional horticulturists (n = 60)	4.1 (0.8)	0.0	5.0	10.0	55.5	30.0
Woodland landowners (n = 74)	4.2 (0.9)	2.7	4.1	2.7	47.9	42.5
4. State laws or mandates should be passed to adequately manage invasive plants.						
Conservation professionals (n = 130)	3.8 (1.1) a	6.2	3.8	19.2	42.3	28.5
Master gardeners (n = 204)	3.7 (1.0) ab	3.4	7.8	29.8	38.0	21.0
Professional horticulturists (n = 60)	3.4 (1.0) b	3.3	18.3	25.0	41.7	11.7
Woodland landowners (n = 74)	3.6 (1.0) ab	1.4	13.7	30.1	37.0	17.8
5. Invasive plants should be managed on a voluntary basis.						
Conservation professionals (n = 130)	2.3 (1.0)	19.4	46.5	17.8	14.0	2.3
Master gardeners (n = 204)	2.4 (1.1)	19.0	40.5	19.0	18.5	2.9
Professional horticulturists (n = 60)	2.5 (1.1)	16.7	43.3	16.7	18.3	5.0
Woodland landowners (n = 74)	2.7 (1.2)	13.9	34.7	22.2	22.2	6.9

[a] Means followed by the same letter within a column for each question are not different at $P \leq 0.05$ according to Tukey's HSD. Means are not different unless noted.

somewhat greater acceptance for horticulturally limiting errors (which would prohibit the use of nonnative plants that were unlikely to become invasive) among respondents, who found error rates between 10 and 20% to be acceptable (Figure 1). Analysis of matched pairs for each error type offered further support of stakeholders' greater acceptance of horticulturally limiting errors than of biologically significant errors ($P < 0.001$). Mean differences between individual responses on these two items ranged from 4.3% for professional horticulturists to 18.7% for conservation professionals.

Nature Relatedness Scores and Relationships to Invasive Plant Perspectives. Overall, nature relatedness (NR) scores for all stakeholder groups were high ($\bar{x}$ = 4.0) and not significantly different from each other; only the NR–Experience subscale differed among groups (Table 7). Variance of NR scores was relatively low (0.41), with a narrow range of scores (2.9 to 5.0). Cronbach's α showed high inter-item consistency for overall NR score (range 0.82 to 0.85) and the subscales, although the low α for NR–Experience among professional horticulturists was an exception (Table 7).

Despite the relative uniformity of NR scores, correlation of overall NR scores to other survey questions differed in strength and significance among stakeholder groups. Correlations were weaker and generally less significant for woodland landowners than they were for the other three groups (Table 8). "In general, I don't see invasive plants as a problem" had moderate negative correlations to NR for

https://doi.org/10.1614/IPSM-D-11-00067.1 Published online by Cambridge University Press

Table 6. Stakeholder responses to survey questions on risk assessment as a management tool for invasive plants. Means and standard deviations (in parentheses following each mean) represent numerical coding of a five-point Likert scale: strongly disagree (1), disagree (2), unsure (3), agree (4), and strongly agree (5).

		Five-point Likert scale (%)				
Survey question and group	Mean (SD)[a]	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. I think risk assessment has the potential to prevent future plant invasions.						
Conservation professionals (n = 130)	3.7 (0.8) b	0.8	10.0	16.9	65.4	6.9
Master gardeners (n = 202)	4.0 (0.7) a	0.5	3.0	13.4	61.9	21.3
Professional horticulturists (n = 57)	3.8 (0.7) ab	1.8	3.5	14.0	71.9	8.8
Woodland landowners (n = 72)	3.8 (1.0) ab	5.6	2.8	15.3	54.2	22.2
2. I don't think we should use risk assessment.						
Conservation professionals (n = 130)	2.2 (0.7) a	12.3	58.5	21.1	6.2	0.0
Master gardeners (n = 201)	2.0 (0.7) b	21.4	58.7	17.4	2.5	0.0
Professional horticulturists (n = 56)	2.2 (0.7) ab	16.1	50.0	32.1	1.8	0.0
Woodland landowners (n = 72)	2.2 (0.7) ab	22.2	48.6	23.6	1.4	4.2
3. I am skeptical about how effective risk assessment could be.						
Conservation professionals (n = 130)	3.2 (0.9) a	3.1	24.6	26.2	43.8	2.3
Master gardeners (n = 200)	2.7 (1.0) b	8.0	44.0	23.5	23.5	1.0
Professional horticulturists (n = 57)	3.1 (1.0) a	3.5	26.3	24.6	43.9	1.8
Woodland landowners (n = 72)	3.0 (1.0) ab	5.6	34.7	22.2	33.3	4.2
4. I am concerned about the accuracy of risk assessment.						
Conservation professionals (n = 130)	3.5 (0.8) a	1.5	10.8	23.8	62.3	1.5
Master gardeners (n = 197)	3.0 (1.0) b	5.6	29.9	28.4	34.0	2.0
Professional horticulturists (n = 57)	3.4 (1.0) a	5.3	14.0	19.3	54.4	7.0
Woodland landowners (n = 72)	3.2 1(.0) ab	2.8	22.2	30.6	38.9	5.6

[a] Means followed by the same letter within a column for each question are not different at $P \leq 0.05$ according to Tukey's HSD.

both conservation professionals and professional horticulturists (Table 8). A hands-off approach to management also was negatively correlated with NR, most strongly for conservation professionals and master gardeners (Table 8). "I don't think we should use risk assessment" was negatively correlated with NR (Table 8). Acceptable error rates of both types were not correlated with NR except for master gardeners, where negative correlations were observed for both biologically significant and horticulturally limiting errors (Table 8). Managing plants only when they cause trouble for people was negatively correlated with NR scores; conversely, belief in responsibility to protect natural areas from invasive plants was positively and significantly correlated with NR for all stakeholder groups (Table 8). Positive correlations with NR for passing state laws and mandates to manage invasive plants were also significant across all stakeholder groups and mirrored by negative correlations to managing plants on a voluntary basis (Table 8).

Correlations of NR subscales to these questions, although not presented here, followed the same directions of the correlations based on the overall NR score. Correlations to subscales were weaker than for the overall NR score for both professional conservationists and master gardeners. In contrast, in three instances (questions 2, 3, and 6 in Table 8), professional horticulturists showed stronger correlations (in the −0.43 to −0.50 range) with NR–Perspective than with the overall NR score. Woodland landowners, whose correlations were weak and nonsignificant with overall NR score, drew more strongly from NR–Experience in five cases (questions 1, 2, 3, 4, and 7 in Table 8). The first three questions were significant when correlated to NR–Experience (strength −0.27 to −0.30), even though corresponding correlations with overall NR score were not.

Discussion

Our respondents had a good understanding of invasive plants and believed they are a problem. They also believed that we have a responsibility to manage invasive plants, both for human and nonhuman well-being. Respondents

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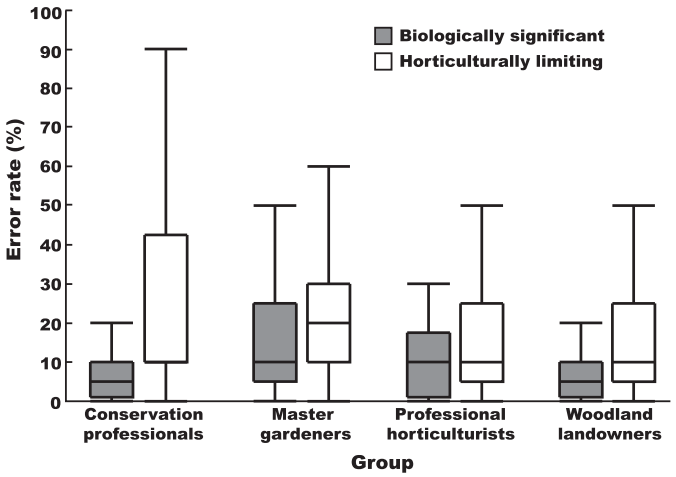

Figure 1. Box plots of maximum-tolerated biologically significant error rates and horticulturally limiting error rates for risk-assessment models as reported by four stakeholder groups. Median does not appear for conservation professionals because it is the same as the 1st quartile. Whiskers extend to outermost data point that falls within 1.5 times the interquartile range. Sample sizes are as follows: land managers (n = 94), master gardeners (n = 159), professional horticulturists (n = 33), and woodland landowners (n = 55).

supported use of risk-assessment models as a management approach for invasive plants, but had concerns about model accuracy. In particular, they showed greater concern about biologically significant errors than horticulturally limiting errors. Nature relatedness shaped individual perspectives on invasive plants as well. Overall, differences between groups were not as pronounced as we expected, indicating an opportunity for cooperation among these groups during risk analysis for invasive plants.

Stakeholder Perspectives on Invasive Plants and Their Management. Colton and Alpert (1998) concluded that public awareness and understanding of biological invasions by plants was poor, and Steele et al. (2006) found that only 34% of West Virginia woodland landowner respondents had heard or read information about invasive plants. However, more recently Daab and Flint (2010) reported 88% of the general public in Colorado had heard or read about invasive plants. Our respondents in Iowa were very aware of the term "invasive plant," and the majority also demonstrated comprehension of its meaning with their write-in answers. They rarely indicated misconceptions about invasive plants; for example, relatively few respondents perceived them to be the same thing as weeds (Table 3). The higher level of understanding and awareness among our stakeholder groups provides a stronger foundation for both informed opinions and discussion on the issue of invasive plants for risk analysis.

Respondents were in agreement that invasive plants are a problem. Our results resembled those of Daab and Flint's (2010) study of the general public in Colorado, who also agreed that invasive plants were a concern. Our stakeholder groups differed somewhat in how strongly they perceived invasive plants to be a problem. Nearly all conservation professionals disagreed or strongly disagreed with the statement "In general, I don't see invasive plants as a problem," but fewer master gardeners and professional horticulturists took this position (Table 3). Given that conservation professionals are more likely to wrestle with the negative consequences of invasive plants through their vocation, the differences between these groups were not surprising.

Other intriguing differences arose when concern about invasive plants was framed in a more group-specific manner (questions 1, 5, 8, 14, and 16 in Table 4). Both conservation professionals and woodland landowners confirmed their strong concern with these targeted questions, but this concordance was not observed for professional horticulturists or master gardeners (Table 4). For professional horticulturists, this might be in part because they feel confident they are already taking steps to minimize use of invasive plants. This is supported by Peters et al.'s (2006) study of professional horticulturists, where 89% of respondents preferred to direct customers to plants that were least likely to harm the environment. Most (78.3%) of our professional horticulturist respondents also did not believe that introducing new plants was more

Table 7. Mean nature relatedness (NR) scores of four stakeholder groups from a survey on invasive plants in Iowa. NR scores are based on a five-point Likert scale. High values represent high nature relatedness and low values represent low nature relatedness. Cronbach's α follows in parentheses.

		Nature relatedness subscales		
Stakeholder group	Overall NR score	NR–Self	NR–Perspective	NR–Experience[a]
Conservation professionals (n = 130)	4.1 (0.83)	4.0 (0.75)	3.9 (0.66)	4.4 (0.64) a
Master gardeners (n = 207)	4.0 (0.84)	4.1 (0.74)	4.0 (0.69)	4.1 (0.67) b
Professional horticulturists (n = 60)	4.0 (0.82)	4.0 (0.75)	3.8 (0.70)	4.2 (0.50) bc
Woodland landowners (n = 74)	4.1 (0.85)	4.1 (0.78)	3.9 (0.68)	4.4 (0.73) ac

[a] Means followed by the same letter are not different at $P \leq 0.05$ according to Tukey's HSD.

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Table 8. Correlations of overall nature relatedness (NR) scores to selected questions about attitudes regarding invasive plants and their management, by stakeholder group.

Survey Question	Overall NR score correlation (r)			
	Conservation professionals	Master gardeners	Professional horticulturists	Woodland landowners
1. In general, I don't see invasive plants as a problem.	−0.41***	−0.12	−0.47***	−0.11
2. If a plant is invasive we should just let nature take its course and not interfere.	−0.44***	−0.32***	−0.29*	−0.17
3. We should only manage plants if they cause trouble for people.	−0.48 ***	−0.34 ***	−0.34 **	−0.18
4. We have a responsibility to protect our natural areas from invasive plants.	0.44***	0.26***	0.44***	0.40***
5. State laws or mandates should be passed to adequately manage invasive plants.	0.26*	0.21**	0.36**	0.37**
6. Invasive plants should be managed on a voluntary basis.	−0.22*	−0.22**	−0.40**	−0.12
7. I don't think we should use risk assessment.	−0.21*	− 0.24***	−0.30*	−0.02
Biologically significant error	−0.02	−0.21**	−0.03	−0.03
Horticulturally limiting error	0.12	−0.26**	0.30	0.02

* Statistically significant at $P \leq 0.05$; ** Statistically significant at $P \leq 0.01$; *** Statistically significant at $P \leq 0.001$.

important than worrying about whether or not they were invasive (Table 4). Master gardeners may believe that plant suppliers are taking primary responsibility by not offering invasive plant selections, reducing concerns that they might have used invasive plants in their gardening. Alternatively, they might feel that because their own property is small, they can effectively remove any invasive plants or weeds they find, and thus do not contribute significantly to the problem.

Although there is a tendency to think of invasive plants as "bad" from a conservation standpoint, other stakeholders might value their benefits. Colton and Alpert (1998) observed that a majority of respondents had something good to say about them. Similarly, our respondents did not necessarily equate invasive plants with "bad" plants (Table 3). In a study by Bardsley and Edwards-Jones (2006) in the Mediterranean, nonecologists ranked the positive impacts of invasive plants more highly and recognized more of their benefits (relative to ecologists). The differences in our stakeholder groups parallel this, with conservation professionals more likely to equate invasive plant with "bad" than were master gardeners and professional horticulturists (Table 3). When working with horticulturists and gardening groups during risk management, it might be worthwhile to consider options that allow benefits from potentially invasive plant species while still minimizing their risks. One possibility could be to develop sterile cultivars of known invasive plants (Ranney 2006), an option that might be agreeable to invasive-savvy plant consumers (Kelley et al. 2006).

For management approaches, we did not find the differences in perspectives among stakeholder groups that we expected. Most respondents across groups believed that some action should be taken to manage invasive plants, and had a preference for state laws and mandates over voluntary programs (Table 5). Previous work by Peters et al. (2006) found that 43% of Minnesota Nursery and Landscape Association respondents preferred government regulation for invasive plants whereas 43.1% desired private or industry self-regulation (which resembles, but is not synonymous with voluntary management). Kelley et al. (2006) found Pennsylvania gardeners similarly nonreceptive to government regulation (only 41.3% supported it). Thus, we expected professional horticulturists and gardeners to favor voluntary regulation over state laws and mandates, but this was not the case for our respondents. There were no differences between groups on voluntary regulation, which was supported less than was the concept of state regulation by all stakeholder groups (Table 5). Given that professional horticulturists often have a personal economic stake in plant introductions, it is a good sign for future negotiations in the risk-analysis process that this group was more amenable to a regulatory approach than previous studies have suggested. Overall, stakeholder respondents in Iowa were receptive to the concept of using state laws and mandates to manage invasive plants, but enough of them were uncertain (26.3%) or in disagreement (12.8% disagreed or strongly disagreed) that it is important to engage them in dialogue about this aspect. While doing so, common points of agreement about invasive plant

management could be used to advance implementation of risk-assessment models. More specifically, because respondents strongly believed we have a responsibility to manage invasive plants both for human and nonhuman well-being (Table 5), this could be emphasized as a central objective with relatively little objection.

Stakeholder Perspectives on Risk-Assessment Models and Error Rates. Conservation professionals were more skeptical about the effectiveness of risk assessment than were other groups. Nearly two-thirds expressed concern about the accuracy of risk assessment. Because conservation professionals reported a much lower tolerance for biologically significant errors than for horticulturally limiting errors ($P < 0.0001$), the design of models that allow few or no invaders to pass through screening will be a critical element in obtaining support from this group. Master gardener respondents were the most optimistic group, but were still uncertain about the accuracy of risk-assessment models. Their mean response to "I am concerned about the accuracy of risk assessment" did not differ from "unsure" ($P = 0.66$), suggesting that master gardeners may not have enough information about risk-assessment models to have formed strong opinions. During risk analysis, more details about risk-assessment models and their strengths and weaknesses should be communicated to master gardeners. Professional horticulturist respondents held views that were intermediate between those of conservation professionals and master gardeners. Professional horticulturists did not differ in their acceptance of biologically significant and horticulturally limiting errors ($P = 0.38$). To meet the needs of this group of stakeholders, addressing horticulturally limiting errors will be as important as addressing biologically significant errors.

Some researchers have expressed concerns that risk-assessment models must have high classification rates (few "further analysis" results) because field trials are expensive and time-consuming for the nursery industry (White and Schwartz 1998). It is encouraging to see that a majority (57.2%) of professional horticulturists expressed willingness to conduct field trials on plants classified as "further analysis" by risk-assessment models (Table 4). In addition, public gardens and arboreta potentially could play an important role in this regard. Still, nearly one-fourth of professional horticulturists would be unwilling to conduct field trials, and we do not know the extent to which those who are willing could actually conduct meaningful long-term trials. Researchers developing risk-assessment models should still strive for good classification rates in light of this information.

It is also important to know if horticulturists would follow the suggested outcomes of risk-assessment models in terms of limiting sale of a potentially invasive plant. In the survey by Peters et al. (2006), 69% of Minnesota respondents agreed or strongly agreed that they would not sell a plant if they knew it had the potential to become invasive; 60.7% of our respondents did the same for a similar question, with slightly fewer agreeing if the plant had a high profit margin (Table 4). Although this is a good start, ideally this value would be much higher to ensure effective regulation because the implementation of risk-assessment models depends on the cooperation of nursery professionals who propagate and sell plants. If nursery professionals are hesitant to follow the results of risk-assessment, they might be encouraged to do so by master gardener respondents reporting that they would rather buy plants from a retailer who used risk assessment (Table 4). Many master gardeners also indicated they would be willing to pay more for plants that had gone through such screening, a finding similar to that of Kelley et al. (2006) among their "invasive-savvy" gardeners. However, it has been noted that although respondents indicate willingness to pay in surveys, their actual behavior might differ (Diamond and Hausman 1994).

Stakeholder opinions on error rates are of particular importance to researchers when developing risk-assessment models. Scientists typically set their own goals for model accuracy, but those of other stakeholders have been unknown. A meta-analysis of risk-assessment models, including and derived from the Australian Weed Risk Assessment (WRA), bore false negative rates (analogous to biologically significant error rates) of 0 to 12.7% and false positives (analogous to horticulturally limiting error rates) of 1.9 to 10.5% (Gordon et al. 2008). A study by Jefferson et al. (2004) in the Chicago region for the Australian WRA yielded biologically significant error rates of 0 to 17.5% and horticulturally limiting error rates of 2.5 to 35.5%. Other regional-scale models for woody invasive plants (which include systems derived from Reichard and Hamilton's (1997) decision tree), range from 2.5% to 9.7% for biologically significant error rates and 3.7% to 23.7% for horticulturally limiting error rates (Widrlechner et al. 2004, 2009).

Based on median values, our results show that a typical stakeholder would accept biologically significant error rates of 5 to 10% and horticulturally limiting error rates of 10 to 20% (Figure 1). Risk-assessment models currently available often meet those targets, because models have been designed to generate fewer biologically significant errors at the expense of increased horticulturally limiting errors. This tradeoff appears to be acceptable to many of our respondents, because individuals within all stakeholder groups usually reported higher acceptable values for horticulturally limiting errors than for biologically significant errors. Because risk analysis is a cooperative process, the needs of all key stakeholder groups should be considered when determining acceptable levels of risk in error rates. Fortunately, there were fewer differences than

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expected in acceptable error rates among these respondents. Although mean biologically significant error rates did follow the pattern we anticipated (conservation professionals and woodland landowners reported lower acceptable values), only master gardeners and conservation professionals differed from one another. Responses on horticulturally limiting error rates were not statistically different from each other. In some cases, lack of significance might be due to outliers or to error rates greater than 50% (probabilistically analogous to or worse than flipping a coin). Some outliers were due to respondents who likely misunderstood the question, but others could reflect respondents who were truly unconcerned about high error rates.

Relationships Between Nature Relatedness and Perspectives on Invasive Plants. Stakeholder groups did not differ in nature relatedness (NR) except for the NR–Experience subscale. It makes sense that conservation professionals rated most highly on this subscale (followed by woodland landowners), as NR–Experience expresses a person's physical familiarity and desire to interact with nature (Nisbet et al. 2009). Conservation professionals interact with nature for their living, and woodland landowners also have a high degree of contact with nature while managing their own private lands. Master gardeners displayed lower NR–Experience scores, possibly reflecting that, although they desire to experience nature, they do so in an avocational context (Table 7).

The relatively narrow range of NR scores was unexpected, but reveals an important characteristic about these stakeholder groups. Part of Nisbet et al.'s (2009) original study involved surveying federal and private executives in Canada. Their NR scores ranged from 2.1 to 4.9 with a median of 3.7 ($n = 145$). Our range of scores ran from 2.9 to 5.0 with an overall median of 4.1 ($n = 471$). This suggests that each stakeholder group represents relatively homogenous populations that are more connected to nature than might be found in other groups. If high NR scores are successfully linked to proenvironmental behaviors as Nisbet et al. (2009) suggested, strong correlations should be present across all these stakeholder groups between NR scores and perspectives on invasive plants.

We did see evidence of these correlations, and the directions they follow make intuitive sense. Where Nisbet et al. (2009) correlated NR scores to broader perspectives on the environment, such as membership in environmental organizations or self-identification as environmentalists, our correlations show that NR as a mental construct also might play a role in shaping environmental attitudes on specific issues. For example, we tailored a pair of questions specifically for comparison with NR scores: ''We should only manage plants if they cause trouble for people'' and ''We have a responsibility to protect our natural areas from invasive plants.'' We expected and found that the first item was negatively correlated with NR score, and the second, more ecocentric statement, was positively correlated with NR score (Table 8).

Although the directions of correlations were as expected, their strength and significance varied across stakeholder groups. Woodland landowner responses showed noticeably weaker correlations than did the other three groups, suggesting that their concern about invasive plants and their perspectives on management might be influenced more by other mental constructs or experiences. Given that correlations to NR–Experience were more significant for this group, woodland landowner's physical relatedness to nature might be more important than other aspects of the NR score. The other stakeholders' perspectives were better explained by their overall NR scores. Conservation professionals and professional horticulturists showed closer links between NR scores and perspectives on invasive plants. For these two groups, their livelihoods involve working with nature, which might account for closer connections. Those with a stronger sense of nature relatedness also might be inherently drawn to such professions.

Implications for Management. Stakeholder attitudes can shape what types of management are acceptable and affect management success. In the worst of cases, conflicting interests can create delays that result in failed control efforts, as occurred with a grey squirrel eradication project in Italy (Genovesi and Bertolino 2001). Management of invasive plants can be controversial, particularly if preemptive measures such as risk-assessment models are applied. Models that allow no new invasive plants into an area often also exclude nonnative plants that would have been innocuous; this creates a potential conflict between those who want to prevent new invaders from establishing (i.e., conservation professionals and woodland landowners) and those whose livelihoods or recreational activities focus on plant introduction (i.e., professional horticulturists and gardeners). However, responses from these different stakeholder groups revealed that differences in perspective regarding the implementation of risk-assessment models were not great. Respondents were united by a sense of relatedness to nature and have a responsible outlook on managing invasive plants. Their support of both risk-assessment models and the use of state laws to manage invasive plants suggest that many would also be receptive to routine screening of nonnative plants for invasiveness. Challenging work on the further details of effective policies remains, which will require additional refinement of risk-assessment models and further education of stakeholders. With a majority of stakeholders in agreement on the problem and possible solutions, preventive management efforts for invasive plants are likely to be more successful than they might be otherwise.

Acknowledgments

This research was supported by the USDA–ARS Floral and Nursery Research Initiative. We offer additional thanks to the following people for their assistance with this study: Philip Dixon and Cindy Yu (Department of Statistics, Iowa State University); Jennifer Bousselot and Cindy Haynes (Department of Horticulture, Iowa State University); Jesse Randall (Department of Natural Resource Ecology and Management, Iowa State University); and Joan O'Brien (Iowa Nursery and Landscape Association). We also thank Michael Dosmann, Jeff Iles, Lynne Westphal, and two anonymous reviewers for their constructive comments on this manuscript. Mention of commercial brand names does not constitute an endorsement of any product by the USDA or cooperating agencies.

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Received August 22, 2011, and approved January 30, 2012.