

Perspectives of New York Farmers, Aquarium Owners, and Water Gardeners on Invasive Species



David R. Lance, USDA APHIS PPQ, Bugwood.org

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EXECUTIVE SUMMARY

Invasive species have been proliferating in New York State for many years, despite the efforts of many organizations and state agencies. The general public, and also specific user groups, can help prevent the spread of invasive species. Understanding the level of awareness, knowledge, and concern about invasive species among the general public and the behaviors engaged in by specific stakeholder groups can guide educators and outreach coordinators as they develop programs to encourage people to behave in such a way as to prevent the spread of invasive species. This type of information has never been gathered before on a statewide basis in New York and can serve as a baseline against which future outreach efforts can be measured.

We expected many residents of New York to have little awareness of invasive species. Therefore, we conducted a three-part study with part one consisting of an initial screening survey to identify those with some level of awareness of invasive species. Part two was a follow-up survey of these individuals to measure their concern about invasive species, and their invasive species-related behaviors. This report details the results of the third part of this study, which included interviews of members of three key stakeholder groups conducted in the spring of 2015.

The specific objectives of this portion of the study were to characterize the experiences and perspectives related to invasive species of three key stakeholder groups: farmers, aquarium owners, and water gardeners. Each of these groups has the potential to influence the spread of invasive species in New York State.

Interview respondents were recruited from individuals who participated in the first two parts of the study. We recruited respondents by telephone, attempting to ensure that our sample was diverse with respect to geographic region of New York State and self-reported levels of knowledge about invasive species.

We conducted the interviews by telephone using an interview guide. The topics covered were:

- Concern about invasive species.
- Knowledge about invasive species.
- Behaviors that contribute to or limit the spread of invasive species.
- Willingness to change behavior to reduce the spread of invasive species.
- Types of messages or arguments most likely to encourage them to change their behaviors to limit the spread of invasive species.

Transcripts were analyzed using a process known as “coding,” an approach that is often used in qualitative data analysis (analysis of data that is in the form of words rather than numbers). During coding, interview transcripts are broken into segments (usually one to several sentences) and assigned to descriptive categories related to the topic of the response.

Farmers

Most of the 12 farmers we interviewed were concerned about invasive species in New York State, but were not particularly concerned about how invasive species affected their farms. Some

of them did not rely on the standard definition of invasive species, but thought of species that caused problems for them as invasive (e.g., deer and coyotes). Although most were aware of ways that people could spread invasive species (such as through moving firewood or not cleaning their boats), they did not think much about how their actions on their farm contributed to the spread of invasive species. Consequently, they did not take actions on their farms specifically to try to prevent the spread of invasive species. All expressed a willingness to change their behavior if they found out that their actions were leading to the spread of invasive species, but some noted that they would only change their behavior if it was to address an important invasive species concern and if they could reasonably change their behavior. Many turned to Cornell Cooperative Extension as a source of information when they were trying to address pest problems on their farms.

Aquarium Owners

All of the 12 aquarium owners kept fish in their aquaria, most of which had been purchased at pet stores. Their level of concern about invasive species varied. They expressed concern about a range of species, but aquatic invasive species, and zebra mussel in particular, were mentioned most frequently. Specific concerns had to do with the impacts of invasive species on properties and on aquatic recreation. Generally, they did not consider themselves knowledgeable about invasive species, but almost all were aware of ways that invasive species could spread – particularly through the movement of recreational boats and firewood. None were taking actions to try to prevent the spread of species from their aquaria; most did not think that spread was possible. All were willing to change their behavior to prevent the spread of invasive species, but only under certain conditions.

Water Gardeners

The water gardens described by our 11 respondents varied considerably in type from larger ponds to small pools. Almost all respondents, however, had added plants and/or fish to their water gardens. Their level of concern about invasive species varied widely, but the vast majority professed to having little knowledge about invasive species. Almost all were aware of ways that people could spread invasive species. The role of recreational boating in spreading invasives was most commonly recognized, and several individuals also realized that garden plants could be invasive. Most did not think about the potential to spread invasive species in their decision making about their water gardens, but some did. Two had released fish and/or plants from their water gardens into other bodies of water. All were willing to consider changing their behavior to prevent the spread of invasive species, but some recognized that their willingness was conditional and would be influenced by what they were asked to do.

Conclusions and Recommendations

Some commonalities emerged across the farmers, aquarium owners, and water gardeners that we interviewed. Many people in all three groups were at least somewhat concerned about invasive species, but few considered themselves knowledgeable about them. Farmers tended to be the most knowledgeable as a group. Some individuals in all three groups thought about invasive species differently than the way in which we defined them. In particular, some tended to view invasive species as problem species rather than necessarily non-native problem species.

The vast majority of interview respondents were aware of ways that people could spread invasive species. In particular, many knew that invasive species could be moved by recreational boats and somewhat fewer knew they could be spread in firewood, even though these behaviors were not necessarily relevant to the populations we were interviewing. They did not, however, tend to give much thought to whether their own behaviors as farmers, aquarium owners, and water gardeners might contribute to the spread of invasive species. In fact, that question seemed to be one that many interview respondents had not previously considered. Sometimes, on reflection, they concluded that taking steps to prevent the spread of invasive species was not relevant to them (because their farm was small, they never discarded live fish, etc.). On the other hand, some interview respondents, particularly among the water gardeners, reported engaging in behaviors that are discouraged because they could lead to the spread of invasive species.

There was a widespread willingness among respondents to consider changing behavior if the change had the potential to lead to the spread of invasive species. However, that willingness was conditional. Some respondents reported that they had to be convinced both that the behavior change would help to address an important problem and that it was feasible.

Based on these results, we make the following recommendations:

- Because many people are aware of invasive species prevention messages focused on recreational boating and moving firewood, it appears that these campaigns have been particularly effective at getting their message out. Outreach programs may, therefore, be able to turn to these programs for insights about how to reach other key stakeholder groups effectively.
- Given that many stakeholders were already somewhat concerned about invasive species, convincing them that invasive species are a problem may not be necessary. Rather, it may be important to communicate that particular actions that they can take: (a) can make a difference in invasive species prevention efforts; and (b) can be taken without undue hardship.
- Because some people think more about the species that they are having problems with than species that are considered invasive, it may be useful to frame some arguments about how to reduce problem species rather than non-native, problem species.

An important caveat in this research is that all of our interview respondents were at least somewhat aware of invasive species. Therefore, this group of farmers, aquarium owners, and water gardeners may have been somewhat more receptive to concerns about invasive species. In addition, while in-depth interviews are effective at capturing a range of perspectives and explaining the thinking underlying those perspectives, they are not effective at quantifying the characteristics of stakeholder populations. This gap could be filled with targeted surveys of specific stakeholder groups.

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INTRODUCTION

Invasive species, both aquatic and terrestrial, have been a concern in New York for a number of years. Following the 2005 report of the New York Invasive Species Task Force to the governor and legislature, a number of invasive species-related actions were taken. In 2007, Title 17 of the New York Environmental Conservation Law, the New York State Invasive Species Council Act, established the New York Invasive Species Council and an Invasive Species Advisory Committee to assess “the nature, scope and magnitude of the environmental, ecological, agricultural, economic, recreational, and social impacts caused by invasive species in the state” and to identify and coordinate actions to prevent, control, and manage invasive species. In 2008, the New York Invasive Species Clearinghouse was formed to provide an information clearinghouse. The iMapInvasives New York Program was formed to provide an on-line all-taxa invasive species database and mapping tool and integrate invasive species databases statewide. Eight Partnerships for Regional Invasive Species Management (PRISMs) were created to focus on regionally important invasive species concerns. The New York Invasive Species Research Institute was established. In late 2010, the Cornell Cooperative Extension Statewide Invasive Species Education Program (CCE ISP) was created. The Program's Mission is “to provide all New York stakeholders affected or potentially affected by (or influencing) invasive species with high quality science-based educational programs and cutting edge research-based information regarding invasive species of major concern to the State of New York” (<http://nyis.info/index.php?action=about>).

The Advisory Committee and the CCE ISP concluded that gaining an understanding of the public’s knowledge and perceptions of the threat posed by invasive species to New York was integral to the development and implementation of effective invasive species prevention, education, and management efforts, as well as for evaluating the success of the state’s legislative, regulatory, and education efforts to protect the state from further invasive species introductions. They perceived the need to collect data statewide on the level of awareness of New Yorkers about invasive species, what residents were currently doing that could impact the spread of invasive species (both positively and negatively), and how best to reach New Yorkers to encourage them to take action to prevent the spread of invasive species. They believed this information would be valuable as they and their partners worked to improve their prevention, outreach and management efforts. This type of information had never been gathered before on a statewide basis in New York, and could also serve as a baseline against which to measure future outreach efforts.

The Human Dimensions Research Unit (HDRU) at Cornell University has conducted numerous studies about the relationship between environmental awareness, concern and behavior. In relation to invasive species, the HDRU has completed a series of recent reports that have characterized outreach programs and other efforts to influence behaviors that could lead to the spread of invasive species (Connelly, Biedron, and Lauber 2014, Heck et al. 2013, Lauber et al. 2015a) and explored the invasive species-related awareness, concerns, and behaviors of key stakeholder groups, such as anglers, boaters, beachgoers, and bait dealers (Connelly and Knuth 2014, Connelly, Lauber, and Stedman 2014a, Connelly, Lauber, and Stedman 2014b, Evensen et al. 2013, Lauber et al. 2014).

The study reported herein links our knowledge about the relationships between awareness, concern, and behavior to a broader audience of New York State residents and a broader range of invasive species. We expected many residents of New York to have a low level of awareness of invasive species. Therefore, we conducted a three-part study: part one included an initial screening survey to identify those with some level of awareness of invasive species (Connelly et al. 2015); part two consisted of a more in-depth follow-up survey by web/mail of those who had some level of awareness (Lauber et al. 2015b); part three consisted of telephone interviews with members of key stakeholder groups.

This report details the results of part three, the interviews with stakeholders. The specific objectives of this portion of the study were to characterize the experiences and perspectives related to invasive species of three key stakeholder groups: farmers, aquarium owners, and water gardeners. Each of these groups has the potential to influence the spread of invasive species in New York State. Because they make up only a small proportion of New York State residents, we could not characterize them in our statewide survey of residents (Lauber et al. 2015b). Nor, going into the study, did we have extensive background knowledge about these groups. Consequently, we used in-depth interviews to characterize members of these groups.

METHODS

Data were collected through semi-structured, in-depth interviews. In-depth interviews are an effective method for capturing the range of experiences and perspectives of a population of interest. They cannot be used to quantify characteristics of a population, however, because the number of respondents is too small to make quantitative statements with any precision. Consequently, rather than selecting a representative sample of a population to be interviewed, researchers typically use sampling strategies that allow them to recruit a diverse sample that reflects most of the range of variation within the population. Such an approach allows identification of the most common characteristics of the population.

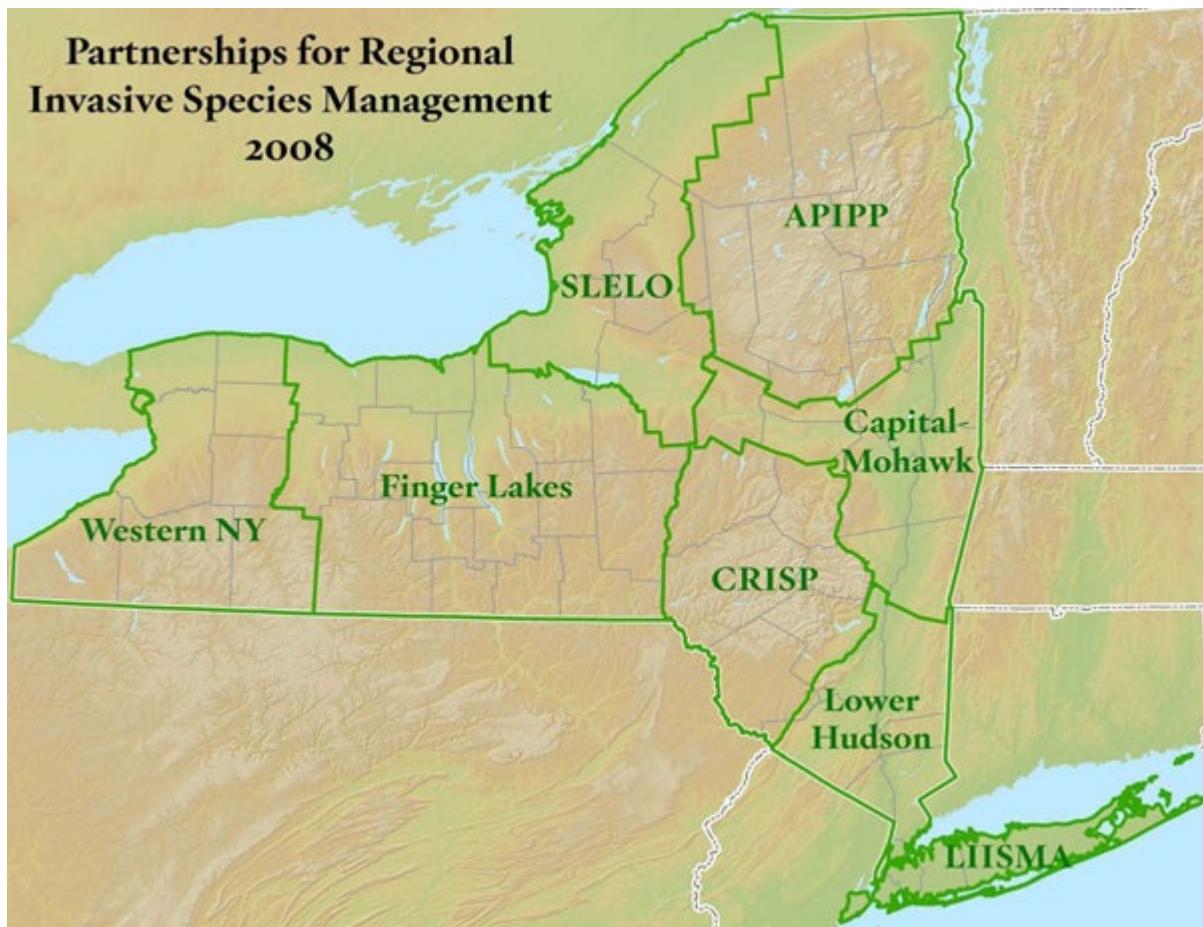
Sample Selection

Interview respondents were recruited from individuals who participated in a telephone screening survey (Connelly et al. 2015) and a follow-up web/mail survey (Lauber et al. 2015b) that took place in the fall and winter of 2014-2015. Survey respondents were told they would be contacted again, and only those who indicated willingness to be contacted again were included in the recruitment pool. Pools of potential respondents in each group of interest were identified based on the screening survey results in which they indicated whether they considered themselves farmers and whether they had an aquarium or water garden. We recruited respondents by telephone, attempting to ensure that our sample was diverse with respect to:

- Geographic regions of New York State; and
- Self-reported levels of knowledge about invasive species.

Geographic regions were based on eight PRISM regions described above and depicted in Figure 1. Several regions were grouped together including SLELO (St. Lawrence-Eastern Lake Ontario) and APIPP (Adirondacks), and Lower Hudson and CRISP (Catskills). Because some counties were not contained wholly within a PRISM region (e.g., Saratoga), the county and those

Figure 1. New York State PRISM boundaries.



surveyed within it were assigned to the geographic region which contained the majority of the population of that county (e.g., Saratoga respondents were placed in the Capital/Mohawk region).

All interview respondents were individuals who: (a) had completed our original telephone screening survey; (b) had at least a basic level of awareness of invasive species; and (c) had our follow-up survey. Individuals we judged to have a basic level of awareness of invasive species (74% of respondents) were those who had:

- Heard the term “invasive species” before; or
- Heard of non-native plants and animals that can cause harm to the environment, the economy, and society.

The sample for the original telephone screening survey was provided by the Marketing Systems Group. It was drawn from New York State telephone listings and also contained a cell phone sample. The sample was stratified by the six geographic regions we had identified for the study.

Interview Instrument

We conducted the interviews by telephone using an interview guide (Appendix A). The topics covered included:

- Concern about invasive species.
- Knowledge about invasive species.
- Behaviors that contribute to or limit the spread of invasive species.
- Willingness to change behavior to reduce the spread of invasive species.
- Types of messages or arguments likely to encourage them to change their behaviors to limit the spread of invasive species.

All interviews were audiorecorded and transcribed (except for several instances in which we did receive permission to record the conversations from the respondents or in which the recorder malfunctioned).

Analysis

Transcripts were analyzed using a process known as “coding” (Miles and Huberman 1994), an approach that is often used in qualitative data analysis (analysis of data that is in the form of words rather than numbers). During coding, interview transcripts are broken into segments (usually one to several sentences) and assigned to descriptive categories related to the topic of the response. Codes were used to characterize respondent:

- Concerns about invasive species;
- Level of knowledge about invasive species;
- Behaviors that could contribute to or limit the spread of invasive species;
- Willingness to change behavior; and
- Conditions under which individuals would be willing to change their behavior.

The coding process was carried out using the qualitative data analysis software ATLAS.ti Version 7.5.6 (Scientific Software Development 2002). The relevant segments of the document are selected and assigned codes (as described above). The software simplifies the process of retrieving and reviewing coded segments.

RESULTS AND DISCUSSION

Results are reported for each stakeholder group.

Farmers

Farmers we interviewed live throughout New York State, with the exception of the New York City-Long Island region (Table 1). Two-thirds of them live in the Lower Hudson-Catskills region and the Finger Lakes region. They reported a range of levels of knowledge about invasive species.

Table 1. Characteristics of farmers interviewed.

Region	Self-Reported Knowledge			Total
	Very Little	Something	A Lot	
NYC-LI	0	0	0	0
Lr. Hudson-				
Catskills	2	1	1	4
Capital-Mohawk	0	0	1	1
ADK/SLELO	1	0	0	1
Finger Lakes	1	2	1	4
Western NY	0	2	0	2
Total	4	5	3	12

The farmers we interviewed managed properties that varied in size from just a few acres to several hundred acres. Farmers planted a range of crops including corn, soybeans, wheat, vegetables, and berries. Some produced tree fruit, and others had woodlots (cherry, walnut, and maple) or grew Christmas trees. Several were livestock operations raising goats, alpacas, horses, sheep, and/or cows.

Concerns about Invasive Species

All farmers expressed at least some level of concern about invasive species. For example:

When things don't belong here it upsets the ecosystems, and when the balance is off it just backwashes onto everything sooner or later... I think everybody should be concerned. I am, even if I don't know about it, and it isn't something that targets me. In the long run it's going to impact me in some way, shape, or manner. (F-10)

Many, however, did not believe they personally had been affected by invasive species as farmers:

It's been a small thing for me, but it's not small for larger operations. (F-7)

Some were most concerned about impacts that invasive species could have on people other than farmers:

Maybe I should be more concerned as a farmer, and I know I would be if those two insects I mentioned earlier had affected me. I know I'd become concerned real fast ... I don't boat ... but I'm almost more concerned when I see what some of these other things have done to the boaters and our river. (F-6)

One was concerned, but fatalistic, making the point that little could be done to stop the arrival of invasive species:

I'm concerned about them, but how the heck are you ever going to stop them from coming in anyway? (F-3)

Another argued that more nuance was needed in the management of invasive species. She had strong concerns about some invasive species, but considered others beneficial:

We don't mind some species that other people might consider invasive... Some of these species that are considered invasive, like purple loosestrife, are wonderful bee plants. And you know as a beekeeper one concern I have is that we not poison our roadways to get rid of invasives because then the bees don't have the wild species. I've actually considered planting on the property ... the name's going to block me, it's a bush that is very invasive, it produces long white, long cascades of white blooms and it's considered an invasive bush in New York State. (F-5)

A wide variety of invasive species of concern were mentioned during the course of the interviews; some of these were species that would be of particular concern to farmers, while others were of more general concern. Several of these were agricultural insect pests, such as corn borer, spotted wing drosophila, and brown marmorated stink bug, although these were mentioned infrequently. A number of terrestrial plants that could pose problems were discussed, including multiflora rose, honeysuckle, giant hogweed, and buckthorn.

The emerald ash borer was mentioned by name or description more frequently than any other invasive species. Other insects mentioned included Japanese beetle and gypsy moths. Deer were identified as a problem species by a number of farmers, and one respondent explicitly described them as an invasive species. Several respondents referred to aquatic invasive species as being of concern, including zebra mussel, milfoil, water chestnut, loosestrife, and “flying carps” (i.e., silver carp).

Those who were concerned about the effects of invasive species on them personally generally referred to the spread of invasive plants:

It takes right over of you don't keep it cleaned out (F-1)

It just spreads like crazy (F-2)

A number of other non-invasive species of concern were discussed because of the impacts they could have on crops (geese, woodchucks, deer, etc.) or livestock (coyotes).

Knowledge of Invasive Species

With regard to their knowledge of invasive species, the farmers we interviewed fell into two groups. Some of them considered themselves to be more knowledgeable than most people, describing themselves as “above the average citizen, but maybe not too much above,” “pretty aware,” or “out of 10, I’d say 7.” Others viewed themselves as less knowledgeable: “minimally [knowledgeable],” “not enough [knowledge],” or “I don’t think I’m as good on invasive species as I am on just being able to identify trees, flowers.”

From their answers, however, it was clear that not every farmer defined invasive species the same way that we did (“non-native plants and animals that can cause harm to the environment, the economy, and society”). Some respondents thought of invasive species as including any species that spread rapidly or caused harm, not considering whether the species was native or non-native. In response to questions about invasive species, these individuals offered lengthy answers about various native plants and animals, such as coyotes:

Like with our livestock... there's nothing that we leave outside here at night... And I don't go for a walk unless I'm armed. I don't build a fence unless I'm armed. I don't pick berries unless I'm armed... Once they introduced the coyotes and they started standing their ground, I never rode without a saddle gun ever. (F-10)

Most (but not all) farmers were aware of at least some ways that invasive species could spread. The movement of firewood was discussed most frequently. Half of our respondents spoke of moving wood as one way that invasive species spread:

I think a lot of people are informed though about firewood and the problems with the emerald ash borer with firewood and other insects... If you've got firewood, you only want to use it locally or if it's been treated. (F-2)

We've cut almost all our ash out of our woods here now to try to get them out before it hits us and ... I know about the ban on firewood sales and movement. (F-6)

Most people I think are pretty well aware of the ash boring beetle and how that can be transferred pretty regularly by transferring firewood. (F-8)

Although the movement of equipment is particularly relevant for farmers, only two spoke of the movement of equipment or vehicles as a way that invasive species spread:

Our combines and big machinery ... he goes probably 40, 45 miles when he ends up planting crops. So, yeah, I imagine if he picked them up down here, he'd take them way ... up in there. (F-1)

I know they're spread by trucks. I know they're spread when they come from a different area. I also realize trucks should be washed down or brushed out. (F-11)

One of these respondents was particularly concerned with the role that hunters could play in spreading invasive species when they brought in their equipment from other areas:

These people come from out of state and they don't wash down their boots and yet I see them walking around... They come in with their trucks and ... four-wheelers. It scares the hell out of me, and they don't wash anything down. (F-11)

Farmers mentioned a number of other ways that invasive species could spread, too, with recreational boats being mentioned by several respondents. One respondent argued that farmers in general were concerned about invasive species being brought in with imports:

There's an impression out there at least in the ag sector... If you ask them how adequate are ... our borders with imports, they'd say 'Not at all. We're not good at it at all.' Now I don't know if that's true or not, but if it's true then ... somebody's got to bone up some funds to try to prevent some of the influx of whether it's insects or pests or whatever. (F-6)

Key Behaviors

We asked respondents whether they had procedures for cleaning their equipment when moving it around their property. Several said that they did:

Yeah ... at the end of every day or so, we power wash stuff and clean everything up and then go from there. (F-12)

Most did not, however. Respondents either argued that it was too time-consuming or that they did not believe it was needed on their property:

I know you're supposed to use bleach and things, but we don't have time for all of that so we do not have those procedures in place. (F-5)

Well, we probably should but we don't... I could suppose we might spread a few weed seeds but ... there's almost like a limited group of about 10 weeds that are all over the farm... So you tend to not care so much that you're moving a plow from one field to the other 'cause they've all got a little bit of those weeds in them. ... From one end of the farm to the other, you take the farthest end of a field in the farthest south part of the farm and head to the farthest field we work and the farthest end on the north end, you might go 3 miles... As the crow flies, probably closer to 2. (F-6)

Generally, farmers did not consider the potential to spread invasive species when they made decisions about farm operations. All, however, said they would be willing to consider changing their behavior if they found out their actions were leading to the spread of invasive species. But some pointed out that their willingness might depend on whether or not they considered the action reasonable and how bad they thought the invasive species problem was:

Respondent: *We would be very willing ... The only problem is that with the ragweed, which is huge here...I think we have contributed to the problem by bringing in organic compost. And so are we willing, would we be willing not to amend the soil with organic compost? The answer to that is probably, 'no.'*

Interviewer: *So it really depends on the circumstances it sounds like?*

Respondent: *It does. It does. (F-5)*

Yeah, I think so... You know that question is asked in a vacuum, and it's easy for me to reply in a vacuum and, yeah, I think we would. What it all boils down to is like how high up a hoop do I have to jump through and how bad is the pest. (F-6)

Sources of Information

Farmers identified several sources of information they turned to when they were having problems with pests on their farm. These sources could be useful channels for getting out information about invasive species prevention. Cornell Cooperative Extension was mentioned by half the farmers we interviewed – more than any other source of information. Three farmers turned to personal contacts, such as other farmers or people they worked with in the industry. The Soil and Water Conservation Service, Cornell University researchers, and the internet were also mentioned.

Summary

Most farmers we interviewed were concerned about invasive species in New York State, but were not particularly concerned about how invasive species affected their farms. Some of them did not rely on the standard definition of invasive species, but thought of species that caused problems for them as invasive. Although most were aware of ways that people could spread invasive species (such as through moving firewood or not cleaning their boats), they did not think much about how their actions on their farm contributed to the spread of invasive species. Consequently, they did not take actions on their farms specifically to try to prevent the spread of invasive species. All expressed a willingness to change their behavior if they found out that their actions were leading to the spread of invasive species, but some noted that they would only change their behavior if it was to address an important invasive species concern and if they could reasonably change their behavior. Many turned to Cornell Cooperative Extension as a source of information when they were trying to address pest problems on their farms.

Aquarium Owners

The aquarium owners we interviewed came from throughout New York State (Table 2). Three-quarters of them lived in Western New York, the Adirondack/St. Lawrence-Eastern Lake Ontario region, or the Finger Lakes. They reported a range of levels of knowledge about invasive species.

Almost all of our respondents kept fish of some type in their aquaria, although two primarily kept frogs. One person reported keeping snails, and only one reported having a plant in the aquarium. The types of fish mentioned were varied and included goldfish, tetras, cichlids, mollies, sucker fish, gourami, bettas, koi, and a type of algae eater from the catfish family. Three respondents were uncertain of all of the types of fish they had in their aquaria.

Many of the aquarium owners bought their fish at chain stores, including PetSmart, PetCo, and CountryMax. Others used locally owned pet stores.

Table 2. Characteristics of aquarium owners interviewed.

Region	Self-Reported Knowledge			Total
	Very Little	Something	A Lot	
NYC-LI	0	1	0	1
Lr. Hudson-Catskills	0	0	1	1
Capital-Mohawk	0	1	0	1
ADK/SLELO	1	1	1	3
Finger Lakes	2	0	0	2
Western NY	2	0	2	4
Total	5	3	4	12

Concerns about Invasive Species

Our respondents expressed a range of levels of concern about invasive species. Some described themselves as “very concerned” (AQ-4). Others said they were “not particularly concerned” (AQ-5). Still others expressed some ambivalence:

If they would do harm to my plants and things, and garden, then I suppose I would be concerned. (AQ-6)

When asked about invasive species, aquarium owners mentioned a variety of species that were of concern to them. Zebra mussels were mentioned more frequently than any other species – by nearly half of respondents. Other aquatic species referred to were northern snakehead, Asian carp, zebra snails, and viral hemorrhagic septicemia virus. Several respondents were particularly concerned about invasive forest insects and spoke of emerald ash borer or pine beetles. Terrestrial plants mentioned included bittersweet and milk thistle. One respondent was concerned about slugs.

Some of the aquarium owners who were concerned about invasive species expressed the types of concerns very generally:

The eco balance and the fresh water, I guess. (AQ-8)

Others mentioned specific concerns about their own properties:

I mean I worry about my hemlocks. I worry about my ash trees. I got a lot of ash trees. (AQ-7)

We have a farm and they [invasive plants] are everywhere. It's like impossible to kill them. And I mean they're on the lawn... It's horrible. (AQ-12)

Some expressed concerns about effects on recreational fisheries and other types of aquatic recreation:

[Northern snakehead] would be devastating because I think the fishery we have is phenomenal ... to have something come in and just tear it up. (AQ-4)

I think it's enough where it's changing the lake, and a lot of seaweed. People don't swim down the beach anymore ... so much stuff on the beach. (AQ-2)

Knowledge of Invasive Species

Most of the aquarium owners we interviewed did not consider themselves knowledgeable about invasive species:

I don't know anything... What I read in the paper. (AQ-2)

Several believed that they were somewhat knowledgeable:

I think I know more than the average person. (AQ-4)

Two had past professional roles that exposed them to information about invasive species. One had previously worked for the New York State Department of Environmental Conservation, and one was a retired newspaper reporter who had written about invasive species.

All but two were aware of at least some ways that invasive species could be spread. More than half of aquarium owners knew that invasive species could be spread by recreational boats if the boats were not cleaned:

If people are fishing like Candlewood Lake, and then maybe they'll go to the Hudson, and then back to Candlewood Lake. You know there's a possibility of transporting something that could have easily been taken care of if they maintained their boat properly and washed and cleaned the bilge and stuff like that. (AQ-4)

Three people recognized that invasive species could be spread by moving firewood.

I know that New York State has a ban on moving firewood more than 50 miles. (AQ-7)

Two mentioned that the transport of bait could move invasive species, and two referred to contaminated recreational equipment or clothing. Individuals also mentioned intentional release of invasive species, climate change, planting invasive plants, and the natural spread of invasive species.

Key Behaviors

Two-thirds of the interviewees said they had never been in the position of having to get rid of fish or other animals from their tanks for any reason. Those who had gotten rid of fish either

returned them to the pet store where they were purchased or gave them away to others. Nobody had ever released an animal from their aquarium outdoors except for one person who returned a crayfish to a creek where it had been caught.

Only one aquarium owner expressed a concern about spreading invasive species as a consideration when getting rid of aquarium animals:

The snails. They tell me to throw them down the drain. Or, you know, put them in toilet or something. And, no, because it's just going to go into the pipes that go somewhere else, and I don't know if that's good or bad. I think they're going to spread around, and I won't do it. (AQ-1)

Just one respondent indicated that they considered whether fish were invasive when deciding which fish to purchase:

I ask them about that because I don't want ... something that's going to deteriorate and I'm going to have to get rid of. (AQ-2)

Those who did not consider the potential of fish to become invasive when making a purchase, offered several reasons why: the pet store would not sell invasive species, aquarium fish would not survive in New York State waters, and they would never release the fish.

We've gotten them all from a pet store, so I guess it never crossed my mind. I assumed they were all fine and not an invasive species. (AQ-3)

I always considered them being tropical and therefore unlikely to survive up here. (AQ-7)

They're going to stay in my aquarium, and they're not going anywhere else. (AQ-9)

Every aquarium owner we interviewed said they would consider changing their behavior if they found out something they were doing were leading to the spread of invasive species. Their degree of willingness varied considerably, however, from “absolutely” to “I suppose so.”

Several offered qualifications to their responses indicating that their willingness would depend on the behavior change required, although they were often not specific:

As long as it's not going to inconvenience me too much. (AQ-1)

Depending on what. (AQ-9)

Sources of Information

Aquarium owners did not specifically discuss where they received information about invasive species, but almost all of them had contact with pet stores, particularly larger chains of pet stores. These stores were often referred to as sources of information about fish.

Summary

All of our respondents kept fish in their aquaria, most of which had been purchased at pet stores. Their level of concern about invasive species varied. They expressed concern about a range of species, but aquatic invasive species, and zebra mussels in particular, were mentioned most frequently. Specific concerns had to do with the impacts of invasive species on properties and on aquatic recreation. Generally, they did not consider themselves knowledgeable about invasive species, but almost all were aware of ways that invasive species could spread – particularly through the movement of recreational boats and firewood. None were taking actions to try to prevent the spread of species from their aquaria; most did not think that spread was possible. All were willing to change their behavior to prevent the spread of invasive species, but only under certain conditions.

Water Gardeners

The water gardeners who took part in our interviews lived throughout New York State (Table 3). About half of them lived in the New York City-Long Island and Lower Hudson-Catskills regions. Only one knew “a lot” about invasive species.

Table 3. Characteristics of water gardeners interviewed.

Region	Self-Reported Knowledge			Total
	Very Little	Something	A Lot	
NYC-LI	0	1	1	2
Lr. Hudson-Catskills	0	3	0	3
Capital-Mohawk	1	0	0	1
ADK/SLELO	1	0	0	1
Finger Lakes	0	1	0	1
Western NY	2	1	0	2
Total	4	6	1	11

The “water gardens” people described varied widely in type. Many were pre-existing ponds:

The one pond is about an acre and it is spring-fed. It's in fairly good condition... The other pond is a smaller pond that's about ¼ acre and it is totally separated from the acre pond, and it gets its water supply as the result of run-off from another pond. (WG-10)

Others were smaller constructed water gardens, which might have features like waterfalls:

There's kind of like two parts to it. Mostly it's a hole in the ground... And on the east side of it ... it's cut into a mound flower garden. And it's a bunch of rocks, and we've got a pump and a little waterfall. (WG-3)

Some considered wetland areas to be part of their water gardens:

There are several vernal ponds and we also have some boggy areas that we're trying to put suitable plants into. (WG-2)

Almost all respondents planted at least some plants in their water gardens. (The two who did not just managed the plants that were already there.) The number of plants they added to these areas varied considerably, however:

Basically I have 3 water lilies that are in it. (WG-1)

We planted willow sticks along the stream bank and also on a hillside that's too wet, and we've been trying to stabilize it because it's eroding. I have a boggy area where I've got a couple of varieties of blueberries that are supposed to like boggy areas. I've got a dogwood ... some perennials that were rumored to like boggy areas... We have a lot of wet areas we planted some Juneberry this year and some chokeberries... And previously we had gotten something like 100 bayberry plants from DEC that are doing well on the same wet eroding hillside... For the past six years now turtleheads I think are doing well in wet areas. (WG-2)

Seven respondents planted water lilies. The other types of plants planted were only mentioned by one or two respondents each. They included willow, blueberries, dogwood, Juneberry, chokeberry, turtleheads, cattails, marsh marigold, iris, and grasses. Local nurseries and online garden supply stores were the most common source of plants, but water gardeners also got plants from their friends, local lakes, and the New York State Department of Environmental Conservation.

Six people added fish to their water gardens, and a seventh maintained a pond that already had fish in it. Various types of goldfish (comets, shubunkins, and koi) were the fish most frequently added. Bass, catfish, and grass carp were also mentioned. The fish were obtained from Walmart, K-Mart, Syracuse Aquarium and Pond Supply, and a local fish hatchery.

Many of the water gardens were self-contained; only three were connected to other bodies of water. These water gardens drained into the ocean, a stream, or a culvert.

There's a metal corrugated iron tube that takes the overflow under the road and into the Batavia Kill across the street. (WG-6)

The larger pond, the one acre pond, has a spillway but the run-off is very, very small. And depending on the amount of precipitation and water coming from the springs themselves, there is very often no run-off... The other pond, it generally runs but ... it's minimal, you know. It's not a fast flowing water at all, it just dribbles out... It's running down the Hudson somewhere but ... I couldn't even call it a stream ... maybe a culvert? (WG-10)

Concerns about Invasive Species

The level of concern about invasive species varied considerably among the water gardeners with whom we spoke. Several individuals described themselves as “very” or “quite” concerned. Others described themselves as at least somewhat concerned, but with qualifications:

I'm concerned but there seems to be ... different degrees of invasiveness. I mean there seem to be things that are like more aggressive or more harmful than others... And you know there are other things that don't seem to be bothering anybody too much. (WG-2)

I am concerned about it, but I think that some people go overboard... I tend ... to look at things from a very broad view. Like, was it a species that was here a long, long time ago or not? And that's kind of the nature of things, that things come and go. So I am not a person who won't have things in my garden if they look pretty. (WG-11)

I think not really concerned. I only have a little place here. I don't know. We battle them in Germany all the time, too. I mean, it's not that ... I absolutely don't care, but I don't go spastic over it. (WG-7)

Several others were not concerned at all, or even thought invasive species could have positive effects:

I have a little problem dealing, talking about invasive species because I have an acre of land that's covered with invasive species that are from this area... I have to say it's not that big an issue for me. (WG-5)

The zebra mussel, in my opinion, did some good... It actually has done a couple of things. It's increased the size of our sporting fish, and it has cleaned up the river... So was that a negative thing? I don't know. I guess it remains to be seen. (WG-4)

Numerous specific invasive species were mentioned over the course of the interviews, with none mentioned substantially more often than others. Terrestrial plants were mentioned most frequently, and these included bamboo, garlic mustard, Asiatic bittersweet, multiflora rose, dandelions, giant hogweed, honeysuckle, Himalayan impatiens, Japanese barberry, and Japanese knotweed. Aquatic and wetland species noted were zebra mussel, water chestnut, water hyacinth, water meal, purple loosestrife, “jumping carp,” and mute swans. Other species included earthworms, killer bees, wild boar, and emerald ash borer.

Several individuals raised specific concerns about invasive species impacts. Some were general concerns about environmental damage:

Nobody wants to see any of our environment threatened by anything. So I certainly have a healthy respect for the need to be aware and to control where at all possible. (WG-4)

When more specific concerns were mentioned, they typically had to do with displacing and/or killing native terrestrial plants:

You can't even walk through that area... Obviously they're taking away the spaces that our natives live in. That's not a good thing 'cause you lose them. (WG-5)

I really think that [Asiatic bittersweet] will take down the forests within like probably twenty years... It's terrible. It just climbs up on the trees and it kills them. (WG-8)

One person discussed concerns specific to zebra mussels:

We were concerned about the impact of the zebra mussels on things like engine intake, water intakes and that kind of thing. But that has turned out to be less of a problem. I think right now we got bodies washing up, shells washing up on the beach. (WG-3)

Knowledge of Invasive Species

Almost all of the water gardeners we interviewed professed to having little knowledge about invasive species. Some of their comments reflected differences with some of the conventional understanding of invasive species. One questioned whether the emerald ash borer was really an invasive species:

There's a lot of things like the ash beetle ... you wonder if it isn't by design of Mother Nature. That eventually something comes along that creates a demise for one species or another. So you just don't know. Now would you consider the ash beetle an invasive species? Well, I wouldn't... It's there in nature. I don't think it was brought from another environment. I think it just made its way to this area. (WG-4)

Another did not consider invasive species as being solely non-native species:

Some of our own native species are just as invasive as anything else. (WG-5)

Two individuals considered themselves somewhat knowledgeable about invasive species. One of these, however, argued that the *overall* state of knowledge about invasive species was fairly low:

I was going to say I don't know enough. Much of what I read is so contradictory it's hard to know exactly what to be concerned about and how much to be concerned.... I mean I've been doing a lot of reading on the subject in the last couple of years, and I don't feel like it's just that I personally am missing the information. I feel like not enough is known, that there ... doesn't seem to be a real consensus in the scientific community. There seems to be a lot of debate and missing knowledge there. So it's not like I could just you know go out and read a pamphlet or something and be informed. (WG-2)

All but one respondent could name at least one way that invasive species could spread. Recreational boating and angling was mentioned most frequently – by more than half of the water gardeners:

My husband and I go kayaking, and I'm aware that you can easily pollute different waterways. And we always disinfect it, you know we wipe our kayaks all down and clean them all out inside and out. (WG-8)

Three individuals noted that some common garden plants could be invasive:

One of the things that I just saw recently is there was an ad ... where they were talking about getting all these wildflower seeds. Add color to your yard and things like that. They have a lot of these invasive species plants that are in there. (WG-1)

Two respondents were aware that moving firewood could spread invasive species, and two were aware that commercial shipping could play a role.

One referred to individuals dumping out their aquaria as a way that invasive species could be introduced:

Here in the town they just finished a project of clearing out the main pond... Somebody told me, now this is hearsay... that this was something that came from somebody's fish tank years ago... The story as it goes, and I don't know if it's true or not, one of the neighbors down the road had some sort of tropical fish from down south and she was moving and the fish died or something and she got rid of everything into the big pond. (WG-1)

Individuals also referred to excessive deer pressure, the release of exotic pets, and imported goods as ways that invasive species could spread.

Key Behaviors

Many respondents said they did not think about the potential invasiveness of plants and fish when deciding what to include in their water garden:

I don't know as I can't honestly say I've thought about that. (WG-4)

However, several did explicitly consider invasiveness:

Well, I know I checked out before I put the water lilies in. I made sure that they would be all right and the guy at the garden center told me that these particular ones do not spread that far. (WG-1)

Well we're favoring native species but not exclusively... I mean we're trying to avoid things that are regarded as invasive obviously. (WG-2)

Yeah, the grass carp that I put in...the hatchery that I get them from ... they can't reproduce. (WG-9)

Most respondents had not been in the position of wanting to get rid of plants or animals from their water garden. Those who were often simply pulled the plants. One, who was currently interested in getting rid of some fish, recognized the importance of not releasing the fish elsewhere:

Right now I have, I'm going to have to find something to do with 14 fish in a 1,000 gallon pond... I'm not going to take them and throw them some place where ... "Gee, maybe they'll live in here." ... I would never do that. (WG-5)

Two, however, described themselves as having released fish and/or plants in local bodies of water:

We have a stream in back of the house. And I had, not goldfish ... something like a goldfish... I shouldn't have more than 5 in my little pond, and I let them go in the river... in the stream I should say. (WG-7)

If I have too many water lilies I chuck them in ... a large lake, it's ... right in the City of Syracuse. It's where a brook is kind of dammed up and makes a scenic area... If I need to get rid of [fish], I put those in that same place. (WG-11)

Every individual we spoke with said they would be willing to consider changing their behavior if they found out something they were doing was leading to the spread of invasive species. Some recognized that their willingness would be influenced by exactly how they were asked to change their behavior:

If they told me how to knock my house down ... I guess it would depend, but if I could help I most certainly would. (WG-6)

One also noted that she would trust in part to her personal experience and not just rely on what she was told by others:

Let's say a certain iris was invasive and I knew, I've been in my same place for like 40 years, and if I knew that that little clump that I have was just about the same as it was 10 years ago, I probably would not lend a lot of credence to getting rid of it as an invasive species if it hadn't acted that way in my garden. (WG-11)

Sources of Information

Water gardeners did not specifically discuss where they received information about invasive species, but most had contact either with on-line or local garden supply stores (for purchasing plants) or with stores that sold fish. The stores from which they bought fish varied from larger retailers like K-Mart and Walmart to local aquarium stores. These retailers are potential sources of information for water gardeners.

Summary

The water gardens described by our respondents varied considerably in type from larger ponds to small pools. Almost all respondents, however, had added plants and/or fish to their water gardens. Their level of concern about invasive species varied widely, but the vast majority professed to having little knowledge about invasive species. Almost all were aware of ways that people could spread invasive species. The role of recreational boating in spreading invasives was most commonly recognized, and several individuals also realized that garden plants could be invasive. Most did not think about the potential to spread invasive species in their decision making about their water gardens, but some did. Two had released fish and/or plants from their water gardens into other bodies of water. All were willing to consider changing their behavior to prevent the spread of invasive species, but some recognized that their willingness was conditional and would be influenced by what they were asked to do.

CONCLUSIONS AND RECOMMENDATIONS

Some commonalities emerged across the farmers, aquarium owners, and water gardeners that we interviewed. Across all three groups, many people were at least somewhat concerned about invasive species, but few considered themselves knowledgeable about them. Farmers tended to perceive themselves as more knowledgeable than did other interviewees. In all three groups, some individuals thought about invasive species differently than the way in which we defined them. In particular, some tended to view invasive species as problem species rather than necessarily non-native problem species.

The vast majority of interview respondents were aware of ways that people could spread invasive species. In particular, many knew that invasive species could be moved by recreational boats and somewhat fewer knew they could be spread in firewood, even though these behaviors were not necessarily relevant to the populations we were interviewing. They did not, however, tend to give much thought to whether their own behaviors as farmers, aquarium owners, and water gardeners might contribute to the spread of invasive species. In fact, that question seemed to be one that many interview respondents had not previously considered. Sometimes, on reflection, they concluded that taking steps to prevent the spread of invasive species was not relevant to them (because their farm was small, they never discarded live fish, etc.). On the other hand, some interview respondents, particularly among the water gardeners, reported behaviors that are discouraged because they could lead to the spread of invasive species.

There was a widespread willingness among respondents to consider changing behavior if the change had the potential to lead to the spread of invasive species. However, that willingness was conditional. Some respondents reported that they had to be convinced both that the behavior change would help to address an important problem and that it was feasible.

Based on these results, we make the following recommendations:

- Because many people are aware of invasive species prevention messages focused on recreational boating and moving firewood, it appears that these campaigns have been

particular effective at getting their message out. Outreach programs may, therefore, be able to turn to these programs for insights about how to reach other key stakeholder groups effectively.

- Given that many stakeholders were already somewhat concerned about invasive species, convincing them that invasive species are a problem may not be necessary. Rather, it may be important to communicate that particular actions that they can take: (a) can make a difference in invasive species prevention efforts; and (b) can be taken without undue hardship.
- Because some people think more about the species that they are having problems with than species that are considered invasive, it may be useful to frame some arguments about how to reduce problem species rather than non-native, problem species.

An important caveat in this research is that all of our interview respondents were at least aware of what invasive species were. Therefore, this group of farmers, aquarium owners, and water gardeners may have been somewhat more receptive to concerns about invasive species. In addition, while in-depth interviews are effective at capturing a range of perspectives and explaining the thinking underlying those perspectives, they are not effective at quantifying the characteristics of stakeholder populations. This gap could be filled with targeted surveys of specific stakeholder groups.

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APPENDIX A: INTERVIEW INSTRUMENT

Consent? Agree to be interviewed? Agree to have the interview recorded?

Questions? Are there any questions before we get started?

- We're interviewing New Yorkers about invasive species. We contacted you because you responded to a phone survey about invasive species in the fall and then a web/mail survey in January. We're particularly interested in talking to [farmers and nursery stock growers/people who own aquariums/people who have water gardens] because sometimes they have special concerns or questions about invasive species. We'd like to ask you a few questions about [your farm [or] nursery stock/your aquariums/your water gardens] and we also have some questions about invasive species.
 - *Aquarium owners:*
 - Do you have an aquarium in your house?
 - What kinds of plants do you have in your aquarium?
 - What kinds of animals do you have in your aquarium?
 - Where do you get the plants and animals for your aquarium?
 - How do you make a decision about what types of plants and animals to include in your aquarium?
 - How do you get rid of plants and animals you no longer want?
 - How often do you “free” plants or animals from your aquarium by releasing them in a local body of water?
 - *Water gardeners:*
 - Do you have a water garden?
 - What kinds of plants do you have in your water garden?
 - What kinds of animals do you have in your water garden?
 - Where do you get the plants and animals for your water garden?
 - How do you make a decision about what types of plants and animals to include in your water garden?
 - How do you get rid of plants and animals you no longer want?
 - Are there any outlets from your water garden? Where does the water go?
 - *Farmers/Nursery stock growers:*
 - Do you work as a farmer or nursery stock grower?
 - What kind of farming do you do?/What kind of nursery stock do you grow?
 - What kinds of crops or plants do you grow?
 - What kinds of problems do you have with unwanted plants? What specific plants cause you problems?
 - What kinds of problems do you have with unwanted insects? What specific insects cause you problems?
 - When you move your equipment from one part of your farm/nursery stock operation to another, do you ever clean it off first?
 - If you were having problems with specific plants or insects, who would you contact for information?

- How concerned are you about having invasive species in New York State? [If necessary, say: Invasive species are non-native plants and animals that can cause harm to the environment, the economy, and society.]
 - How concerned are you about invasive species compared to other problems that New York State faces?
 - What kinds of effects of invasive species are you most concerned about?
 - What particular invasive species are you most concerned about?
- How much would you say you know about invasive species?
 - What do you think contributes most to the spread of invasive species in New York State?
 - What kinds of activities that *individuals* get involved in do you think contribute most to the spread of invasive species in New York State?
- *Aquarium owners:*
 - How much do you think about the invasiveness of plants and animals when you make decisions about what to include in your aquarium?
 - How much do you think about the invasiveness of plants and animals when you make decisions about how to dispose of plants and animals from your aquarium?
- *Water gardeners:*
 - How much do you think about the invasiveness of plants and animals when you make decisions about what to include in your water garden?
 - How much do you think about the invasiveness of plants and animals when you make decisions about how to dispose of plants and animals from your water garden?
 - In the way you've designed your water garden, how much have you considered trying to make sure that plants don't escape from your water garden into natural waterways?
- *Farmers/nursery stock growers:*
 - How aware are you of which plants and insects on your farm/nursery stock operation are invasive?
 - How much do you think about the invasiveness of plants and insects that might be on your farm/nursery stock operation when you make decisions about how to manage your farm/nursery stock operation?
 - *Nursery stock growers only:* How much do you think about whether plants are native or non-native when you make decisions about which kinds of plants you will raise and sell?
- If you found out that some of the things you were doing were contributing to the spread of invasive species in New York State, how willing would you be to change your behavior?
- Under what conditions would you be willing to change your behavior?
 - What kinds of information might convince you that changing your behavior was important?
- Those are all the questions I have for you. Is there anything we haven't talked about that you think is important for me to know?
- Thank you!!