PROJECT SUMMARY

Instructions:
The summary is limited to 250 words. The names and affiliated organizations of all Project Directors/Principal Investigators (PD/PI) should be listed in addition to the title of the project. The summary should be a self-contained, specific description of the activity to be undertaken and should focus on: overall project goal(s) and supporting objectives; plans to accomplish project goal(s); and relevance of the project to the goals of the program. The importance of a concise, informative Project Summary cannot be overemphasized.

Title: Invasive Insect & Disease Outreach, Detection, And Reporting

PD: PD/PI Malinoski, Mary K.	**Institution:** University Of Maryland
CO-PD: PD/PI 2 Clement, David L.	**Institution:** University Of Maryland
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CO-PD: PD/PI 5 Name (Last, First, MI)	**Institution:**
CO-PD: PD/PI 6 Name (Last, First, MI)	**Institution:**
CO-PD: PD/PI 7 Name (Last, First, MI)	**Institution:**

This is an “Extension Project.” Invasive insects and diseases pose an enormous threat to our forests, agronomic crops and landscapes. Their threat is second only to habitat loss and biodiversity with an estimated annual cost of $1.4 trillion worldwide. Our national resources and ecosystems are under constant pressure from new and invasive species. Prevention is the first-line of defense, but unfortunately numerous pathways for introduction increase the possibilities of invasive entry. The best IPM option for invasives is early detection coupled with a rapid response. Early reporting of invasives increases the likelihood that localized populations will be found and eradicated. Utilizing new smart phone technologies such as phone apps enable easy reporting and location of new invasive species. This grant will enable us to modify an existing Mid-Atlantic Early Detection Network (EDDMapS) iPhone app and mobile web site and create a new Android phone app to report new key invasive insect and disease pests throughout the northeast and southern regions. The Center for Invasive Species and Ecosystem Health (Bugwood) will program, maintain and house the phone apps and web sites. A key component of the new phone apps will be the enhanced flow of reporting information back to key local experts, and state and federal, agencies that have managerial responsibilities. In addition, sets of color identification cards featuring key invasive insects and diseases and a QR tag that will connect to the phone app will be distributed to further enhance successful identification and timely reporting.

This file MUST be converted to PDF prior to attachment in the electronic application package.

Project Title: Invasive Insect & Disease Outreach, Detection, and Reporting

PD (Lead Institution): Mary Kay Malinoski, University of Maryland
Co-PDs (Institution): David L. Clement, University of Maryland
Nevin Dawson, University of Maryland

(i) Problem, Background and Justification

- **Problem**

It is well documented that invasive insects and diseases pose an enormous threat to the economic, social, and environmental value of forests, crops, and urban landscapes. Invasive species cost an estimated $1.4 trillion annually in their environmental and economic impacts worldwide and are second only to habitat loss as a threat to biodiversity (www.icbi2009.org). Many invasive insects and diseases, such as Sudden Oak Death and Asian longhorned beetle, have gone undetected for years, resulting in very expensive and usually unsuccessful eradication efforts after the infestation is already well established. It is also widely accepted that if an invasive is found early when the infestation is small, it can be successfully eradicated with minimal effort. Monitoring education and reporting are the keys to early detection. Additionally, false reports received by inspection agencies lead to an expenditure of time and resources better spent elsewhere. High quality identification tools can help reduce the percentage of false reports received by inspection agencies and save time and money.

- **Background**

This proposal addresses the following priorities:

Invasive Species – Issues and Opportunities

"Historically, reacting to problems associated with invasive species has been the norm. Although reactive strategies will continue, new research should move to a proactive approach, in order to document the current and potential threats associated with invasive insect species and the threats from non-insect invasives on native insect populations. The long-term goal of this research must be to use the knowledge gained in a prospective manner to prevent the continued introduction and/or damage from deleterious invasive species." (USDA CSREES - Stakeholders' Workshop Plant and Pest Biology - November 20, 2007)
http://aspb.org/publicaffairs/stakeholders/2007/FinalStakeholdersReport2007.pdf

Natural resources and recreational environments

"Our nation's natural resources and ecosystems are under constant pressures from encroaching invasive species. Invasive species diminish habitat quality and diversity for wildlife. Additionally, Americans spend large amounts of leisure time in natural and recreational environments such as lakes, streams, and parks. Greater efforts are required to develop and quantify the impact of IPM programs in these environments. It is critical to protect public health and ecosystem function and minimize adverse environmental effects on natural areas, while maintaining functional and aesthetic standards. Environmental and health benefits should include reduction of pesticide residues in waters used for human consumption or for recreational purposes, as well as minimizing the effects of pesticides on non-target species." (National Road Map for Integrated Pest Management www.ipmcenters.org/ipmroadmap.pdf)

"Prevention is the first-line of defense. It can be the most cost-effective approach to protection

against invasive species. Once a species becomes widespread, controlling the species may require significant and sustained expenditures. Therefore, public investment in prevention tools, resources, and infrastructure are indispensable in protecting human health, agriculture, and natural resources … Early detection, rapid assessment, and rapid response (EDRR) increases the likelihood that localized invasive populations will be found, contained and eradicated." (Williams 2007)

There are many examples of the cost of invasives both economically and environmentally in the Northeast US and across the country. Non-native, wood boring insects such as the emerald ash borer and the Asian longhorned beetle exact an estimated $1.7 billion in local government expenditures and approximately $830 million in lost residential property values each year (Aukema, et al 2011).

Emerald ash borer has devastated areas across the Midwest and Mid-Atlantic. Some estimates calculate the national death toll of ash to be 60-70 million trees. Ash trees are a vital part of both rural and urban forests. Many communities in the Midwest, particularly in Michigan, lost all of their street trees to emerald ash borer. As the range of emerald ash borer continues to expand, the northeast is increasingly at risk. It currently infests areas of New York, Pennsylvania, West Virginia, and Maryland. According to the Maryland Department of Agriculture, "Green ash is among the top five trees planted and one of the most frequently successful in riparian forest buffers. Ash is planted in more than 2,400 acres of riparian forest buffer plantings on the Eastern Shore and supports about 150 types of butterflies and moths. Ash is the most common tree in Baltimore City with approximately 29,300 trees and accounts for about six million trees in the surrounding counties. USDA has estimated that losses could exceed $227.5 million in the Baltimore area alone if the emerald ash borer were to become established."

Invasive diseases have also caused and continue to cause severe damage to ecosystems and industry. Sudden oak death (*Phytophthora ramorum*) has a wide host range and occurs throughout the Northern California and Oregon coast range, and is also found in parts of Washington State. This disease has also caused serious problems for the nursery industry from the movement of infected plant material. According to the Center for Invasive Species Research, "The precise economic impact of Sudden Oak Death is not known, but it is estimated to be in the tens of millions of dollars from loss and quarantine of nursery crops that can spread Sudden Oak Death, decrease in property values, cost of monitoring and eradication, and losses of recreational, aesthetic, and cultural value" (http://cisr.ucr.edu/sudden_oak_death.html).

Thousand Cankers disease of Walnut is yet another example of an invasive that spread throughout a large area before being detected. It has caused widespread death of walnuts in the west, especially that of black walnut in Colorado. It is in Tennessee and has recently been found in Virginia and Southeastern Pennsylvania. "Black walnut is a key species that sustains the American hardwood industry … At present there are not controls identified that have high promise for managing the disease once it has become established in a new area … it is extremely important that every effort be made to slow the spread of thousand cankers and, particularly important to prevent its human-assisted movement to new areas." (Cranshaw and Tisserat 2011)

- **Justification:**

As described by these sources, invasive insects and diseases are environmentally, economically, and socially devastating. It is very important that they be detected early and managed swiftly.

In addition to the aforementioned species, several other invasive insects and plant diseases have been detected in the Mid-Atlantic region, such as Japanese cedar longhorned beetle, oak wilt, and boxwood blight. Early detection is only possible with education. As extension educators dedicated to raising awareness about invasive species, we have evaluated many educational ID tools for their usefulness with professional foresters, arborists, landscapers, regulatory officials, and Master Gardeners. We used their feedback to develop a pocket-sized set of invasive insect and disease ID cards that feature photos, brief diagnosis tips, and reporting contacts for Maryland (See Appendix A). A University of Maryland Extension grant covered the cost of printing 1,000 card sets. Their distribution was targeted at professionals and citizen scientists who are in the field every day, including foresters, loggers, arborists, nurserymen, environmental groups, several volunteer groups, and the staff of Maryland Department of Agriculture, Department of Natural Resources, and USDA APHIS.

They have been used by Bartlett Tree Experts and Brickman Co. in employee trainings. M. Adams of Bartlett said that they "Haven't seen Thousand Cankers yet, though the crews are informed about it as a result of the cards." M. Travis, USDA-APHIS-PPQ, State Plant Health Director- MD/DC said that the clients receiving the card sets were "PPQ Officers, Pest Survey Specialists, CPB Ag specialists and DC Urban foresters. They used them for some surveying and as outreach materials to the public. Good tools for field staff!!" A senior principal scientist from Bayer Advanced ordered 500 card sets to distribute to Bayer employees and customers across the country as part of their education and training program. D. McCullough, emerald ash borer researcher at Michigan State University, is planning to adapt the cards for use in Michigan. The cards can easily be adapted for regional or national use. Our goal is to make it easier for individuals to identify suspect infestations of these insects and diseases in the field.

We also plan to make reporting easier. The ID card sets printed as a part of this project will direct users to the Mid-Atlantic Early Detection Network portion of the EDDmapS site (www.eddmaps.org) to report their sightings of invasives, either through the full website on a computer, or through the mobile website or iPhone App on a smartphone. Currently the focus of this system is on invasive plants. The proposed project will add invasive insects and diseases, identify verifiers, and develop an Android App for reporting and mapping verified reports. The attached letter from The Center for Invasive Species & Ecosystem Health (http://bugwood.org/) explains this in detail. A quick response (QR) code will be placed on the ID cards, which smart phone and tablet users can scan to download the appropriate app. The Invasive Plant Atlas of New England is working to develop similar tools for use in that region. All versions of the reporting system will include identification photos and descriptions of each species to aid in accurate identification.

These tools should also help increase the accuracy of incoming reports of invasive insects and plant diseases, decreasing the amount of time and money resources spent in following up on false reports. The phone room supervisor at the University of Maryland Extension Home and Garden Information Center estimates that 95% of the emerald ash borer reports received by the Center are false. Each of these false reports represents approximately ten minutes of staff or volunteer time in follow-up responses either by phone or email. Further resources are expended when the report passes initial screening and is passed to the state inspection agency, which sends a staff member to examine the reported infestation in the field. High quality field identification tools will help prevent a user from mistakenly reporting a target species.

The ID cards and phone apps can be used throughout the mid-Atlantic to report possible invasive pest and diseases in a timely manner, even while in the field. The importance of finding invasives quickly cannot be understated. These are simple tools that can be easily distributed and simple to use. We propose to conduct a pilot project over a three year period with collaborators who can identify groups to trial the ID cards and reporting apps. An online evaluation survey for the ID cards has already been approved by the IRB at the University of Maryland.

(ii) Objectives And Anticipated Impacts:

1. **Use Bugwood as a service provider to update and manage the insect and plant disease reporting system in the Mid-Atlantic Early Detection Network section of the EDDMapS web site (www.eddmaps.org) and database. The site is managed by the Center for Invasive Species and Ecosystem Health (Bugwood.org) and currently focuses on reporting of invasive plants.**

Increased and more accurate reporting of targeted invasive insects and diseases should occur as a result of this project through the use of user-friendly new technology. Smartphone apps and mobile websites allow users to compare photos and descriptions to field conditions while still in the field without any additional tools or equipment, leading to fewer false reports. Apps and websites are available to the target audience of natural resource professionals as well as lay citizens, further increasing the availability of quality identification and reporting tools. Early detection of invasive species safeguards the environment and reduces the overall costs and increases the likelihood of successful eradication. More accurate reporting equates to less staff time and less travel funds spent on report verification. A follow-up survey of registered users of the EDDMapS tools will be developed to determine the need for any modifications and to request suggestions for new insect and disease additions to the database.

2. **Expand existing Invasive Field ID card sets (see Appendix A) from four species to six in year one, add two additional species in year 2 based on feedback from regulatory officials, and update reporting information for use at national scale**.

Early detection of invasive species safeguards the environment and reduces the overall costs and increases the likelihood of successful eradication. Field ID cards allow users to compare photos and descriptions of target species to field conditions, leading to fewer false reports. An online survey has been developed and is approved by the University of Maryland Institutional Review Board. It will be used to measure any knowledge gain about the target invasive insects and diseases, and to determine whether the user discovered a target species using the card set. The survey will be distributed via email to all recipients of the card sets. The pilot online survey can be accessed at http://bit.ly/FieldIDcards.

(iii) Approach and Procedures.

Objectives:

1. Use Bugwood as a service provider to update and manage the insect and plant disease reporting system in the Mid-Atlantic Early Detection Network (MAEDN) section of the EDDMapS web site (www.eddmaps.org) and database. The site is managed by the Center for Invasive Species and Ecosystem Health (Bugwood.org) and currently focuses on reporting of invasive plants.

This will involve updating a recently released iPhone app, existing web site, mobile web site, and the development of an Android app with functionality similar to that of the iPhone app. Bugwood will manage, update, and house the Mid-Atlantic Early Detection Network section of the EDDMapS web site (www.eddmaps.org) and database. This region includes the following states: Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, Virginia, and West Virginia. This project will expand the focus of the MAEDN from invasive plants to include invasive insects and plant diseases.

Six invasive insects and plant diseases will be added to the reporting system in year one. Additional insects and diseases will be added in years two and three. We will identify contacts in each of the participating states listed above to serve as verifiers for invasive insect and disease reports, which in most cases will be separate from the contacts already identified for invasive plant reports. Bugwood will provide the programming expertise, manage the report database, and maintain software updates with advice from the project investigators. Reports of invasive species can be made within the system using either the full website, the mobile website, or the app. Reports will automatically be routed to the appropriate contact within each state for verification.

The full website offers photo submission and manual entry of location data, the mobile website offers automatic geo-location data inclusion but no photo submission, and the apps will feature both photo submission and automatic geo-location features. In contrast to the mobile website, the apps also allow full functionality on iPhones, iPads, and iPhone Touches without need for a cellular data signal or data plan. Additional features include a tool for viewing the user's current map location and the location of nearby confirmed reports.

2. Expand existing Invasive Field ID card sets (see Appendix A) from four species to six in year one, add two additional species in year 2 based on feedback from regulatory officials, and update reporting information for use at national scale.

The existing card set will be updated as follows. Cedar longhorned beetle and boxwood blight cards will produced by the project investigators and added to the set. National reporting contact information, full-color photos, and key diagnostic features will be included on each card. A QR code (a square barcode) will be included on each card that, when scanned with a smart phone or tablet camera, will link the user to the identification and reporting apps and/or mobile website described below. Card sets will be printed in color on plastic stock. We will work with key collaborators who can identify contacts in groups such as professional landscapers, arborists, loggers, and foresters. The project will be on a pilot scale to targeted groups throughout the Mid-Atlantic region which is the area covered by the Mid-Atlantic Early Detection Network section of the EDDMapS. This area covers parts of the Northeast and Southern IPM regions. The card set will be expanded to 8 cards in year two, with two additional species to be determined by

regulatory officials. Based on successes and with input from collaborators and an online survey tool, the project will be expanded to new groups in years two and three.

Timetable

Objective	Phase	Tasks	Completion Date
1. Use Bugwood as a service provider to update and manage the insect and plant disease reporting in the Mid-Atlantic Early Detection Network section of the EDDMapS web site (www.eddmaps.org) and database	First Phase update web sites and iPhone app.	Add insects, diseases, and verifiers to new iPhone App, mobile web site, and EDDMapS web site.	End of year 1
	Second Phase Android App development	Develop and test Native Android App for reporting invasives to Mid-Atlantic Early Detection Network section of the EDDMapS	End of year 2
	Third Phase maintenance of apps and web sites	Continue to update and maintain database, software for apps and web sites.	End of year 3
2. Expand existing Invasive Field ID card sets	First Phase initial distribution.	Update existing cards, design new cards, print cards. Survey recipients.	End of year 1
	Second Phase expand distribution.	Edits if needed, print and distribute additional card sets. Survey recipients.	End of year 2
	Third Phase evaluation of ID Cards	Survey ID card recipients.	End of year 3

(iv) Evaluation Plans

1. **Use Bugwood as a service provider to update and manage the insect and plant disease reporting system in the Mid-Atlantic Early Detection Network (MAEDN) section of the EDDMapS web site (www.eddmaps.org) and database. The site is managed by the Center for Invasive Species and Ecosystem Health (Bugwood.org) and currently focuses on reporting of invasive plants.**

The adoption rate of the apps will be tracked through information available through app stores, especially total number of downloads and downloads per month. An increase of 40% in the number of downloads per month over the course of the project is the goal.

The project should result in a higher number of reports made through the EDDMapS system, especially in the Mid-Atlantic region. The number of reports made through the MAEDN system will be tracked through the EDDMapS system. This project's goal is to increase this number of reports by at least 20% over the course of the project.

The change in percentage of accurate reports will be measured as follows. The percentage of reports made using the MAEDN reporting system and verified as accurate will be tracked by the verifiers in each state. This percentage will be compared to a baseline percentage as estimated by each state's verification contact using data from reports received through channels outside of EDDMapS prior to the initiation of this project. For example, the phone room supervisor at the University of Maryland Extension Home and Garden Information Center estimates that only 5% of the emerald ash borer reports currently received by the Center are accurate. The target increase in overall report accuracy for target species as a result of EDDMapS usage is 10%, which equates to a significant savings in time and effort spent in following up on false reports. These data will be supported by responses collected through an online survey instrument showing whether users feel that the EDDMapS identification and reporting system makes accurate identification of target species easier.

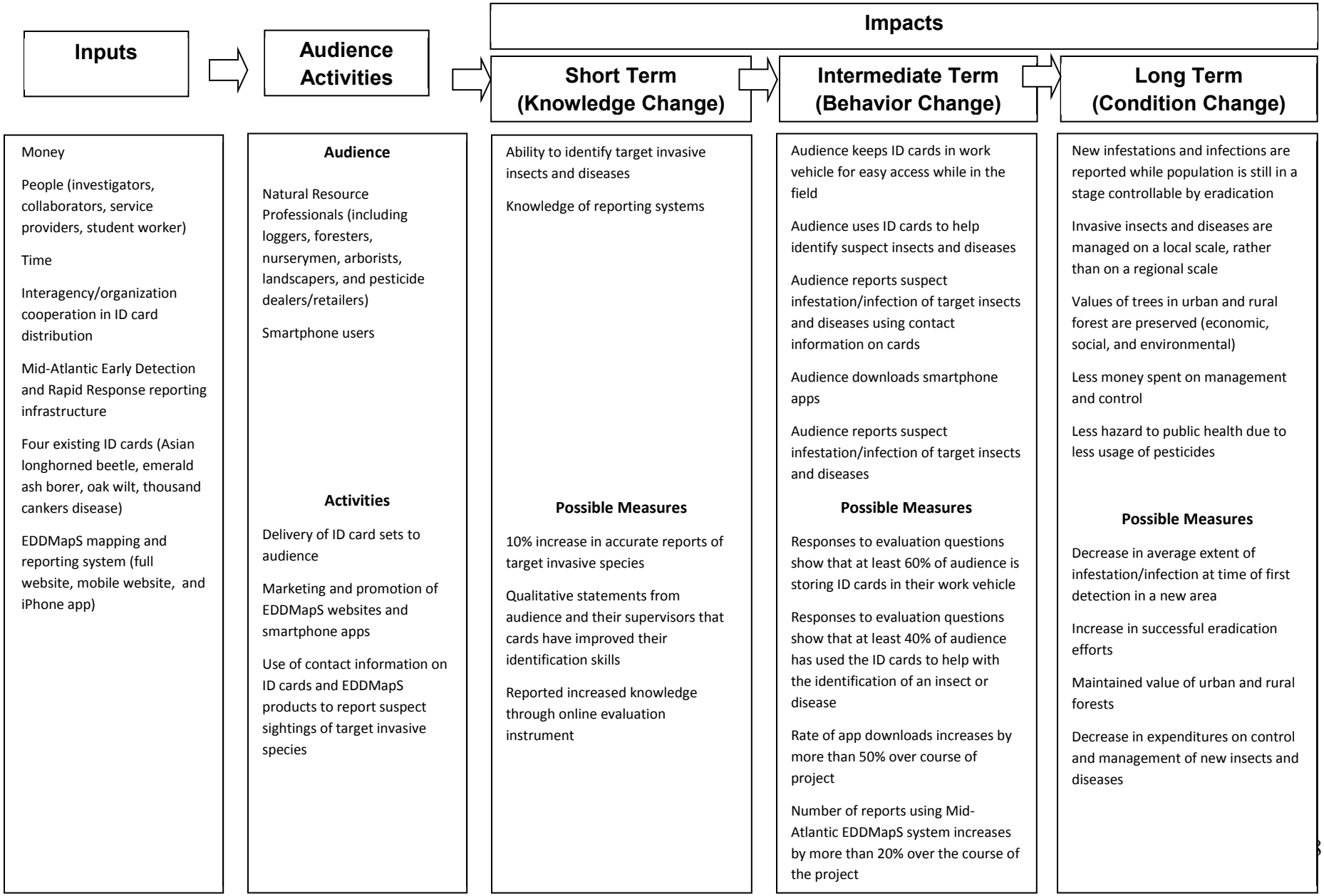
2. **Expand existing Invasive Field ID card sets (see Appendix A) from four species to six, in year one, add two additional species in year 2 based on feedback from regulatory officials, and update reporting information for use at national scale**.

The primary tool for evaluating the ID card sets will be an online survey instrument. A pilot version has already been developed by the project investigators in conjunction with Teresa McCoy, Assistant Director of Evaluation & Assessment for University of Maryland Extension. The survey instrument has been approved by the University of Maryland Institutional Review Board.

Each recipient of a card set will be asked to submit their email address, and will be contacted six to twelve months after receiving the card set. The current location of the card set is a proxy for its perceived value. The target for respondents indicating that the card set is currently in their work vehicle for easy access while in the field is 60%.

Direct questions about the respondent's use of the card set will show how useful it is as a tool in the field. The project's target is for 40% of respondents to report using the card set to help with the identification of an insect or disease. Any positive identification of target species will also be recorded.

Focus Area: Natural resources and recreational environments
Impact Area: Invasive species
Roadmap Goal: Protect our nation's natural resources and ecosystems from invasive species



(v) Key Personnel:

Mary Kay Malinoski, PI, will oversee the project and coordinate with Center for Invasive Species & Ecosystem Health (Bugwood) on invasive species updates to iPhone app, development of an Android app, updates to mobile, and existing EDDMapS web sites for the Mid Atlantic Early Detection Network. She will work with regulatory officials to identify additional invasive insects for the web sites and apps.

David L. Clement, Co-PI will work with regulatory officials on identifying invasive diseases to add to the apps and web sites.

Nevin Dawson, Co-PI will work with forestry contacts to distribute ID cards and collect survey data. He will also do the graphic design for the new ID cards and serve as the point of contact for the printer of the cards.

All key personnel will work together to re-design invasive ID cards, work with regulatory officials to identify additional invasive insects and diseases for apps, field test apps, and coordinate distribution of ID cards and online evaluation surveys and data collection.

LITERATURE CITED

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