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Source: Natural Areas Journal, 41(3) : 203-208

Published By: Natural Areas Association

URL: https://doi.org/10.3375/043.041.0306

Stewardship in Action

Targeted Species Projects for Volunteers to Increase Early Detection Capacity: The Water Chestnut Mapping Challenge

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Associate Editor: Mike Jenkins

ABSTRACT

Here we present a framework for creating targeted invasive species mapping projects for volunteers, using simple gamification techniques to encourage participation. In Pennsylvania and New York, we chose to focus on water chestnut (*Trapa natans*) because this species is easy to identify, and it is often feasible to eliminate small populations from newly infested waterbodies. We established a "friendly competition" in which participants would search for water chestnut and report their findings during a specified date range. Online trainings were offered on species identification and submitting data to iMapInvasives, a mobile and browser-based mapping system. During the challenge period, volunteers were kept engaged through up-to-date data tallies and email communication from mapping challenge administrators. At the end, participants with the greatest number of data entries or most locations searched, whether submitting presence or absence information, were announced as winners and received small prizes. The data were shared with regional invasive species managers through email alerts and a summary report. Challenge participants detected water chestnut in new waterbodies and contributed valuable absence data. Over the course of three years in New York (2016–2018), participants discovered 23 new water chestnut infestation locations in 14 waterbodies. In Pennsylvania, over the course of two years (2017–2018), 44 new water chestnut infestation locations in 12 waterbodies were identified. The programs in both states have continued to build on and improve these challenge events by adding additional target species and piloting new ways to keep participants engaged through real-time dashboards and other technologies.

Index terms: aquatic plants; citizen and community science; iMapInvasives; invasive species; observation data

INTRODUCTION

Natural resource managers regularly include recommendations for survey or control of invasive species in their management plans and daily duties. They are often tasked with managing populations of certain established invasive species to meet management goals (such as to maintain recreational access or to protect populations of rare species), while also looking for new species that are in the early stages of establishment when successful removal may be feasible. The information on invasive species populations gathered by professionals is invaluable, but is often limited by the capacity of the organization collecting the data.

Volunteers trained in invasive species identification and mapping techniques (also called community scientists or citizen scientists) can help fill important data gaps and increase a region's overall early detection capacity (Crall et al. 2015). The use of volunteer monitoring to further conservation and research goals has grown immensely over recent years as smartphone-based data collecting and web-based training technologies become readily available. However, recruiting and maintaining the interest of volunteers is a common challenge for natural resource professionals, requiring programs to develop creative engagement and retention techniques. For projects focusing on invasive species, the sheer number of species present in a given area can be overwhelming for volunteers. Also, if there is no connection to how the data will be used to promote action and protection of natural resources, enthusiasm can fade quickly. Focusing efforts on a small number of problematic species, encouraging both presence and absence reports, and employing "friendly competition" can help keep volunteers motivated.

In order to engage more participants, "gamification" has become popular within the scientific community and volunteer programs (Bowser et al. 2013). Gamification is the process of making a routine activity, such as mapping invasive species, into an enjoyable, engaging game by "rewarding" volunteers. The Pennsylvania and New York Natural Heritage Programs, which manage invasive species tracking databases (i.e., iMapInvasives) for their states, along with other state partners such as the New York State Department of Environmental Conservation, held separate invasive species mapping challenges to focus volunteer training and efforts on one species, water chestnut (*Trapa natans* L.). Data for each challenge was reported by volunteers into iMapInvasives, an online mapping and data management system used to assist volunteers and natural resource professionals working to protect natural resources from the threat of invasive species (NatureServe 2020). In subsequent years, additional high-priority invaders were added to each state's challenge.

Water chestnut is a highly invasive aquatic plant that can choke waterbodies, limiting light and oxygen for native species and impeding boating and other recreational activities (Figure

Figure 1.—Water chestnut observed in Silver Lake in Wayne County (Pennsylvania) by Barbara Lathrop, Water Program Specialist with the Pennsylvania Department of Environmental Protection (iMapInvasives Presence ID 1032016; https://imapinvasives.natureserve.org/imap/services/page/Presence/1032016.html).

1). This easily recognizable species was selected because of the potential to eliminate small populations by manual removal (such as hand-pulling) when it is detected early. Although established in both states, the distribution is scattered and many waterbodies are not yet infested (Figure 2).

Creating a Targeted Species Mapping Challenge

Designed to engage natural resource professionals and members of the public, the annual water chestnut mapping event (deemed the "Water Chestnut Chasers Challenge" in both states) asked participants to search for water chestnut in their local lakes, ponds, streams, or rivers in the month of July, starting in 2016 and 2017 in New York and Pennsylvania, respectively. Participants recorded both presence and absence findings in the iMapInvasives database. By including absence data, volunteers did not have to find the target invasive species to participate. Below are the general steps taken by each program to design and implement the mapping challenges:

1) Select an invasive species that is easy to identify, under-surveyed, and potentially controllable if a small infestation is found.
2) Establish competition details, such as the date range during which the data will be counted for the competition. It is important to consider when the target species is easily detected.
3) Schedule a training webinar so anyone can participate from anywhere, and then advertise it widely. We sent email announcements to the registered iMapInvasives users in both states, invasive species groups and list serves (such as New York's PRISMs [Partnerships for Regional Invasive Species Management]), and other conservation and community groups. We also posted information on our respective websites, including a way to register for the event.
4) Conduct an online webinar training that conveys the impacts of the selected species, how to identify it (including possible look-alikes), and how to collect verifiable presence and absence data. Emphasizing the importance of each participant's data contributions, we trained volunteers to submit data to iMapInvasives using the mobile app and online system, and provided time for live tech support for participants. The webinar was recorded and posted online.
5) During the challenge data collection window, send emails to remind participants to submit data.
6) Have experts and/or database administrators review records each day during the challenge (or as needed) and include ongoing results in reminders to volunteers. This helps keep the competitive spirit active.
7) At the close of the challenge, announce the results and winners. We counted presence and absence reports equally in the final tallies. The winners received small prizes or handmade trophies.
8) Analyze the data for new locations and share results with local land and water managers and challenge participants.

Data Collected

Challenge participants in New York and Pennsylvania consisted of new and existing iMapInvasives account holders. For both states, participants included a mix of members of the general public and natural resource professionals from state and federal agencies and several nonprofit organizations.

During the mapping challenge time frame (i.e., two weeks in July of 2016–2018 in New York; entire month of July in 2017–2018 in Pennsylvania), participants reported the presence of water chestnut at 23 locations in New York and 44 locations in Pennsylvania (Table 1). All volunteers were trained to submit photographs with their presence reports to iMapInvasives so the species identification could be verified by experts. Participants also reported targeted searches in which they did not detect any water chestnut. These data, referred to as absence or "not-detected" reports, do not guarantee the lack of water chestnut in a particular waterbody, but do increase our understanding of its current distribution. During the challenge time frame, 22 not-detected locations were recorded in New York and 94 were recorded in Pennsylvania.

The focused training of volunteers in the mapping and surveillance of water chestnut was useful for attaining distribution information and increased overall capacity to detect new populations (Table 1). For example, in 2017 and 2018, a combined total of 12 locations were discovered in Pennsylvania that contained previously unknown populations of water chestnut. Volunteers discovered water chestnut in 14 new waterbodies in New York over a three-year time period.

DISCUSSION

Species Distribution Awareness

Increased awareness of water chestnut and better knowledge of its distribution can lead to public and professional control efforts that may prevent its further spread. The mapping challenges in both New York and Pennsylvania contributed data in under-surveyed areas while also increasing awareness of this

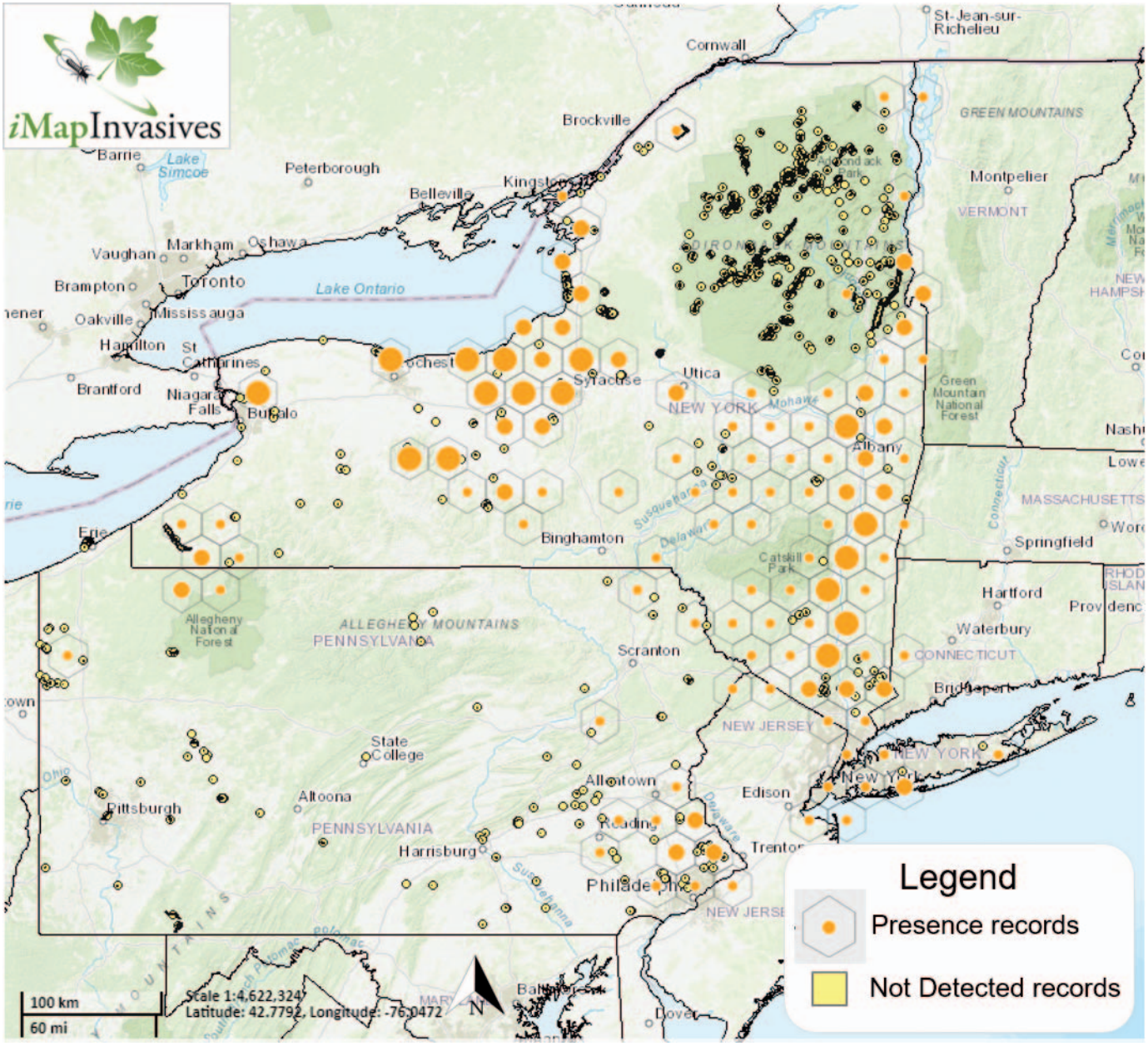

Figure 2.—Screenshot of water chestnut presence (circles inside hexagons) and not detected (small, open circles) data for Pennsylvania and New York in iMapInvasives (www.imapinvasives.org; date accessed: 20 June 2020).

Table 1.—Results from the New York and Pennsylvania "Water Chestnut Chasers Challenge" from 2016 to 2018, comparing data collected during the mapping challenge weeks and data collected prior to each year's mapping challenge.

			Water Chestnut data reported **during** each Mapping Challenge				Water Chestnut data reported **prior** to each Mapping Challenge	
State	Year	Challenge participants	Counties searched	Presence locations	Absence locations	Newly detected waterbodies	Presence locations	Detected waterbodies
NY	2016	7	7	7	3	1	2,306	87
NY	2017	14	13	6	9	5	2,662	96
NY	2018	9	9	10	10	8	3,849	103
PA	2017	11	20	25	61	6	54	18
PA	2018	7	7	19	33	6	75	31

high-priority invasive species in each state. Also, each year, the mapping challenge organizers in New York and Pennsylvania examined the outcomes, both in data contributions and volunteer participation, and made improvements to their project for the following year.

In Pennsylvania, water chestnut is known to exist in three primary areas of the state: in the southeast corner, the northeast corner, and in two counties in the northwest. When volunteers submit absence reports, especially for waterbodies not yet known to contain water chestnut (Figure 3), project leaders know that at least one set of trained eyes surveyed a particular waterbody and found no obvious signs of water chestnut at that time, making our understanding of its current distribution more complete.

For example, in 2018 one newly reported location to the iMapInvasives database was found near Horsham Township in Montgomery County, Pennsylvania (iMapInvasives Presence ID 955132; https://imapinvasives.natureserve.org/imap/services/page/Presence/955132.html). Photos submitted by the observer show this location contained a dense population of water chestnut (Figure 4). News of this well-established infestation was brought to the attention of local land managers and the concerned public by the Pennsylvania iMapInvasives administrator who highlighted it in the 2018 challenge results. Through this effort, the iMapInvasives program hoped to raise awareness of this high-priority species and also inspire people to prevent the spread of water chestnut in new areas and conduct on-the-ground treatments when chances of success are high.

Logistical Considerations

The cost of administering this type of survey event is relatively low compared to the effort contributed by volunteers. Approximately 3–5 d of staff time were invested each year for each mapping challenge. That total includes organizing and hosting a training session, corresponding with volunteers, tallying the results, and awarding prizes to the challenge winners. In contrast, traveling to and surveying many waterbodies across the state can require a substantial amount of time and capacity. While the amount of time needed to survey any given waterbody can vary greatly depending on location, accessibility, and shoreline length, one can reasonably estimate that each waterbody could take a full day of effort.

Collecting both presence and not-detected records in the challenge events engaged volunteers and provided useful distribution information. Reporting the absence of water chestnut is still valuable to tracking the spread of this invasive species and could inform management activities. For example, a lake in which water chestnut is not found, but where a nearby sighting occurred, might be a target location for outreach that encourages recreational users to clean their gear to avoid the spread of water chestnut. Recording not-detected data also provides volunteers with a reason to search for the target species in as many places as possible and record all their findings—presence and absence—since both are counted in the final challenge tallies.

Many valuable outcomes result from these types of targeted species challenges. For one, they allow each state's iMapInvasives program to tap into a large base of volunteers to accomplish a task that, alone, the programs would not have the capacity to achieve. By providing adequate training for each participant, volunteers are given the tools they need to correctly identify the invasive species being searched for and properly document their search efforts, in this case, in iMapInvasives. Also, having a large group of volunteers can increase the scope of areas searched, as some participants have access to private waters, which would not usually be surveyed by natural resource professionals. Additionally, in providing a specified window of time for the challenge (2–4 wk for the projects described here), volunteers can participate at their own pace.

Choosing one species for volunteers to focus their search efforts on and providing training (prior to the beginning of a challenge) helps to decrease the number of misidentifications. Additionally, less time is needed on part of the iMapInvasives program administrators to provide continued assistance to volunteers on species identification throughout the event.

Gamification in Action

Over the years, New York's challenge organizers have added multiple components to their mapping challenge to engage participants and drive competition. For example, in 2019, a "leaderboard" was added to the New York iMapInvasives website where the top three participants with the most presence/absence reports were listed. The leaderboard was updated regularly and inspired friendly competition. At the end of the challenge, winners were formally announced on New York's Invasive Species Awareness Week website. Additionally, challenges in both states incentivized search efforts by awarding prizes such as homemade trophies and other small gifts.

Challenge Follow-Up

In Pennsylvania, a data analysis report highlighted all presence and absence records submitted as part of each year's challenge. Data recorded outside the challenge timeframe of July for each year were also included in the data analysis. The goal of the analysis was to provide an understanding of the species' statewide distribution and to promote awareness of the need for management. All years' data analyses are posted on the Pennsylvania iMapInvasives website. In New York, a real-time "dashboard" of water chestnut data was embedded in the program's website using the iMapInvasives web map service, which provides a constantly updated stream as data are confirmed within the database. Also, data entered into iMapInvasives triggered email alerts for regional managers so that new findings could be considered in their management plans.

Continuing to Build

Beginning in 2019, both programs included two species for participants to search for in addition to water chestnut. In New York, the challenge included tree-of-heaven (*Ailanthus altissima*) and jumping worms (*Amynthas–Metaphire* spp.), and in Pennsylvania, hydrilla (*Hydrilla verticillata*) and wavyleaf basketgrass (*Oplismenus undulatifolius*) were added to the search list. These additional species were chosen based on their high priority status in each respective state and were presumed to be underreported. Also, tree-of-heaven is a preferred host of the quickly spreading invasive insect, spotted lanternfly (*Lycorma*

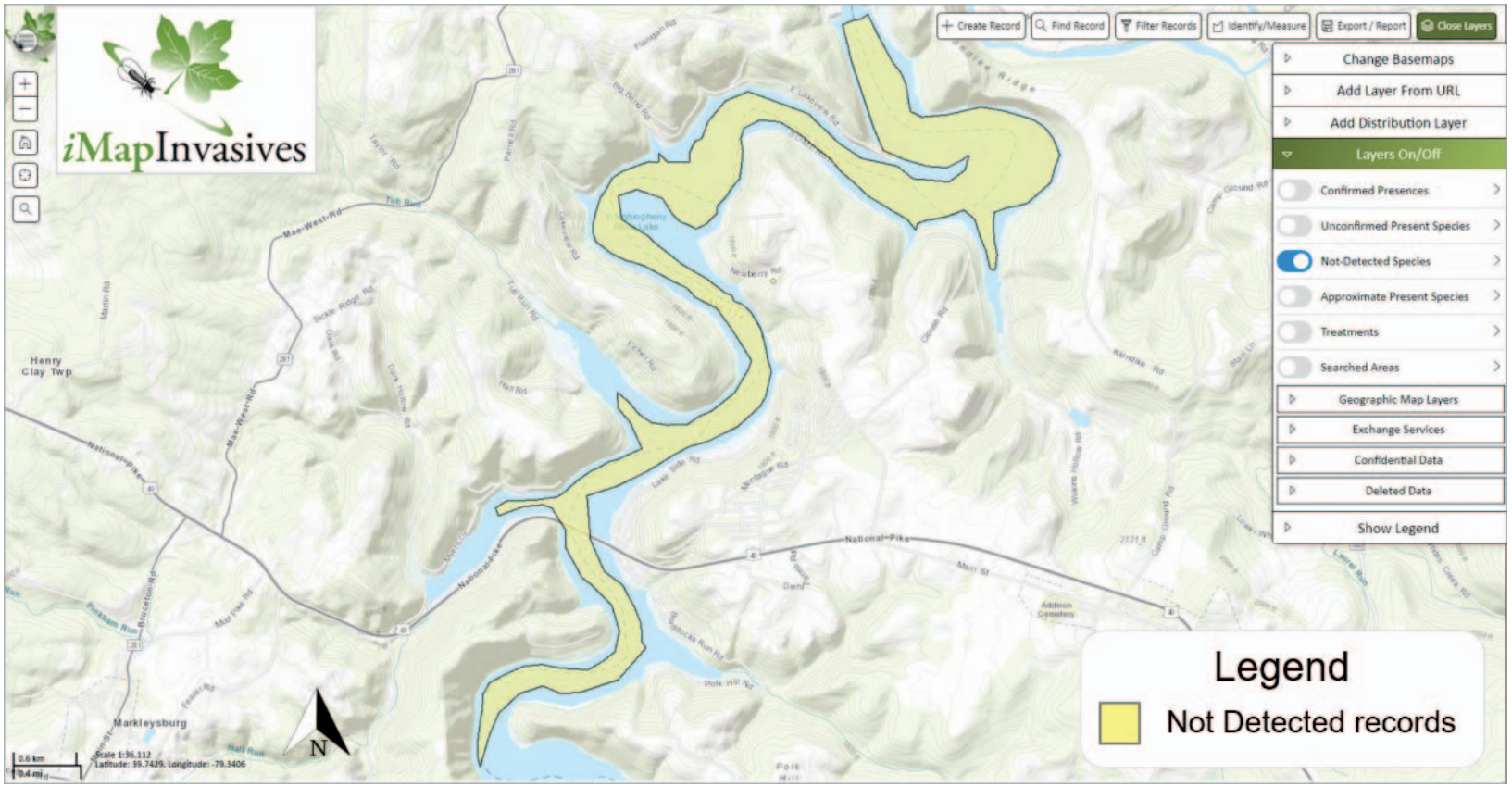

Figure 3.—Example of a Not Detected record for water chestnut in the Youghiogheny River Lake in Fayette and Somerset counties (Pennsylvania), submitted by an employee with the U.S. Army Corps of Engineers (iMapInvasives Not-Detected ID 6415; https://imapinvasives.natureserve.org/imap/services/page/NotDetected/6415.html) during the 2017 Mapping Challenge. Data about search efforts and methods are available in each record and associated Searched Area record by logging into iMapInvasives.

Figure 4.—Infestation of water chestnut in an unnamed waterbody near Arbor Glen in Montgomery County (Pennsylvania), observed by Jim Walter, Master Watershed Steward (iMapInvasives Presence ID 955132; https://imapinvasives.natureserve.org/imap/services/page/Presence/955132.html).

delicatula), which raises the need to survey for this particular tree species.

By using these challenge events as a means for additional data collection, land managers can better understand the prevalence of each species and make strategic decisions about whether to implement management if deemed feasible and justified. For example, if newly discovered invasive species populations pose a threat to a rare, threatened, or endangered native species population or important habitat, then rapid response actions may be warranted.

One goal both New York and Pennsylvania have for future challenges is to connect an action component to the overall mission of data collection. As participants enter records, email alerts are sent to regional invasive species managers or agencies, such as the state game land managers or regional invasive species partnerships. Local leaders in invasive species efforts can determine which reports are of significance in their area and conduct follow-up activities if appropriate. For water chestnut, if an infestation is detected in its beginning stage, manual control can be quite effective in eliminating the population. Groups are encouraged to report management actions and follow-up surveys into iMapInvasives. This process can demonstrate the importance of volunteer contributions, and conveying action results from previous years to participants can help increase motivation.

Other ideas for future challenges include improving the email reminders to participants by including tips and fun facts with the reminder to enter data. The use of social media to promote leaders throughout the challenge time frame would be another way to help motivate and hold the interest of volunteers. Additionally, a follow-up survey of participants would help challenge administrators better understand what inspired them to participate and what could be improved upon for future challenges.

ACKNOWLEDGMENTS

We are grateful to the many volunteers who participated in the mapping challenges in Pennsylvania and New York. These projects were funded by the New York State Environmental Protection Fund as administered by the New York State Department of Environmental Conservation and the Great Lakes Restoration Initiative.

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