

A survey of hydrilla management educational materials for optimal stakeholder preference, learning, and knowledge transfer in Florida

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ABSTRACT

Delivering scientific content to user groups with diverse backgrounds can be challenging. In the case of invasive species management, it is essential to educate and involve the community to prevent reintroductions and spread, but also so that they understand management efforts. The goal of this study was to determine the most effective way to communicate with our stakeholders so that they would be more engaged as ambassadors to their communities. We targeted a wide audience through four channels to deliver educational materials on the topic of hydrilla integrated pest management and followed with a Qualtrics-based survey. Our stakeholders found educational materials, including the comprehensive book, summarized booklet, and website, more useful than promotional materials. Based on survey results, the book was the most likely to change the way people felt about hydrilla management. However, information from the tri-fold brochure was more likely to be shared and was shared with the most people when compared with other distributed educational materials. Therefore, depending on the goal of the educational program, using targeted materials for individual goals might be most effective.

Key words: biological control, citizen science, education, IPM, outreach, training.

INTRODUCTION

Delivering scientific content to different user groups with diverse backgrounds can be challenging. In the case of invasive species management, it is essential to educate and involve the community to ensure prevention of reintroductions and spread. Surveillance for invasive plants, particularly in the early phases of an infestation, is labor intensive and cost prohibitive. Because of the economic benefits of early detection, it is justifiable to invest in surveillance in order to identify problem areas before the populations increase in number or spread in area (Mehta et al. 2007). Involving the community in protecting their surrounding environment is not only cost efficient and operationally effective (Jordan et al. 2014), but also promotes a sense of

pride in the community that results in increased social connectedness, well-being, and participation in other activities that benefit the environment.

Hydrilla verticillata, or hydrilla, is an invasive nonnative freshwater plant that causes annual impacts on the U.S. economy of greater than US \$120 billion (Pimentel et al. 2005). This impact is largely due to its growth pattern. A rooted submersed macrophyte, hydrilla grows up through the water column and then branches at the surface, forming “mats” (Langeland 1996). These mats impact recreational use of waterways for boating, swimming, and angling, as well as impeding the proper use of irrigation canals (Coetzee et al. 2009). Furthermore, the ecological impacts of hydrilla, which are related to its ability to grow in a wide range of conditions and reproduce through multiple mechanisms, allow it to outcompete native plants, resulting in unmeasurable costs to the environment.

The effects of aquatic invasive species, such as hydrilla, can impact a diverse set of stakeholders from homeowners to natural-resource land managers to businesses that support ecotourism. The priorities and concerns of these stakeholders also vary. For example, anglers and duck hunters like waterbodies with hydrilla, as the dense plant material provides a suitable habitat for some sport fishes and attracts some game duck species. In contrast, swimmers and boaters do not appreciate the mats of hydrilla that become tangled in legs and boat propellers. Homeowners and natural-resource managers typically do not like hydrilla because of its growth patterns and invasive qualities, but are also highly concerned about management efforts and the impact on the environment. Therefore, the community needs to be educated on the pros and cons of management efforts, and the management process needs to be as transparent as possible.

The predominant means of invasive nonnative species introduction is through human action (Dolan et al. 2015). Therefore, it is important to involve the community by aligning invasive species management plans with community priorities, ensuring their education to reduce or prevent reinvasions or spread, and utilizing interested participants in management efforts either for direct physical management or positive communication to others. Citizen science, the collaboration of professional scientists with members of the public to complete research objectives, is not considered to be community driven (Dolan et al. 2015). Despite this, the benefits of citizen-scientist engagement extend far beyond data collection, as its participants are members of a community and they often act as strong

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advocates for science-based changes to ecological practices within their home communities (Jordan et al. 2014).

Earlier surveys (Gillett-Kaufman et al. 2014a) provided a framework for programmatic material development and delivery mechanisms to stakeholders for maximum impact. Survey results showed primary user groups wanted material that was accessible online and that provided regular science-based updates. We also found some users were more interested in printed materials. To satisfy both needs we developed several online and print-based deliverables.

Different learning styles and user groups can make delivery of scientific material challenging, even for seasoned professionals who work extensively with the public. Understanding user motivations can help professionals get new information distributed in a timely way. It has been reported that citizen-scientist volunteers do not value rewards as much as they value the communication of programmatic results (Alender 2016). With this in mind we hoped to share our scientific results with our stakeholders, including the Florida LAKEWATCH citizen scientists (volunteer water quality monitoring program; Hoyer et al. 2014), water body managers, aquatic pesticide applicators, and waterfront homeowners through multiple information channels and media and evaluate each for its ability to inform and change perceptions.

The goal of this study was to determine the most effective way to communicate with citizen scientists so that they would be more engaged as ambassadors to their communities. We targeted a wide stakeholder audience to deliver training on hydrilla integrated pest management and remind water body visitors about the importance of minimizing the spread of invasive species to new locations. The objective of this study was to evaluate educational materials to determine which materials were perceived to be more useful, were more likely to change perceptions, and would result in greater transfer of knowledge.

MATERIALS AND METHODS

Distribution of materials

Using the results of the initial needs assessment survey (Gillett-Kaufman et al. 2014a) and based on the preferred information channels of the survey participants (Figure 1), we established a website including learning lessons and a newsletter archive (<http://entomology.ifas.ufl.edu/hydrilla>; Figure 2). In addition, we prepared educational (brochures, booklets, and books) and promotional (fishing rulers, bookmarks, and Web cards) materials and distributed them throughout the state and on the website when possible (posted online as PDFs, Figure 2).

Survey distribution

Following the distribution of our educational materials, we prepared a survey to evaluate the opinions of our stakeholders about the educational (website, newsletter, brochures, booklets, and books) and promotional materials produced (fishing rulers and bookmarks). The survey was evaluated and exempted by the University of Florida Institutional Review Board (UF IRB) and deemed appropriate for distribution (UF IRB Exemption 2014-U-1209). Stakeholders identified through an interest in educational materials were contacted and asked to complete the survey; these included University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Florida LAKEWATCH, the UF/IFAS Center for Aquatic Invasive Plants (CAIP) LISTSERV, UF/IFAS Extension faculty, and the Florida Lake Management Society (FLMS). The entirety of the UF/IFAS Florida LAKEWATCH LISTSERV, who are current or previous lake-monitoring volunteers (citizen scientists who are typically lakefront homeowners and recreational users of lakes), received the link to complete the survey, as our educational materials are distributed at all 16 annual

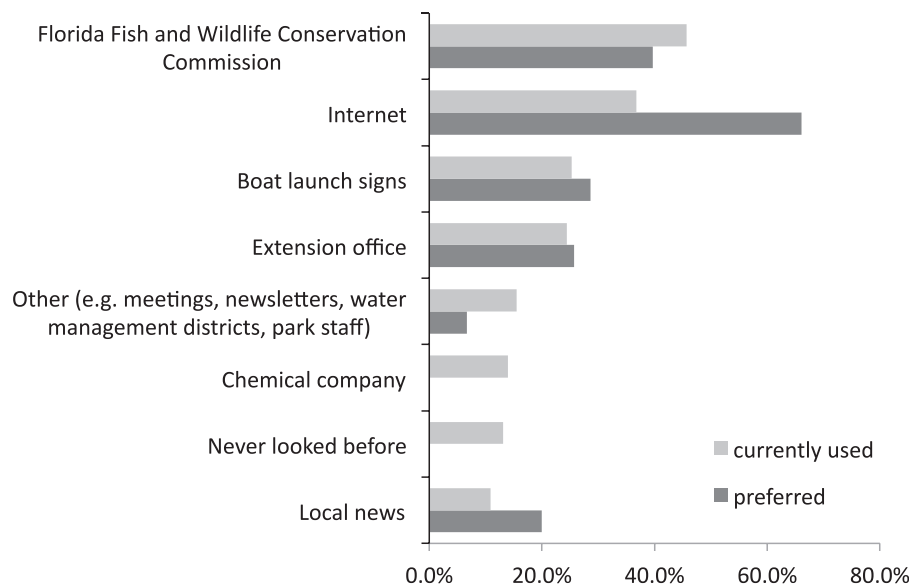


Figure 1. Comparison of currently used and preferred information channels as reported by survey respondents (Gillett-Kaufman et al. 2014a).

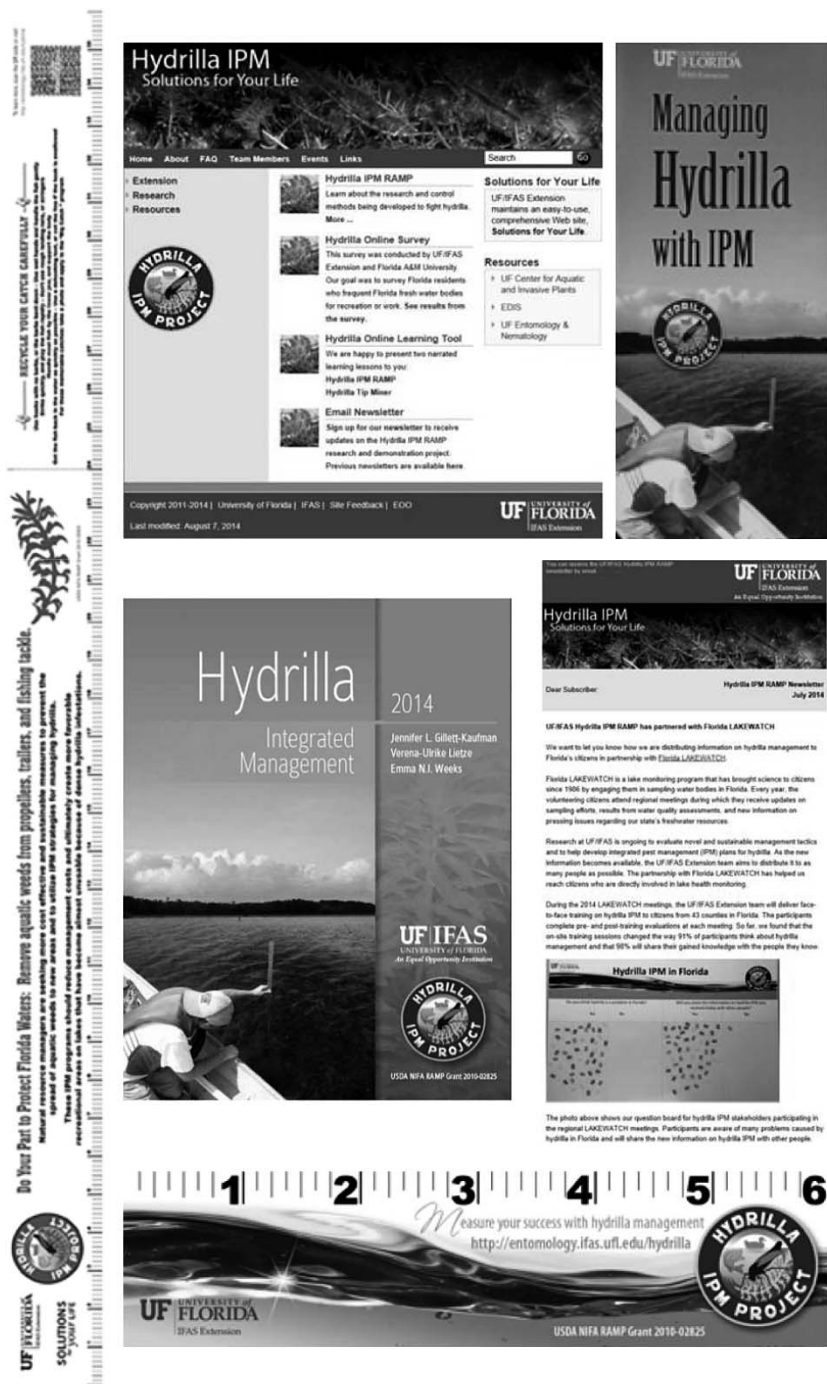


Figure 2. Educational materials, from top left clockwise: fishing ruler, website, tri-fold brochure, newsletter, bookmark, and book. The booklet was similar in appearance to the book.

regional meetings every year ($n = 1,143$). Additionally, an advertisement was placed in the Florida LAKEWATCH newsletter. The UF/IFAS CAIP LISTSERV reaches 1,826 people who are mostly aquatic, wetland, and invasive plant researchers, regulators, managers, and students.

UF/IFAS Extension faculty who received the survey were selected from a list of Extension agents who collected education materials from a booth at the Extension

Professional Associations of Florida conference in 2013 and 2014 ($n = 48$ and 28 , respectively). FLMS sent the survey link via E-mail to all attendees at the previous annual meeting, where our educational materials had been distributed in their welcome packets ($n = 142$). All recipients of the survey link received a reminder at 4 wk and the survey remained open for 6 wk.

Survey questions

Questions asked were focused on our previously distributed materials. For each educational item (i.e., website, newsletter, brochures, booklets, and books) that the participant claimed to have seen they were asked the following questions:

- Did you read the hydrilla management material in the <item name>?
- Did you find the hydrilla management information in the <item name> useful?
- Did you share the hydrilla management information in the <item name> with other people?
- Did the information in the <item name> change the way you think about hydrilla management?

For each promotional item (i.e., fishing rulers and bookmarks) that the participant claimed to have seen they were asked the following questions:

- Did you see the hydrilla integrated pest management <item name>?
- Did you find the hydrilla integrated pest management <item name> useful?
- Did you find the <item name> visually attractive?
- Did you use the website links on the <item name> to find out more information about hydrilla integrated pest management?

Statistical analysis

Statistical analysis was completed on select Likert-style questions to compare mean scores across items. Specifically, the two questions: 1) did you find the hydrilla integrated pest management <item name> useful? and 2) did the information in the <item name> change the way you think about hydrilla management? were analyzed. An analysis of variance was conducted using JMP® Version 6¹ ($\alpha = 0.05$) with Tukey's honest significant difference tests to compare mean scores across items as applicable. Contingency tables were used to compare answers to yes/no questions by educational material using JMP Version 6 ($\alpha = 0.05$).

RESULTS AND DISCUSSION

We developed materials to target a wide stakeholder audience to deliver training on hydrilla integrated pest management and remind water body visitors about the importance of minimizing the spread of invasive species to new locations (Figure 2). The hydrilla integrated pest management website (<http://entomology.ifas.ufl.edu/hydrilla>) has been visited by stakeholders 87,304 times in 6 yr (2012–2017). The website provides links to our online learning lessons, which are cross posted on the eXtension national website and have been accessed 17,039 times. Our newsletter, which is distributed quarterly and is archived on our website, has 201 subscribers. To date we have distributed the following educational items: 1-yard vinyl

fishing rulers (10,000), 6-inch bookmarks (70,000), Web cards (17,000), brochures (30,000), booklets (3,500), and books (1,300).

Our survey was completed by 209 people (6.5%; $n = 3,187$), 134 Florida LAKEWATCH volunteers (11.7%; $n = 1,143$), 49 UF CAIP LISTSERV receivers (2.7%; $n = 1,826$), 12 UF/IFAS Extension faculty (15.8%; $n = 76$), and 14 FLMS attendees (9.9%; $n = 142$). All the data were combined to analyze the responses to the questions reported below. Of those that completed the survey demographics question, 38% were Florida LAKEWATCH volunteers, 20% were water body managers, 14% were lakeside residents, 12% were Extension faculty, 6% were aquatic pesticide applicators, and 4% were recreational water body users. Of the 5% that answered "other" there were nine independent answers with a range of involvements including students, county commissioners, researchers, state park staff, etc.

Although 11.7% of the Florida LAKEWATCH citizen scientists contacted completed the survey, 38% of those that completed the survey identified as Florida LAKEWATCH volunteers. This is not surprising, as citizen scientists are known to be highly engaged with their volunteering and training (Roggenbuck et al. 2001, Bruyere and Rappe 2007, Asah and Blahna 2012, Alender 2016, Jennett et al. 2016). As most Florida LAKEWATCH volunteers live on or near the lakes they monitor as part of the program, they are typically highly motivated to be involved in all aspects of lake management.

When asked which of our educational and promotional materials they had seen, the following responses were recorded, website = 44, newsletter = 32, book = 50, booklet = 44, brochure = 40, bookmark = 26, and fishing ruler = 44. Only if the participant said that they had seen an item would the focused questions for each item appear. However, for each education item, for confirmation, we asked if they had read the item; 72, 77, 86, and 89% said they had read the newsletter, book, booklet, and brochure, respectively. Of the promotional items 100 and 92% said they had seen the bookmark and fishing ruler, respectively. Of those that said they had seen our website, 83% said they had visited it.

The usefulness of educational items varied significantly by type. Not all items were deemed to be equally useful ($F = 4.57$, $df = 6,200$, $P = 0.0002$). When asked if they found the information useful (i.e., very useful, useful, and somewhat useful) 91, 81, 94, 91, and 87% said the website, newsletter, book, booklet, and brochure were useful, respectively. With regards to the promotional items, 73 and 64% found the fishing ruler and bookmark useful, respectively. When the usefulness score (1 = very useful to 7 = very useless) was compared across items, the most useful items were the educational materials and the promotional items were considered less useful (Figure 3). The book, booklet, and website were significantly more useful than the bookmark ($P < 0.05$), and the book was significantly more useful than the fishing ruler ($P = 0.0233$). Although the perceived usefulness of the promotional materials was low, it is difficult to determine their impact on increasing awareness about the project.

The most useful items were a mixture of online and printed materials, although the most useful item was

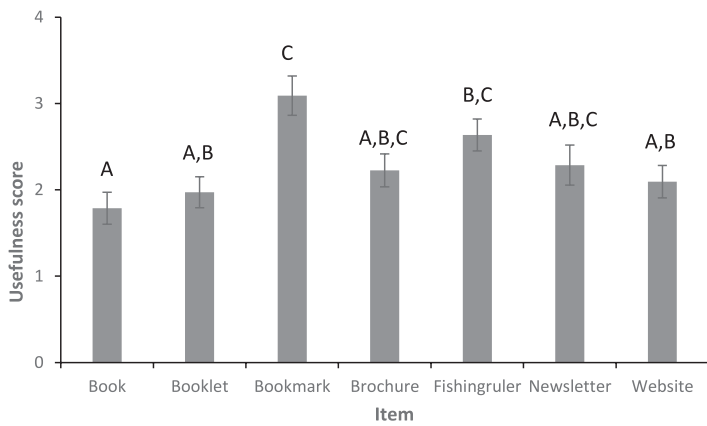


Figure 3. Perceived usefulness of educational and promotional items. Each item was scored on a 7-point scale from 1 = very useful to 7 = very useless, with 4 = neutral. Mean score \pm standard error of the mean. Bars with the same letter are not significantly different by Tukey's honest significant difference means comparison test ($P > 0.05$).

reported to be our printed book. Of our online materials, our website was reported to be the most useful. The least useful educational item was reported to be our newsletter, perhaps because of the specificity of the information.

Citizen scientists are motivated to participate by opportunities to learn and teach. According to Roggenbuck et al. (2001) these motivators fall second and third, behind protecting the environment, as reasons to be involved in a water monitoring program. Those that viewed our educational materials reported that they would share the information they received, a form of "teaching." When asked if they shared the hydrilla management information with others, 47, 63, 61, 62, and 70% of those who saw the website, newsletter, book, booklet, and brochure said that they did share the information with 327, 239, 276, 347, 461 others, respectively. Therefore, those that received our educational materials shared them with other people, giving a potential one person trained to three people reached. There was no significant effect of material type on the likelihood that a person shared the information ($\chi^2 = 3.5896$, $df = 4$, $P = 0.4644$). Although those that viewed the website were less likely than the average to share that information, it was not significantly less than the average likelihood.

When asked if the information changed the way they think about hydrilla, the percentages that said yes (i.e., yes, totally; yes, a lot; and yes, a little) were 62, 60, 79, 77, and 71% for the website, newsletter, book, booklet, and brochure, respectively. When a score was applied to how much the item changed the way people thought about hydrilla management (1 = totally to 5 = not at all) and this score was compared across items, the most opinion-changing items were the book and the booklet, and the least were the brochure and the website, with the newsletter in the middle. There was no significant difference in the ability of an item to change the opinion of the reader/participant ($F = 0.80$, $df = 4, 147$, $P = 0.5266$); on average all items changed the opinion of the survey participants a little, a score of 3. Our newsletter was supplied quarterly; of the 20

people that responded, 95% thought the frequency was just right and 5% thought it was a little too frequent.

Additional questions regarding our promotional items asked how visually attractive the items were, and 84, 90, 86, and 85% found the website, newsletter, bookmark, and fishing ruler attractive (i.e., very attractive, attractive, and somewhat attractive). When asked if they used the links on the promotional items to locate more information about hydrilla integrated pest management via our website, only 24 and 19% used the links on the bookmark and fishing ruler, respectively. This result indicates that perhaps this space could be put to better use by providing additional information.

One limitation of our study was the low response rate to our survey. We determined, based on funding availability and possible complications with mailed surveys, that an online survey would provide a satisfactory completion rate. Understanding that some of the Florida LAKEWATCH volunteers did not use or have access to computers, we offered the option to fill out paper surveys (with postage-paid return envelopes), and we offered newsletter readers the opportunity to call in to take the survey, but none chose to participate in this manner. The percent of survey responders was low at 6.5% (209/3,187 people). However, we did get better response rates with our citizen scientists (Florida LAKEWATCH, 11.7%) and the UF/IFAS Extension faculty (15.8%). Surveys of other citizen scientists that were also water quality volunteers reported similarly low responses of 26% even with participation incentives (Alender 2016). Although the percent of survey responders was low compared to online surveys of other Florida natural resource volunteers, such as the 59% response rate by Jacobson et al. (2012) as well as the national survey average of 52% reported by Archer (2008) for output/impact evaluation in online surveys, we were able to reach a wide audience through several LISTSERVs.

A second limitation is the bias in sampling for the study, as we targeted those that already had an interest in aquatic plant management and water body health and had likely been exposed to educational and outreach efforts in these areas. For example, Florida LAKEWATCH volunteers attend annual meetings where they are supplied with educational materials and are lectured on water body health topics. In some respect this bias was intentional, as from an operational perspective we were hoping to access those people that we knew would be interested with the hope that they would pass on their knowledge to the broader community; however, from a research perspective this perhaps resulted in a preference for educational items with denser information that might not be as appreciated by those new to the topic. Additional groups, which could be surveyed in future research, with less experience in citizen science are anglers, duck hunters, and boaters.

Because of the challenges with delivering scientific content to different user groups with diverse backgrounds, the goal of our study was to determine the most effective way to reach citizen scientists. Our citizen scientists and other stakeholders were highly satisfied with our materials; depending on the item 81–94% said it was useful and 60–79% said that it changed the way they thought about

hydrilla management. Of the educational materials, our book was most frequently reported to be the most useful, and the item that most frequently changed perceptions (although not significantly different compared to all items). Therefore, distribution of our book, which is a comprehensive hydrilla integrated pest management guide (Gillett-Kaufman et al. 2014b), to citizen-scientist volunteers is expected to facilitate technology transfer and help stakeholders and volunteers find the answers to their questions.

SOURCES OF MATERIALS

¹JMP Version 6, SAS Institute Inc., Cary, NC 27513.

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