



EDRR Pilot Project | Contractor's Report



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NOTE FROM THE EXECUTIVE DIRECTOR

The 2016–2018 *National Invasive Species Council (NISC) Management Plan*¹ called for the Council to “promote pilot projects across a variety of U.S. ecosystems that explore innovative, multi-stakeholder approaches to the early detection of and rapid response to invasive species.” This Contractor’s Report is the output of one of three pilot projects responding to priority action 2.5.4.

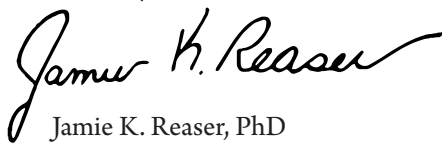
Invader Detectives has been conceptualized as a national program to facilitate the detection of invasive species in urban environments. The majority of invasive species enter the country through the large commercial sea ports and airports located in our Nation’s cities. If we can rapidly detect and respond to potentially harmful non-native species at or near our borders, we can prevent them from spreading to natural areas and agricultural landscapes. Please see our complementary report on invasive species impacts on infrastructure (Vissichelli 2018²).

Invader Detectives is to be administered through partnerships between government agencies (mostly local municipalities) and “citizen scientists” – members of the public who have sufficient technical capacity to contribute to scientific endeavors and do so voluntarily. This approach can be cost-effective, while also ensuring that relevant laws and policies are being followed, local *Invader Detectives* chapters effectively use existing resources (e.g., organizations, experts, educational information), and the data generated by program participants makes a difference over the near- and long-term (e.g., by being included in national databases that are used for environmental planning).

Ultimately, this Contractor’s Report is intended to serve as the conceptual framework for developing and implementing *Invader Detectives* on a national scale through a chapter-based (regional) model. It is a living document and should not be regarded as final guidance. We welcome your input at invasive_species@ios.doi.gov.

Together, we can find them and stop them. We can protect what matters.

Sincerely,



Jamie K. Reaser, PhD
Executive Director
National Invasive Species Council

1 <https://www.doi.gov/invasivespecies/management-plan-and-executive-order>

2 https://www.doi.gov/sites/doi.gov/files/uploads/invasive_species_impacts_on_federal_infrastructure.pdf

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2. CALL TO ACTION

Invader Detectives is a national program (currently under development) that facilitates the detection and eradication of potentially harmful non-native organisms (known as “invasive species”) in urban environments. Why invasive species? Among other things, invasive species threaten the survival of our native species, limit food and water availability, impair human health and safety, and damage critical infrastructure, including buildings and roads. Their impacts in the United States are already measured in the 100s of billions of dollars per year. Why urban environments? The majority of invasive species enter the country through the large commercial sea ports and airports located in our nation’s cities. If we stop these organisms at or near our borders, they can’t cause harm anywhere else – we protect the American people and everything we care about.

Invader Detectives is administered through partnerships between government agencies (mostly local municipalities) and “citizen scientists” – members of the public who have sufficient technical capacity to contribute to scientific endeavors and do so voluntarily. This approach can be cost-effective, while also ensuring that relevant laws and policies are being followed. Local Invader Detectives chapters effectively use existing resources (e.g., organizations, experts, educational information), and the data generated by program participants makes a difference over the near- and long-term (e.g., by being included in national databases that are used for environmental planning).

3. INTRODUCTION

3.1 Audience

This document is designed for individuals and organizations hoping to start or enhance an invasive species early detection / rapid response (EDRR) program.

This document focuses on the details of how the first Invader Detectives (ID) chapter was set up in the Washington DC metropolitan area and how to go about setting up your own Invader Detectives chapter. For details about the operational aspects of the Invader Detectives chapter in the Washington DC Metropolitan area see the companion document *Invader Detectives DC Operations Manual*. Each section number used in this document is connected to the section number in the companion document. For example, if you want to learn about what occurs in the DC area related to some discussion in 12 – Alerts then read 12 – Alerts in the companion document.

3.2 Purpose

This document is meant to provide the tools necessary to encourage and facilitate the establishment of Invader Detectives chapters. New ID chapters will lead to an increase in 1) the early detection of invasive species at all scales and 2) the rapid response to those species. Rapid and successful treatment will protect natural areas and agricultural areas and reduce the costs to land and facility managers of all kinds.

Locations that are the highest priority for EDRR are those with either many potential pathways of introduction or areas deemed of the highest value (ecological or otherwise). ID was conceived as a project for urban areas – especially ports. Ports are especially important areas for EDRR because they are exposed to many pathways and, therefore, introductions (see Box 1). However, EDRR is necessary in all areas and we hope that all areas will establish EDRR programs.

3.3 Defining Terms

EDRR really contains a set of inter-linked actions and concepts. A few of the key terms are defined here.

Early Detection: A process of surveying for, reporting, and verifying the presence of a non-native species

Box 1: Top 25 US ports by tons of goods moved

Based on Tomer and Kane (2015)

1. Los Angeles-Long Beach-Santa Ana, CA
2. New York-Northern New Jersey-Long Island, NY-NJ-PA
3. Detroit-Warren-Livonia, MI
4. Houston-Sugar Land-Baytown, TX
5. Anchorage, AK
6. Laredo, TX
7. Miami-Fort Lauderdale-Pompano Beach, FL
8. Seattle-Tacoma-Bellevue, WA
9. San Francisco-Oakland-Fremont, CA
10. Chicago-Joliet-Naperville, IL-IN-WI
11. New Orleans-Metairie-Kenner, LA
12. Buffalo-Niagara Falls, NY
13. Savannah, GA
14. El Paso, TX
15. Brownsville-Harlingen, TX
16. Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
17. Virginia Beach-Norfolk-Newport News, VA-NC
18. Charleston-North Charleston-Summerville, SC
19. Rest of New York
20. Rest of Louisiana
21. Baltimore-Towson, MD
22. San Diego-Carlsbad-San Marcos, CA
23. Rest of North Dakota
24. Dallas-Fort Worth-Arlington, TX
25. Beaumont-Port Arthur, TX

duction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health (Executive Order 13751).

Non-Native Species: With respect to a particular ecosystem, an organism, including its seeds, eggs, spores, or other biological material capable of propagating that species, that occurs outside of its natural range (Executive Order 13751).

Pathway: The means by which invasive species are moved, intentionally or unintentionally, into new areas (DOI 2016).

Preparedness: Having the knowledge, financial resources, tools, trained personnel, and coordination structures in place to streamline activities at each of stage in the EDRR process (DOI 2016).

Rapid Assessment: Determination of a species' abundance and distribution, the risks and impacts associated with its occurrence, as well as the potential management responses to address the invasion (NISC 2003).

Rapid Response: A process that is employed to eradicate the founding population of a non-native species from a specific location (DOI 2016).

Risk Analysis: The set of tools or processes incorporating risk assessment, risk management, and risk communication, which are used to evaluate the potential risks associated with a species or pathway, possible mitigation measures to address that risk, and the information to be shared with decision-makers and other stakeholders (DOI 2016).

before the founding population becomes established or spreads so widely that eradication is no longer feasible (DOI 2016).

Eradication: The elimination of all individuals and propagules from an area with low likelihood of needing to address the species in the future (DOI 2016).

Horizon Scanning: The systematic examination of future potential threats and opportunities that can contribute to the prioritization of invasive species of concern and the means to address their introduction and spread (Roy et al. 2014).

Incident Command System: A standardized on-scene emergency management construct specifically designed to provide for the adoption of an integrated organizational structure that reflects the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries. ICS is the combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure, designed to aid in the management of resources during incidents. It is used for all kinds of emergencies and is applicable to small as well as large and complex incidents. ICS is used by various jurisdictions and functional agencies, both public and private, to organize field-level incident management operations (FEMA 2017).

Invasive Species: With regard to a particular ecosystem, a non-native organism whose intro-

Watch list: A list of alien species not yet present in a territory – or present only in a limited range – that are considered potentially to pose risks to the invaded area and for which it is recommended to monitor arrival, expansion and impacts, and/or application of prevention measures (Genovesi et al. 2010).

3.4 Time needed to initiate ID

The initiation stage requires substantial time. Using the information presented here should dramatically cut the total amount of time required. In general the major steps and time required are:

- Review this document and key links 10 hours
- Create your own plan 50 hours
- Organize and hold kick off meeting 20 hours
- Develop specific areas to search 10 hours
- Prepare FreshData for Alerts (if applicable) 160 hours
- Prepare Watch lists 80 hours
- Training/outreach presentations 20 hours
- **Total 350 hours**

All of these tasks can be split up and spread out. A core group of five working over six months would only need to spend two or three hours per week each to make the project a reality. In fact, spreading the work over more than one person and many months will result in a more robust program.

3.5 EDRR Guidance

In 2003 the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW) produced *A National Early Detection and Rapid Response System for Invasive Plants in the United States: Conceptual Design* (2003). This was the culmination of the first large-scale effort in the United States to outline what was needed for a national EDRR system.

In 2016 the National Invasive Species Council Secretariat (NISC) and the Department of the Interior built on the 2003 FICMNEW plan and recent technological advancements to produce a plan outlining what a National EDRR Framework should entail (DOI 2016) and incorporated the establishment of pilot projects as part of the management plan (NISC 2016).

Appendix B includes a conceptual diagram of the key EDRR components. This diagram is somewhat more detailed than most others that are in the literature. It may be useful in determining which steps occur in what order for your own EDRR efforts.

There are many guidance resources that informed the ID-DC pilot. A few efforts, including in the Great Lakes region (Crall et al. 2012) and the San Francisco Bay Area (Frey et al. 2015) were particularly useful. In addition, the United States Geological Survey produced a useful compendium of methods relevant to EDRR (Welch et al. 2014) and the New York State Department of Environmental Conservation produced a Rapid Response Framework (NY DEC 2016) that outlines the basic details for many key EDRR steps. Appendix C includes additional example plans that may be useful when you are writing yours.

3.6 How to use this document

Every region will have unique constraints, participants with distinct interests, and different sets of organizations combating invasive species. This document is designed to outline the key steps necessary to launch an Invader Detectives chapter. There are sections on how to get started, what to include in your Operations Manual, and suggestions on specific processes. A lot of key information has been compiled in this document but you will need to consult other sources to be successful.

Each section of the document ends with a set of lessons learned. These are key ideas that were of particular importance to ID-DC. Some of these items were considered before the pilot was initiated and some were learned based on challenges that were faced during ID-DC initiation.

3.7 Lessons learned – Introduction

- Identify a core team
- Leverage existing platforms/tools/organizations/trainings
- Spread the work over at least a few months

4. PROGRAMMATIC IMPLEMENTATION

4.1 Existing efforts

First, survey what is already happening in your area. If you have gotten as far as reading this document you probably have a pretty good idea about organizations and projects related to invasive species. However, after you make a draft diagram representing local efforts (e.g., Figure 1) share it with colleagues and make it as complete as you can.

If an organization exists that is perfectly aligned geographically, taxonomically, and environmentally with the potential Invader Detectives chapter goals, then you should approach that organization to initiate an EDRR project.

If one or more modifications are needed to one organization to make ID fit, then consider the ramifications of making those changes. If the changes would be a net positive then approach that organization with your proposal.

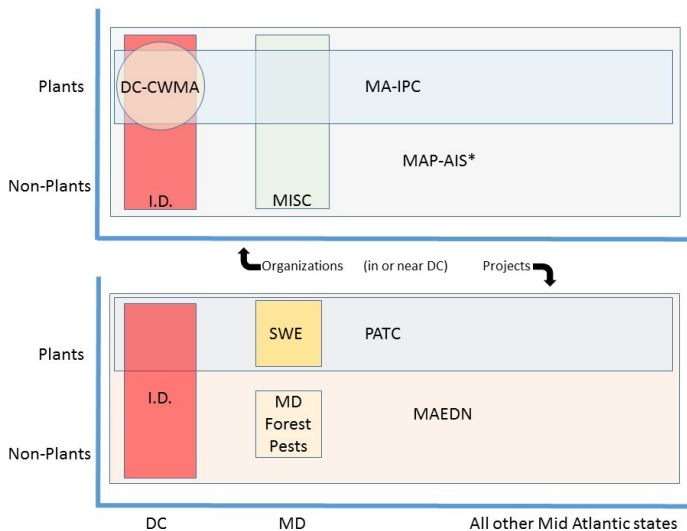


Figure 1 Conceptual diagram used for the ID-DC showing organizations (on top) and projects (below) with overlapping geographic and/or taxonomic interests. DC-CWMA=DC Cooperative Weed Management Area, MA-IPC=Mid-Atlantic Invasive Plant Council, ID=Invader Detectives, MISC=Maryland Invasive Species Council, SWE=State Wide Eyes, PATC=Potomac Appalachian Trail Club, MAEDN=Mid Atlantic Early Detection Network, MD=Maryland

If no suitable organization exists you may need to start a new one or identify a larger organization that would be willing to have the EDRR efforts as a project. If a new organization is needed consider the CISMA (Cooperative Invasive Species Management Area) and PRISM (Partnership for regional invasive Species Management) models. CISMAs grew out of the CWMA (Cooperative Weed Management Area) model.

There is an effort called “First Detectors” that is managed by the National Plant Diagnostic Network (<https://firstdetector.org/>). This is a network of states with some states (notably, Wisconsin <http://fyi.uwex.edu/wifdn/>) having active programs to have volunteers detect and report invasive species. These efforts cover entire states and don’t appear to have as strong an early detection focus as Invader Detectives. But, if First Detectors is active in your state they may be the best home for Invader Detectives.

4.2 Geographic

Included the closest urban center or transportation hub. Include associated jurisdictions (such as primary suburban counties). Use distinct boundaries such as state and county lines.

4.3 Taxonomic / Ecological

Include all taxonomic groups unless there is some organizational or regulatory reason to split up taxonomic groups. Include terrestrial and aquatic areas unless there is some organizational or regulatory reason to split them up.

4.4 Objectives

Set some objectives for your first year and for subsequent years. Objectives are 'SMART' if they are **S**pecific, **M**easurable, **A**chievable, **R**ealistic and, **T**imely (or time-bound). For example:

- Recruit volunteers at three events before summer 2018
- Hold a kick off meeting in the first quarter of 2018
- Develop Watch lists for five groups by January 1st, 2018

4.5 Create an Operations Manual

Use the guidance in this document and the companion document to create an Operations Manual for your project. The Operations Manual will be a centralized location where methods are recorded. It will speed up information transfer among cooperators and ensure collaborators are being consistent.

4.6 Lessons learned – Setting the Scope

- Explicitly define the geographic extent
- Identify an existing organization to operate the project – don't create a new organization unless you have to
- Include all taxonomic groups, if possible
- Include both aquatic and terrestrial systems, if possible
- Create an Operations Manual

5. ADMINISTRATION

5.1 Leadership

A Planning Team is needed to initiate ID. If the parent organization is robust, the organization leadership may form the core of the EDRR Planning team. If not already included, consider representatives from:

- Large public landholder
- County government
- Citizen Science Specialist
- Invasive species policy expert
- County extension
- Master Naturalist Coordinator
- Urban Forestry
- Entomologist
- Port Official
- Nursery Professional
- Landscape professional
- Urban wildlife researcher
- Data Scientist
- Non-Profit representative
- Taxonomists

5.2 Committees

Committees will likely be needed, especially for:

- **Outreach:** To coordinate branding, initial outreach about the program, recruitment of new volunteers, communication with existing volunteers, and sharing information related to new discoveries.
- **Training:** To develop training materials, plan regular training events, and identify training needs. Training will primarily be existing training rather than new training.
- **Areas to search:** To identify areas of particular interest that would be searched regularly for a wide range of taxa. These include both general locations and specific types of environments in the general locations. The group will discuss how to use data to determine where to look.
- **Alerts:** To identify and implement a strategy (primarily technological) to produce lists of species of interest. In addition, the group will propose methods for disseminating information about reports of species of interest in the future. Species not of interest might include native species and non-native species that are too common to be considered ED targets.
- **Watch Lists:** To produce multiple lists that will contain small numbers of species on each list. Lists may be targeted by taxa (e.g., terrestrial vertebrates, aquatic plants) and/or user group and/or area (e.g., hikers, fishermen, hunters). This process may involve coordinating species assessments using the EICAT (Environmental Impact Classification of Alien Taxa) tool.

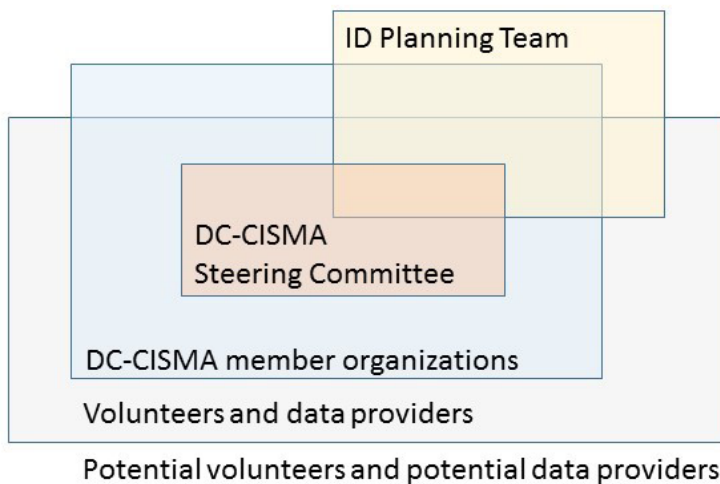


Figure 2 The relationship between the DC-CISMA and components of the DC Invader Detective chapter.

be to harness as many data collectors and data evaluators as possible. Don't restrict yourself to only existing volunteers – also include existing staff and potential new staff and volunteers.

Create a list of organizations that are involved in managing, monitoring, or observing plants and animals. These organizations can assist in getting the word out, providing data, and providing volunteers. Consider environmental education organizations, birding clubs, “friends of” groups, invasive species organizations, trail clubs, river keepers, native plant societies, master gardeners, master naturalists, herpetological societies, county, state, local, and federal agencies, native plant nurseries, and colleges and universities.

5.5 Citizen Science

Citizen science is critical to your success.

The Federal Toolkit (<https://crowdsourcing-toolkit.sites.usa.gov/>) provides a catalog of projects and tips. The process they describe is:

1. Scope out your problem
2. Design a project
3. Build a community

5.3 Partners/potential partners

Ensure the membership of the host organization is very broad. Government agency staff who manage natural areas are likely already included but representatives from other portions of governments such as transportation, agriculture, and extension may not be included yet.

Even though it is often hard to get participation, it is important to realize how people can feel left out if they are not invited to participate. Clarify how the various groups are related (e.g., Figure 1)

5.4 Participants

Data quantity and data quality are both important aspects of a successful chapter. One key goal should

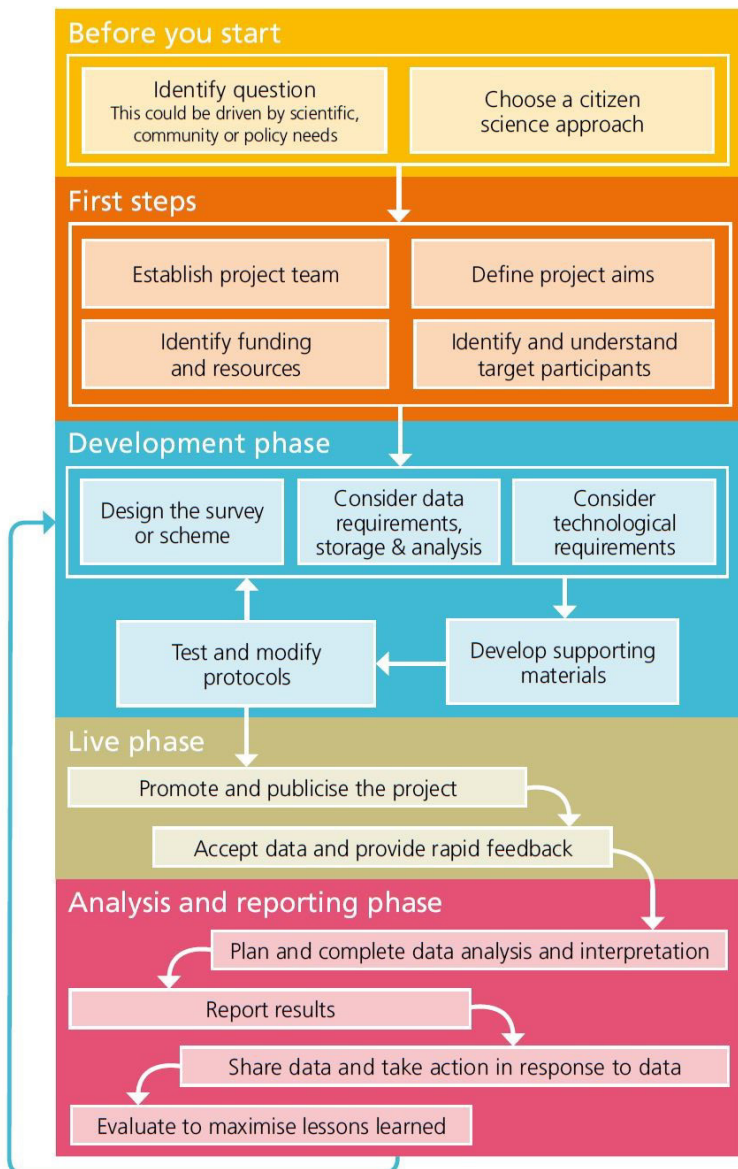


Figure 3 Citizen Science framework from Tweddle et al. (2012)

- needs
- Ensure the membership of the host organization is very broad
- Include staff and volunteers with diverse expertise and from across your area in your efforts
- Create a list of organizations (and contact information) that are involved in managing, monitoring, or observing plants and animals
- Include citizen science experts on the planning team
- Plan on strategies to recruit AND retain citizen scientists
- Include professionals as well as traditional volunteers in your plans to recruit, train, and retain

6. AGREEMENTS

6.1 Organization

The primary agreement is one that allows members of the parent organization to collaborate. The CWMA cookbook (MIPN 2011) has the following recommendations:

4. Manage your data
5. Sustain and improve

Tweddle et al. (2012; Figure 2) outline the process in more detail. Shirk and Bonney (2015) provide an updated and even more detailed review of citizen science. A few key insights they provide include:

- Understand and appreciate the goals and motivations of participants.
- Assess what capacity already exists before building new capacity
- “While citizen science can be economical, it is not free – projects need to be resourced...”
- Review existing efforts related to your goals. SciStarter and CitizenScience.org may have similar projects.
- In addition to managing for retention also value volunteer consistency and reliability.
- Celebrate “the contributions of volunteers and their roles in project outcomes.”
- Help constituents understand how the results apply to them. That requires an understanding of what they want out of the experience.
- Set clear goals

5.6 Lessons learned – Putting the people together

- Be explicit about who is in which group and what groups there are
- Establish a robust leadership team with diverse areas of expertise
- Establish committees to target specific

Keep the agreement short and as simple as possible. An agreement should

- identify the partners and their responsibilities.
- establish the legal authority or authorities under which the agreement is made.
- define the purpose of the agreement
- list items of agreement.
- describe land area covered under the agreement.
- detail how the CWMA will function.
- describe products the CWMA will produce, such as a strategic plan, annual operating plan, and reports.

An example MOU is here: <https://www.mipn.org/cwma-resources/>

6.2 Lessons learned – Agreements

- Shorter is better. The shorter it is, the easier it is to review.
- Structure the MOU so that each organization signs independently of other organizations.
- Control actions will likely require separate agreements with only one or two organizations (the land owner and the responders)

7. OUTREACH / TRAINING

7.1 Outreach

Outreach efforts are needed at many stages of the EDRR process. Outreach plays a role in identifying potential partners, providing training, notifying interested parties when an action is to be taken, and sharing the results of control efforts whether or not they were successful.

Recommended steps for getting the word out about Invader Detectives, training interested participants, and recruiting volunteers:

1. Build a website and outreach materials
2. Hold a kick-off event
3. Make a handful of presentations to groups who might want to participate
4. Get a blurb in many newsletters and direct interested individuals to the website
5. Ask other groups to take your flyer with them and have it on their table when they attend events

In addition to the more general outreach strategy outlined above it is important to communicate project activities to all internal and external interested parties. The ID-DC strategy is outlined in Table 1.

For ID-DC we identified a handful of outreach opportunities to cover in the first year that we felt would reach people with a broad range of interests and wouldn't create an overwhelming time commitment. In

Group	Topics		
	Activity alert	General overview	Request data
Current volunteers	As needed	Quarterly	
Planning Team members	As needed	Quarterly	
DC-CISMA members	As needed	Quarterly	
DC-CISMA Steering Committee	As needed	Quarterly	
Certain data providers			Annually
Other interested parties	As needed		
General public		Annually	

Table 1 Interested groups and communication strategy

addition, we identified dozens of local organizations that we will coordinate with to ensure our information goes out in newsletters and as part of existing tabling outreach efforts.

7.2 Training

Training plays an important role in ensuring data quality, recruiting volunteers, and retaining volunteers. Before developing new training determine what training already exist. Training topics include species identification, how to use the electronic reporting tools, and monitoring techniques.

Many CWMAS, CISMAS, and PRISMS have training information posted; be sure to check the organization in your area before creating anything new. Some tools developed in other regions can help serve as models. For example, the Wisconsin First Detector Network (<http://fyi.uwex.edu/wifdn/>) has useful resources including species lists, species fact sheets, and videos highlighting some of the newer invasive species.

7.3 Lessons learned – Outreach / Training

- Hold a kick-off event
- Leverage partner and related groups to get the word out

8. METHODS – OVERVIEW

8.1 Background

EDRR requires someone to look somewhere for something. Other sections discuss the questions of who that someone should be. The following sections discuss the questions of where to look and what to look for.

Providing a short watch list to a volunteer and asking them to report any occurrences of the species on the list provides a manageable task for the volunteer. However, it provides a challenge for the organizers. How do we identify a small enough number of species? Will the volunteer feel discouraged if they never see any of them?

Focusing efforts on incidental reporting places an unrealistic burden on volunteers; in essence what we are asking is for them to report every single species they find. Table 4 presents a summary of the two strategies.

Neither of these approaches gets at the most likely pathways of introduction. Rather than solely relying upon watch lists or on incidental reports, ID chapters should use a three-pronged strategy involving Target Areas,

Alerts, and Watch Lists. The approaches are summarized in Table 5 and explained in more detail in the next few sections.

	Watch List	Incidental
Number of species to look for	Small	Too large
Reports per volunteer	Very small	Very large
Volunteer feeling	Important	Hopeless
Data volume	Very small	Very large
Thoroughness (potential)	Less	More

Table 2 Comparing Watch List and Incidental strategies for EDRR

8.2 Data collection methods

Have volunteers use the online tools they are most comfortable with. If they want to use a single tool, have them use iNaturalist.

The North American Invasive Species Management Association (<https://www.naisma.org/>) has minimum standards for data collection. The standards apply not to the methods of observation but to what information is recorded. The primary questions the data should be able to answer are: What is the species? Where is it located? and, How large is the infestation? These standards were last updated in 2014 and have largely been incorporated into digital tools. If you develop your own reporting tool or platform you should review the NAISMA standards (<https://www.naisma.org/standards>) and the USGS NAS database reporting system (<https://nas.er.usgs.gov/SightingReport.aspx>).

For determining how to search – this varies by taxonomic group. Rough guidelines for each taxonomic group are provided in Appendix D.

Have your volunteers search monthly.

	Target Areas	Alerts	Watch Lists
GOAL	Areas likely to host target species are searched monthly	Automatic alerts are generated when a species of interest is reported on any platform	Provide short lists of species of interest to specific user groups
METHODS	Identify and assign target locations	Aggregate data	Create watch list by taxonomic group
	Search target locations	Filter data for species of interest	Disseminate watch lists
	Report new species	Send Alerts for species of interest	
SPECIES	All non-native	Non-native, uncommon, and invasive	Alerts sub-set
VOLUNTEER ROLE	Search and report	Incidental reporting	Targeted reporting
LOCATION	Targeted	Any	Any

Table 3 Conceptual design for 3-pronged approach

9. METHODS – TARGET AREAS

9.1 Building a list

Data are likely not available in sufficient density to be useful in identifying areas most likely to host invasive species. In the absence of such data, take these steps to build a list of areas to search:

1. Identify types of pathways of particular concern (e.g., railways, highways, rivers)
2. Locate (on a map) key areas where these pathways are most concentrated
3. Fill in additional areas to get even distribution across the region
4. Add unlimited spots for backyard surveys

9.2 Where to search – what locations in a landscape

In addition to identifying areas to search, ask searchers to focus on priority locations within the landscape, including backyards (e.g., Discover Life backyard moth collection).

Factors to consider that increase the likelihood of finding invasive species:

- Human corridors
- Natural corridors
- Industrial use
- Personnel nearby that can survey the area
- Utility lines
- High disturbance areas

Areas that were considered and rejected for ID-DC:

- Utility boxes – potentially low reward areas with high level of suspicion/danger
- Below large windows in the early morning – birds may have struck the window at night – there are so many birders around that this area will not be required to find any new bird species
- Under and around street lights – flying insects and bats will congregate – only valuable if the light is remote from other lights
- Trail heads – propagules transported by boot or bike – primarily valuable at a park level rather than a landscape level

9.3 Assigning to volunteers

Once your list is made, seek volunteers for each spot. Email volunteers at least quarterly to make sure they are still active and feel supported.

9.4 Lessons learned – Target Areas

- Choose sites that don't require seeking permission to enter
- Target transportation hubs

Distribute across the area

10. METHODS – SPECIES DATA

The information in this section is relevant to both Watch Lists and Alerts. It is organized into sections related to using FreshData for data aggregation. FreshData allows the user to take advantage of more than 1,000 data sources. If, instead, you would like to use only one data source, then use iNaturalist. iNaturalist has recently become widely used and, at least in DC, is the source of the vast majority of current records. To use iNaturalist you would need to set up a new project that includes a polygon of your area of interest and the reports from that polygon will be sent to anyone who subscribes to that project. The remaining sub-sections in this section pertain only to FreshData.

10.1 Aggregation (FreshData)

Access to data improves the Target Areas strategy but it is essential for building Alerts and greatly improves Watch Lists. There are a handful of data aggregation tools that specialize in pulling data together and, as a consequence, have quite a bit of data; each of them supports web services. The aggregation tool of choice for Invader Detectives is FreshData (<http://gimmeFreshData.github.io/>), because it contains more data than the other known aggregators and can be queried to meet a range of goals.

10.2 Existing Data (FreshData)

Data are needed to 1) create a robust Alerts process, 2) build accurate Watch Lists, and 3) ensure sufficient reports will be contributed in the future so that candidate species are identified.

Data sources that are currently incorporated into FreshData in some way

- iNaturalist (<https://www.inaturalist.org/>)
- EDDMapS (<https://www.eddmaps.org/>)
- iDigBio (<https://www.idigbio.org/>)
- NEON – (National Ecological Observatory Network; <http://www.neonscience.org/>)
- Reef Life Survey (<http://reeflifesurvey.com/>)
- USGS – Nonindigenous Aquatic Species (<https://nas.er.usgs.gov/>)
- Maryland Biodiversity Project (<https://www.marylandbiodiversity.com/>) – invasive species only
- National Institute of Invasive Species Science (<http://www.niiss.org/> in process)

- eMammal (<https://emammal.si.edu/>)
- Biodiversity Information Serving Our Nation (BISON; <https://bison.usgs.gov/>)
- GBIF – (Global Biodiversity Information Facility; <http://www.gbif.org/>)
 - Smithsonian collections (<http://collections.si.edu/search/>)
 - VertNet (<http://portal.vertnet.org/>)
 - Ebird (<http://ebird.org/>)
 - Fishbase (<http://www.fishbase.org/>)
 - Birding Bird Survey (<https://www.pwrc.usgs.gov/bbs/>)
 - 1,287 other data sources not listed above

Data source considered but not incorporated:

- Map of Life (<https://mol.org/>) – Includes data from GBIF and 200+ other sources. We don't include it here because none of the non-GBIF sources met our criteria of having more than 1,000 records, including non-native species, covering part of the USA, and being less than 5 years old.
- AquaMaps (<http://www.aquamaps.org/>) – Primarily aggregating data and primarily marine so not useful for us.
- USGS Disease maps (<https://diseasemaps.usgs.gov/mapviewer/>) – Only state-level data for Maryland and Virginia so not worth it for ID-DC
- USFS Forest Health Protection Data (<https://foresthealth.fs.usda.gov/portal/Flex/IDS>) – Limited data, only common names, not worth it now.
- Christmas Bird Count (<http://netapp.audubon.org/cbcobservation/>) – Limited value for invasive species and requesting data is burdensome.
- North American Butterfly Association (<http://www.naba.org/>) – Did not respond to inquiries
- USDA Forest Inventory and Analysis (<https://www.fia.fs.fed.us/>) – Limited value for invasive species and requesting data is burdensome.
- SERNEC (<http://sernecportal.org/portal/>) – Many collections are included in iDigBio and the remaining collections will be included by early 2019
- iMapInvasives (<http://www.imapinvasives.org/>) – Very little information in our area
- NAPIS (National Agricultural Pest Information Services; <https://napis.ceris.purdue.edu/home>) – Only limited data gets input and the states control it. Getting access is likely possible in some way but the barriers are high and the reward is unknown.
- EDWIP (Ecological Database of the World's Insect Pathogens; <http://cricket.inhs.uiuc.edu/edwipweb/>) – No geolocations
- WHISPERS (Wildlife Health Information Sharing Partnership; <https://www.nwhc.usgs.gov/whispers/>) – Naming conventions make this challenging
- i-Tree (<https://www.itreetools.org/>) – i-Tree coordinators are willing to assist but only if local organization agrees. For DC – Casey Trees is willing to share only at the county level

10.3 Acquiring data (FreshData)

For your area there are likely other data sources; get as much data available online as possible. There are many people collecting relevant information every day. Some of those people may not be natural resources professionals (e.g., city tree managers) or they may not share their data with anyone. To increase data access:

1. Brainstorm a list of governmental and non-governmental entities that might be collecting data
2. Go through this dichotomous key for each data source:

Do they collect data on organisms that includes both a scientific name and location information?

No – Cross them off of your list

Yes – Do they share their data online?

No – Are they willing to share their data annually?

No – Email them at least annually and ask for any reports of species that might be of interest

Yes – Email them annually and ask for the data from the last year

- Yes – Is it in FreshData?
- No – Is it easy to add it?
- No – Is it very valuable?
- No – Don't bother
- Yes – Work with FreshData to see if there is a solution
- Yes – Ask FreshData to add it.
- Yes – Great!

This likely requires contacting individuals at many organizations and is made easier with a robust Planning Team. This process was quite time consuming so I recommend sending out a survey of sorts to solicit input. Also, focus on the big data sources rather than small collections of data. Instead, plan regular outreach to ask interested parties if they have seen anything of potential interest since you last talked to them.

In addition to the databases listed above, other organizations are collecting potentially valuable data and not sharing it online. For ID-DC we have implemented an annual data request to biologists or data managers in the region that have indicated their data may be useful and they are willing to share it. See the companion document for a summary of the organizations that are active in the DC area and notes about where their data go.

10.4 FreshData information

FreshData is not currently designed with a sleek user-friendly interface. However, you can set up a data monitoring query here: <http://gimmefreshdata.github.io>. Data providers can register data archives with FreshData using <http://archive.effechecka.org>. Data may be uploaded once or set up for periodic updates. For more information on FreshData contact Jen Hammock (HammockJ@si.edu).

10.5 Lessons learned – Species data

- Leave enough time for identifying and then incorporating additional data sets
- Focus on large data sources

11 METHODS - ALERTS

11.1 Process options

This sub-section covers the process ID-DC used for FreshData. If you choose to use only iNaturalist you will not be able to take advantage of automated sorting but you could produce a list that was checked individually for species of potential interest. Although this will be substantially more time consuming you may be able to overcome that time use by distributing the list by taxonomic group. An entomologist will not need to consult the list for many insect species that are reported but would have to for many plant species.

11.2 Process overview (FreshData)

The Alerts process involves thousands of taxa and tens of thousands of records. The goal is to have a customized FreshData query provide you with a short list of records that are within your area of interest and only include non-native species that are not currently known from your area of interest (or are very uncommon). To accomplish that:

1. Develop a list of native and common non-native species to exclude
 - a. Seek specific lists for specific taxonomic groups of native or common species; be as thorough as possible
 - b. Include synonyms
 - c. Included version of names (e.g., if you include *Panthera tigris tigris* also include *Panthera tigris* ssp. *tigris* and *Panthera tigris* subsp. *tigris*)
2. Set up a geographic area of interest; draw a rough outline of your area of interest in FreshData

3. Once a list is drafted, run the query in FreshData to provide a list of all taxa recorded in your polygon and excluding your list of taxa. This list will likely still be quite long.
 - a. Use the generated list to identify significant taxonomic gaps
 - b. Fill those gaps by searching for more lists and getting groups reviewed by taxonomic experts when possible
4. Students/Volunteers: Have one or more people adopt a taxonomic group for a week. If they can find reliable information online they should look up each taxon and note: Native/non-native, common/uncommon, and whether it should be included on the candidate list or excluded from the candidate list. If they can't find the information they should look for experts in the group in your region to help and make a list of experts that may
5. Biologist: Go one-by-one through the remaining list and do as much as you can. Many species can be quickly assessed – plants can be categorized using USDA PLANTS and EDDMapS within 30 seconds. Other groups take a few minutes each. Many taxa will have limited information online.
6. If unknown – leave those taxa as potential candidates. Once new records of that species come in you may be able to focus additional energy on determining its status.
7. You will end up with 1) a very long list of taxa to exclude, 2) a list of taxa to consider for Watch Lists, and 3) a list of taxa that fit neither of those lists. This third list of taxa may include species recorded in the area but not out of cultivation/captivity, likely misidentifications, and perhaps other species. If these taxa are reported in the future you will need to assess the species and the site for each report to determine if response is warranted.
8. Identify list of interested parties
9. Set up automatic alerts

11.3 Process for ID-DC (FreshData)

The first step was to create a draft list to exclude. In reality these took place in a few iterations but the process is presented here as a single effort for clarity. Data sources for all taxonomic groups were incomplete and for some groups no region-appropriate lists were found online. Lists that were used included:

- Plant species found in Montgomery County, MD and extracted from the Maryland Biodiversity Project in 2014. Only plants with more than nine records were used. The assumption was that plants with more than nine records just for one county were very likely to be either native or common non-natives.
- North American Myxomycetes from 1939 – https://archive.org/stream/myxomycetesdescr00macb/myxomycetesdescr00macb_djvu.txt
- Darkling beetles on Plummer Is. http://entomology.si.edu/StaffPages/steiner/2008_plummersisl.pdf
- iNaturalist taxa listed as native and/or endemic from MD and/or VA
- Herptiles of Maryland <http://dnr2.maryland.gov/streams/Documents/HerpKeyForWeb.pdf>
- Centipedes of Virginia (http://virginiannaturalhistorysociety.com/banisteria/pdf-files/ban5/Banisteria5_Hoffman_Centipeds%20of%20VA.pdf)
- Maryland Odonates <http://www.marylandinsects.com/MDDCOdonateRecords.html>
- Native Chrysomelidae from Staines and Staines
- Bees of Howard Co., Maryland with the removal of introduced species that might be uncommon
- Orhoptera of West Virginia. <http://www.jstor.org/stable/pdf/25077530.pdf?refreqid=excelsior:fcd29e-7ce13e54512e956cd26ae4b870>
- Leeches of N America less *Barbroni weberi* <http://wwn.inhs.illinois.edu/~mjwetzl/FWLeechesNA.html>
- Ants of eastern North America taken from Ants of Dyke Marsh and excluding species found in only a single study
- Virginia Digital Atlas native plant species
- Birds listed on Wikipedia for each of Maryland, DC, and Virginia plus the Encyclopedia of Life Birds of DC list. We removed *Cygnus atratus* and *Parus major* because we were not sure if they would qualify as common.

The second step was to evaluate species that made it past our filter. Individual species were determined if they were native or exotic, how common they were, and how invasive they were likely to be. This process was quite slow and relied upon many experts. Resources that include distribution information were particularly useful. Some key sites that were very helpful for specific taxonomic groups:

- Bug Guide – <http://bugguide.net/>
- World Spider Catalog – <http://www.wsc.nmbe.ch/>
- Odonata Central – <http://www.odonatacentral.org/>
- AmphibiaWeb <http://amphibiaweb.org/>
- FishBase – <http://www.fishbase.org/>
- AlgaeBase – <http://www.algaebase.org/>
- Butterflies and Moths of North America – <https://www.butterfliesandmoths.org/>
- Collembola checklist – <http://collembola.org/>
- AntWiki – www.antwiki.org/
- Rotifer World Catalog – <http://www.rotifera.hausdernatur.at/>
- Plecoptera Species File – <http://plecoptera.speciesfile.org/>
- Species Files exist for other taxa – http://help.speciesfile.org/index.php/Current_Species_Files

Some other resources for species in general that often include distribution information:

- Encyclopedia of life – <http://eol.org/>
- DiscoverLife – www.discoverlife.org/ – often has maps
- Nonindigenous Aquatic Species information resource for the USGS – <https://nas.er.usgs.gov/>
- NatureServe – <http://www.natureserve.org/>
- Global Index of all living things – <http://www.taxapad.com/global.php>
- Search for the taxonomic group plus the state or region (e.g., Hemiptera of Maryland)
- If you aren't successful at one level go to a finer level (e.g., Sternorrhyncha, Heteroptera, and Auchenorrhyncha instead of Hemiptera)
- State DNR websites sometimes have full lists of known taxa of a group or known natives

For groups of species we also sought input from professionals and/or used the resources listed above. For many taxa it was not possible to determine if they were native. In those cases “likely native” and “perhaps exotic” categories were used.

With all of that information compiled and the polygon created, we did another FreshData output using the updated list of taxa to exclude. The first unfiltered query resulted in 2.8 Million records in 12,172 taxa. After our first filter was applied on July 15th 17,879 records in 3770 taxa passed through the filter.

With the July 15th output additional steps were taken including:

- Added notes on species that had been identified as watch list candidates during the first review process
- Evaluated all taxa with more than 9 records
- Removed from consideration taxa that:
 - Had the same name (but perhaps differently formatted authority) as another taxon on the list
 - Listed as a genus only
 - Listed as an indeterminate species
 - Listed in more than one way as a sub-specific taxa (e.g. if var. *smithii*, subsp. *smithii*, and ssp. *smithii* are listed then only var. *smithii* was retained)
 - Were listed as sub-specific taxa but also as the species. This was only done if the species had been evaluated and there was no sub-specific differences in which category the taxon should be put.
 - Had multiple cultivars listed
 - Were listed as a sub-specific taxa but the species had already been excluded
 - In this way, 540 additional taxa covering 3970 records were added to the exclude list and 542 taxa from 1799 records were no longer considered. After those edits 2423 taxa made it through the filter and were used to start the watch list process.

To deliver the alert information to interested parties some system has to be put in place. For ID-DC we came up with this process:

- Determine a hashtag for the alerts results – for ID-DC we use #noveltaxadc
- Sign up for twitter
- Sign up for IFTTT
- Search available IFTTT applets for "if twitter mention then email me"
- Select the applet that Jen Hammock created
- Turn the applet on and configure it (gear icon). In the "Search for" box, enter your agreed upon hashtag

11.4 Lessons learned – Alerts

- Plan ahead
- Leave time to look up thousands of taxa
- Be sure you have the full list of taxa before asking experts. I found that experts were very responsive for my first request but often did not respond at all to a second or third request.
- Leave enough time for collecting lists of native and/or common taxa
- Create a single compiled list of taxa based on the FreshData output that includes Species, Native/Exotic, Common/Uncommon, Notes
- At least annually, ask interested parties for any records of unknown or uncommon non-natives

12. METHODS – WATCH LISTS

12.1 Watch lists – existing

Review existing watch lists for your area. Some states produce lists and the regional panels of the Aquatic Nuisance Species Task Force have produced regional lists.

The Cooperative Agricultural Pest Survey produces priority lists (<https://caps.ceris.purdue.edu/pest-lists>) of species that are of environmental and economic concern.

12.2 Watch list – creating

Watch lists may serve one or more goals including:

1. Provide location information for a species that may or may not be common but is likely under-reported.
2. Increase the chance of finding the first record of a species of great concern that is not yet known from the area
3. Encourage reporting by making participants feel valued
4. Provide information to support a species-specific control effort
5. Provide location or other information for a local study on some species or group of species

Regardless of the rationale for your particular list, each list should have 10 to 20 species listed and be accompanied by a one page handout and iNaturalist Field Guide. You may want to structure the lists so the top ten are on the front and the next set of ten are on the back so people can ignore those if they want. Perhaps with a line like "if you think you have a handle on the top ten – consider looking for the species on the back too!" Regardless of the number or type of species on the watch lists participants should be encouraged to report anything that might be of interest – anything that looks odd to them.

To summarize the process for ID-DC was:

1. Aggregate data for our area
2. Exclude common and native species
3. Separate into enviro-taxonomic groups
4. Go through each species to ensure un-common, non-native, and invasive
- 5a. If the resulting list is too short: seek suggestions (e.g., ANSTF, AmericanHort, PA invasive species list)
- 5b. If the list is too long: seek expert opinion and do additional species by species investigation

The recommended process in more detail is:

First brainstorm a list of watch lists to create. For example, ID-DC used:

- Aquatic vertebrates
- Aquatic invertebrates
- Terrestrial vertebrates
- Terrestrial invertebrates
- Terrestrial plants
- Aquatic plants
- Plant diseases and pests

Second, determine how many species will be on each list. For ID-DC, we targeted 10 species.

Third, refine the lists:

1. Take the FreshData list of Watch List candidates (or your list produced without FreshData, summarized by taxonomic group and number of records)
2. Review each species in more detail to ensure that each species is non-native, uncommon, and has a high likelihood of being invasive in your area. If time allows, use EICAT for each candidate. Only include species that are present in your area in very low numbers and/or are likely to be introduced and are known to be invasive nearby or in similar climates. For ID-DC data there were records of species used as houseplants and only invasive in tropical climates – those were easy to exclude. It gets harder as the zone of invasion gets closer. In general, if the species had many records but only in a climatologically dissimilar area I trusted that that species was unlikely to be a problem in our area. Conversely, if there were only a small number of records I assumed that there were insufficient cases of introduction to make an assessment on climatological restrictions to invasion.
3. If the resulting list for a group is too short seek additions from adjacent areas.
4. If the resulting list is too long, do EICAT for each species and/or seek expert opinion. If you have a group of interested partners or access to a class of college students then each candidate species should be ranked using the EICAT species assessment protocol (Hawkins et al. 2015) to evaluate the risk posed by candidate species. The EICAT has the potential to be a new global standard for assessment and Helen Roy recommends its use instead of the system she used.
5. Assemble the Watch List by group.

Fourth, create the watch list handouts with the top species for each group. Producing both a paper handout and a digital guide (see below for more information).

Finally, distribute the lists.

12.3 Watch lists – updating

Review one or two per year in detail. Remove species that are not suitable (absent, low potential to cause negative impacts, too common to be worth responding to, etc.). Add species based on EDRR actions.

12.4 Identification Guides

In addition to pdf watch lists (see example in Appendix E), create online versions using iNaturalist (<https://www.inaturalist.org/guides>). The guides allow you to choose which species to list and when a user looks at the guide they see the thumbnail photos. When they click on each photo they see a map of records nearby and a little bit of information.

To add a list to iNaturalist:

- Sign in to EOL
- Identify taxa to add and click “add to a collection” button. Repeat this until you have each watch list as

its own collection in EOL.

- Sign in to iNaturalist.org
- On the top menu bar: Click on Guides
- Click “Create a guide”
- Name the guide
- Click “Add taxa”
- Click “From EOL Collection”
- Paste in the URL from your EOL collection
- You should be able to view it in within the App now

12.5 Lessons learned – Watch Lists

- Create both paper and digital watch lists
- Leave time for detailed evaluations of at least dozens of species

13. REPORTING / COLLECTING

13.1 Reporting tool(s)

If you don't use FreshData then only iNaturalist may be used. Using FreshData means that then many reporting tools are acceptable. EDDMapS and iMapInvasives are prominent efforts focused on invasives that are well supported by apps. Ebird and iNaturalist are prominent tools that do not focus on invasives but are also well supported by apps. Alaska has a system with online, email, and telephone reporting options (<http://www.adfg.alaska.gov/index.cfm?adfg=invasive.report>). Don't spend your time trying to get people to report on two apps. Instead spend your time encouraging reporting on any platform that produces data you can get access to.

Note that there is a national reporting tool for aquatic species (<http://nas.er.usgs.gov/SightingReport.aspx>).

13.2 The importance of absence data

For the foreseeable future we will be faced with incomplete data on species distributions. Species distributions are made up of areas of presence and areas of absence. For common species there are typically sufficient records of presence to provide a rough approximation of the range of the species at a regional scale. However, for rare species, only systematic searches can result in the same degree of confidence in a species' range. In addition, as the size of the area of interest decreases the number of occurrence points in the area of interest will decrease. At some scale the information will become insufficiently detailed to provide confidence on the finer scale distribution.

For modelling suitable habitat and to get a more complete picture of distribution, absence information is valuable. However, absence information is rarely collected and some key tools don't support it. For example, iNaturalist does not appear to support negative (i.e., absence) reports. Other tools (such as the MAEDN app for EDDMapS) do have that capacity.

13.3 Collection protocol

Although a voucher specimen is the best type of collection to verify the species, vouchers are often impractical or illegal. As long as tools such as iNaturalist or EDDMapS are used to report species occurrences, sufficient information will be collected to make the records useful. That information includes a photograph, spatial information, a tentative ID, and a way to contact the reporter.

13.4 Photography Protocol

If a voucher is not taken, take a photograph. If a photograph is taken here are some tips for producing a useful image:

- Write detailed descriptions of the specimen and the habitat
- Record the location in writing
- Hold still – ideally with a tripod
- A macro lens or macro setting is often needed
- Include an item to help identify the size of the specimen. A ruler is ideal but many objects can be used to help the viewer determine how big the specimen is.
- Use maximum magnification
- Take a range of photographs that have key parts in focus
- Take the time necessary to take a good photograph
- Take multiple views including from above, below, and the side
- Ensure consistent lighting. A diffuser or reflector is ideal but another option on a bright sunny day is to keep the specimen in shadow. The shadow from an object that is not 100% opaque (like a tree canopy) is better than the shadow from an object that is 100% opaque (like the photographer)
- Use a neutral background if possible. You can move yourself or the image to improve the background. For example, instead of half of the image with the trail is the background and half with green leaves, shift so only the brown trail are in the background.
- Remove detritus from the specimen
- Photograph reproductive structures of plants and animals if possible – these are often essential for identification

13.5 Delineation protocol

Although patch delineation can be quite complicated (e.g., see guidance here http://www.natureserve.org/prodServices/pdf/EO_Specs_Separation_Distance_and_Mapping_Guidelines_for_Animals.pdf), for our purposes we only need to have a rough idea of how big the patch is. If it is a true early detection there should not be very many individuals or patches.

In general, observers should walk around the occurrence to the best of their abilities and estimate the size of the infested area. EDDMapS apps include the ability to record polygons which can help this process. If you use a tool that doesn't allow polygons add in the notes information about the size of the population.

13.6 Lessons learned – Reporting / Collecting

- Encourage reporting individuals to use online tools such as eBird and EDDMapS
- Encourage good photographs

14. VERIFICATION

14.1 Crowd-sourced verification

iNaturalist has a crowd-sourced verification process whereby users of the application confirm or deny the identification provided by the reporter. After two confirmations the record is labeled as “Research Grade.” Even without two confirmations the record is still visible as soon as it is posted. And, just because a record is “Research Grade” doesn't guarantee accuracy. Before action is taken an expert must verify the species.

14.2 Existing avenues by jurisdiction

A handful of government offices provide identification services for a small number of taxa. Additional groups and offices may provide identification services to a subset of a taxonomic group or do so voluntarily rather than as an official duty. The companion document summarizes those services for the DC area. It is important to expend effort in trying to identify the target organism to the lowest taxonomic group you can before seeking help. Many of the online resources listed elsewhere will be very useful.

The Aquatic Nuisance Species Task Force has an experts list by state that may be useful:
<https://www.anstaskforce.gov/experts/>

14.3 Vouchering

Any species must be authoritatively identified before irreversible action is taken. Identification may be possible without destructively harvesting any individuals but, in any case, destructive harvesting for voucher creation will be needed. This information is a rudimentary overview of the vouchering process and should serve as a reminder about the key steps after the reader has been trained.

Plants

1. **Collect** a representative sample of the target plant. Ideally you will have roots, stem, leaves, flowers, and fruits.
2. **Dry flat** – ideally in a plant press (wooden frame, corrugated cardboard ventilators, blotter paper, and folded paper (typically a newspaper)). Ideally fit in an area 11x16 in.
3. **Identify** – Either include your name, the plant name if you know it, detailed location information, habitat description, plant habit description, and date on the paper containing the specimen or include a reference number on the paper and a key to what the reference number means in a field notebook.
4. **Expert consultation** – Once dry

A color digital scan of the specimen before drying may help future identification.

Invertebrates

Detailed instructions are available here:

<http://invertebrates.si.edu/USAP2/usapspec.html>

1. **Collect** a representative sample of the target specimen. Follow euthanasia guidelines by taxon.
2. **Preserve** – follow preservation guidelines by taxon.
3. **Identify** – Either include your name, the species name if you know it, detailed location information, habitat description, specimen description, and date on the specimen label or include a reference number on the label and a key to what the reference number means in a field notebook.
4. **Expert consultation** – Once prepared

Vertebrates

Take a picture or a video. In most cases, collection to be left to professionals. However, if you are lawfully fishing or hunting then follow the fishing and hunting laws.

Note date, time of day, any size information, and a description of the activity of the animal.

Microorganisms

Collecting microorganisms usually involves collecting a host animal, host plant, water sample, or soil sample.

Collect a range of samples.

Store samples so they will not be crushed, so plant hosts will remain alive, and so invertebrate hosts cannot escape. Do not collect vertebrate hosts.

14.4 Lessons learned – Verification

- Before launching your project build a list of verification resources for your area by jurisdiction and taxonomic group.

15. IDENTIFYING THE LAND-OWNER

Secure permission to enter any land; an example letter is in Appendix F. When seeking permission to enter a specific private or public property to work on projects include a “Hold Harmless” agreement in the form

the land-owner signs to allow access. An example Hold Harmless Agreement is here: <https://www.mipn.org/cwma-resources>. An example form is in Appendix G.

15.1 Lessons learned – Identifying the land-owner

- Draft letters to send and receive from land-owners before you need them.

16. NOTIFICATION

16.1 Involved entities

Once the species identity has been confirmed and the land-owner has been informed, all relevant Federal, state, County, and local agencies and any private organizations that might be involved should be notified.

Notify and educate others who may have a vested interest (site users, taxon enthusiasts, nearby business owners, individuals or groups who are or will be affected, individuals or groups who think they will be affected, people whose support is needed).

16.2 Outreach to the public if warranted

In some cases you may need to conduct outreach right away when a species is found. Perhaps it is a noxious weed, the method by which the species was introduced is of particular interest, or the location where the species was found is of particular interest.

In other cases, outreach will be needed before a response is undertaken to eradicate the pest or after a response has been successful.

Regardless of what outreach the team decides is necessary, if possible, the team should identify a single point of contact for media interaction. A single point of contact reduces conflicting information and helps ensure a coherent story. Key messages should include:

- Being a “host community” to an invasion is a burden
- What the risks of no action are
- What response actions are being considered
- How the decision will be made (who, what factors, when)
- What comes next

For medium and large actions, develop a written public information strategy; include:

- Press releases
- Information packets
- Whether or not you will hold public meeting(s) to present the problem and identify issues
- A list of who the various interests are that may be affected
- A strategy to establish and maintain two-way communication between the management team and identified interests
- A strategy to summarize information and comments gathered at public scoping and other meetings and write responses to the comments

16.3 Lessons learned – Notification

- When in doubt, notify
- Some agencies have jurisdiction based on taxonomic groups and others on geographic area, affected human population or affected resource. Make a list of agencies with jurisdiction before you launch your chapter.

When a species is found, make sure the relevant government agencies (in particular land owners, state extension, natural resources) are aware right away.

17. IDENTIFYING NEEDS FOR PREVENTION

Each time a species is found there is an opportunity to re-evaluate prevention efforts. Perhaps prevention efforts related to that particular species can be implemented or modified. Or maybe prevention actions are needed related to the pathway by which the species was introduced or related to the location where the species was found.

17.1 Lessons learned – Identifying needs for prevention

- Each introduction is a failed prevention – learn from each introduction to identify ways to implement or supplement prevention efforts that would have stopped the introduction.

18. PERMITTING / COMPLIANCE

Identifying which laws and regulations apply to what actions by a given type of employee can be quite challenging. Below are a preliminary list of regulations and things to consider; consult with compliance specialists for all of the jurisdictions within your area.

18.1 Federal

National Environmental Policy Act (NEPA) – Any “federal action” requires NEPA compliance. Compliance documents can include Memo-to-the-file, Categorical Exclusion, Environmental Assessment (EA), or an Environmental Impact Statement (EIS).

Endangered Species Act (ESA) – Section 7 Consultation – Section 7 of the Act, called “Interagency Cooperation,” is the mechanism by which Federal agencies or other entities funded by a Federal agency (action agency), ensure the actions they take (or fund) do not jeopardize the existence of any listed species.

Rivers and Harbors Act – Section 10 – Covers certain activities conducted below the Ordinary High Water (OHW) elevation of navigable waters of the United States. These activities must be permitted by the U.S. Army Corps of Engineers. For our purposes this includes dredging and filling or otherwise disturbing the sediment. Unlikely to apply to most terrestrial responses.

Clean Water Act (CWA) – Section 402 – NPDES (National Pollutant Discharge Elimination System) permit (or modification of existing general permit) from the Environmental Protection Agency or delegated state agency. Even if action is small but pesticides are used then some sort of compliance action related to NPDES is likely needed.

Clean Water Act (CWA) – Section 404 – Permit for discharge of dredge/fill material. Unlikely to apply to most terrestrial responses.

National Historic Preservation Act (NHPA) – Section 106 – Similar to NEPA, NHPA Section 106 requires federal agencies to consider the effects on historic properties of projects that are carried out, approved, or funded by federal entities.

Animal Damage Control Act of 2000 – Gives USDA Animal and Plant Health Inspection Service the authority “to mitigate for wildlife damage on federal, state, or private land” (7 USC 426–426c, March 2, 1931, as amended 1987, 1991, and 2000). (ANSTF & NISC 2015)

Carlson-Foley Act of 1968 (43 U.S.C. § 1241, et seq., P.L. 90–583) – “Directs agency heads to allow state officials to enter upon federal lands under the agencies’ jurisdiction in order to destroy noxious plants growing on such land.” (ANSTF & NISC 2015)

Lacey Act – Title 16 (16 U.S.C. §§ 3371–3378) – “Provides that it is unlawful for any person to commit or attempt to commit any act described in § 3372(a), including to import, export, transport, sell, receive, acquire,

or purchase any fish or wildlife or plant taken, possessed, transported, or sold in violation of any law, treaty, or regulation of the United States or in violation of any Indian tribal law. It is also unlawful for any person to import, export, transport, sell, receive, acquire, or purchase in interstate or foreign commerce any fish or wildlife taken, possessed, transported, or sold in violation of any law or regulation of any state or in violation of any foreign law; or to import, export, Interagency Committee on the Movement of AIS onto and off of Federal Lands and Waters transport, sell, receive, acquire, or purchase in interstate or foreign commerce any plant taken, possessed, transported, or sold contrary to certain state or foreign laws.” (ANSTF & NISC 2015)

See ANSTF & NISC (2015) for additional information on regulations related to aquatic species and federal lands, especially agency-specific roles and responsibilities.

18.2 Regional

Some regional bodies exist that can pass binding regulations. For example, the Potomac River Fisheries Commission (PRFC) can pass regulations that apply in both Maryland and Virginia.

18.3 State and local

The potential for applicable state and local regulations is great. Be sure to check with a local specialist to determine what regulations might apply to EDRR activities. Here is a sampling of the more common types of regulations. Be sure to consider departments of Environment, Agriculture, Natural Resources, Public Works, and Transportation.

Rare species

Many states have legislated lists of rare species and the protection of those species may be required, at least on state lands.

Storm water

If control efforts require ground disturbance, a Stormwater Pollution Prevention Plan may be required.

Pesticides

Some local jurisdictions have passed laws to restrict pesticide use. Consult a county employee to understand how those regulations might affect EDRR.

Target pests

Many states have official Noxious Weed lists that generally include only widespread species and only those that threaten agriculture. However, the regulations establishing those lists may provide for access to private property under certain circumstances when dealing with a significant pest.

Land access

Each state sets rules about under what circumstances access to private land is allowed. The Nature Conservancy and the Environmental Law Institute (TNC & ELI 2007) present a review of these authorities for quite a few states. https://www.invasive.org/gist/products/gallery/edrr_final_version.pdf

18.4 Lessons learned – Compliance

Consult local specialists in each of the jurisdictions in your area.

19. ASSESSMENT

19.1 Species assessment

Check online to see if an assessment has already been done. A general search for Species name + assessment and species name + ranking may lead you to a ranking but there are a few sources that have posted a fair number of assessments (<http://explorer.natureserve.org/>, <http://cal-ipc.org/paf/>, <http://nyis.info/?action=israt>, <http://accs.uaa.alaska.edu/>). In addition, <http://www.iucngisd.org/gisd/> should post EICAT assessments soon. It is unlikely that all of your candidate species have had a species assessment done. If one has not already been conducted a new one should be conducted following EICAT protocols. Hawkins et al. (2015) present the full guidance.

19.2 Site assessment

If action may be warranted a site assessment is needed. Hold a meeting of key stakeholders; at a minimum, include representatives from:

- Government agencies with authority over the location
- Government agencies with authority over the species, if any
- Lead entity
- Representative from responding entity, if any

At the meeting (or in preparation) answer these key questions:

- Is the land-owner willing to act or grant access?
- Has a lead entity been identified?
- What is the distribution and abundance of the species occurrence?
- What are the potential environmental, health, and economic impacts of the target species?
- What rapid response options are available?
- Is the pathway known?
- Is the risk of reintroduction low enough to justify action?
- Can the species continue to be contained to this small location while control measures are planned and implemented?
- Are treatment methods available?
- What are the regulatory hurdles?
- Is funding available to act?
- Is funding sufficient to mount a thorough response?
- If no action is taken, what are the consequences?
- Is there commitment to get to eradication?
- Can the occurrence be quarantined?
- Is the public supportive?
- Has sufficient outreach been done?
- What are the pathways for further spread?
- Are there jurisdictional issues?
- Do we understand the permits required?
- Do we have permission to access the area?
- Do we understand response methods?
- What are the potential environmental, health, and economic impacts of the response?
- Do we have the required species technical experts on board?
- Do we have the required control method experts on board?

19.3 Lessons learned – Rapid Assessment

- Early coordination is key.

20. TECHNOLOGY

The problems posed by invasive species are great and the consequences of failure are dire. By embracing ideas that are new and re-purposing ideas used in other disciplines we can increase our chances of success. The NISC Secretariat hosted its first Invasive Species Innovation Summit in December 2016 and the plan is to make that an annual event. Martinez et al. (2017) present an inventory of innovative ideas. What follows are those technologies that might be useful for EDRR; technologies that would require action at a national or international scale are left out.

20.1 Detection technology

Visual monitoring

- Surveillance cameras that are already deployed for non-resource use could provide resource-related information
- Camera traps that are already deployed for resource use could provide additional data about species occurrences
- Current technology in use is good for large or medium sized animals but technology exists for much high resolution images
- Potentially useful for macrophytes if the cameras are moved around (on a drone, backpack, vehicle) although image quality would be a problem with current technology
- Potentially useful for small animals if used as a sort of pit trap in areas of interest

Image analysis

- Image analysis currently takes time but can be assisted by crowd-sourcing
- The technology is being developed to take existing camera trap images and to automate the detection of species of interest (Klein et al. 2015)
- Some tools exist (e.g., leaf snap, iNaturalist) that can, under ideal conditions, identify species. See Martinez et al (2017) Table 5 for more examples.

Sensors – acoustic

- Technology exists to monitor in aquatic and terrestrial systems for individual species. Researchers at the Cornell Atkinson Center have deployed acoustic sensors in the ocean and in terrestrial areas.
- A project has been started to detect mosquitoes using acoustic monitoring (<http://humbug.ac.uk/>)

Sensors – chemical

- Nanobiosensors can detect microorganisms
- Trained dogs can detect specific plants, animals, and disease
- Engineered dog nose mimics have been developed that can detect microorganisms

Sensors – eDNA

- Sampling for environmental DNA in water has become possible although the information provided is not sufficient on its own to locate the problem species
- A project supported by Conservation X Labs should be producing a portable tool for quickly detecting the presence/absence of a small number of specific species using a water sample from a water body of interest.
- Over time, sampling air should be possible

Sensors – visual

- Microsoft's Project Premonition, is developing traps that will selectively capture mosquitoes based on machine vision.

Multi-spectral imagery

- Existing satellite and aerial imagery provide images from above that can be used to detect some large species. This requires work to develop a species-specific search strategy using multiple spectra. Once a system is developed, GIS can be used to search large areas. NASA has the AVIRIS (Airborne Visible / Infrared Imaging Spectrometer) program that can produce images with resolution as fine as 1m.
- Images from sources like Google Street view may provide an additional opportunity, at a finer resolution and horizontally.
- In small areas drones and kites mounted with cameras may be useful

20.2 Assessment technology

- There are many online sources that contain information about species distribution and species traits including
 - <http://www.feis-crs.org/feis/faces/index.xhtml>

- <http://www.invasiveplantatlas.org/index.html>
 - <http://powo.science.kew.org/>
 - <http://wiki.bugwood.org/Invasipedia>
 - <http://www.iucngisd.org/gisd/>
 - <http://www.cabi.org/isc/>
- In theory, algorithms could be developed to mine online data sources and greatly speed up species risk assessments.

20.3 Reporting technology

- Sharing existing data is the most important strategy given current technology.
- In addition to information collection from purpose-built application (e.g., iNaturalist and EDDMapS) we must increase the sources to include other applications collecting relevant data for other sources. Many of these are not shared online.
- Harnessing tools currently used to detect other things in the environment such as devices carried by utility crews, backpack pesticide sprayers, and delivery vehicles.

20.4 Response technology

- Sharing what we learn from our successes and our failures will increase the likelihood of success for our efforts and the efforts of others

20.5 Lessons learned – Technology

- Technological advances may provide new tools and resources to improve every step of the Invader Detectives effort.

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22. APPENDICES

- Appendix A – Compiled lessons learned / recommendations
- Appendix B – EDRR Conceptual diagram
- Appendix C – EDRR plans
- Appendix D – Monitoring Guidance
- Appendix E – Watch List example
- Appendix F – Permission Letter
- Appendix G – Permission Form

22.1 Appendix A – Compiled lessons learned / recommendations

The lessons learned identified in the body of this document are repeated here.

Lessons learned – Introduction

- Identify a core team
- Leverage existing platforms/tools/organizations/trainings
- Spread the work over at least a few months

Lessons learned – Setting the Scope

- Explicitly define the geographic extent
- Identify an existing organization to operate the project – don't create a new organization unless you have to
- Include all taxonomic groups, if possible
- Include both aquatic and terrestrial systems, if possible
- Create an Operations Manual

Lessons learned – Putting the people together

- Be explicit about who is in which group and what groups there are
- Establish a robust leadership team with diverse areas of expertise
- Establish sub-committees to target specific needs
- Ensure the membership of the host organization is very broad.
- Include staff and volunteers with diverse expertise and from across your area in your efforts.
- Create a list of organizations (and contact information) that are involved in managing, monitoring, or observing plants and animals
- Include citizen science experts on the planning team
- Plan on strategies to recruit AND retain citizen scientists
- Include professionals as well as traditional volunteers in your plans to recruit, train, and retain

Lessons learned – Agreements

- Shorter is better. The shorter it is the easier it is to review.
- Structure the MOU so that each organization signs independently of other organizations.
- Control actions will likely require separate agreements with only one or two organizations (the land owner and the responders)

Lessons learned – Outreach / Training

- Hold a kick-off event
- Leverage partner and related groups to get the word out

Lessons learned – Target Areas

- Choose sites that don't require seeking permission to enter
- Target transportation hubs
- Distribute across the area

Lessons learned – Species data

- Leave enough time for identifying and then incorporating additional data sets
- Focus on large data sources

Lessons learned – Alerts

- Plan ahead
- Leave time to look up thousands of taxa

Lessons learned – Watch Lists

- Create both paper and digital watch lists
- Leave time for detailed evaluations of at least dozens of species

Lessons learned – Reporting / Collecting

- Encourage reporting individuals to use online tools such as eBird and EDDMapS
- Encourage good photographs

Lessons learned – Verification

- Before launching your project build a list of verification resources for your area by jurisdiction and taxonomic group,

Lessons learned – Rapid Assessment

- Early coordination is key.

Lessons learned – Identifying the land-owner

- Draft letters to send and receive from land-owners before you need them.

Lessons learned – Notification

- When in doubt, notify
- Some agencies have jurisdiction based on taxonomic groups and others on geographic area, affected human population or affected resource. Make a list of agencies with jurisdiction before you launch your chapter.
- When a species is found, make sure the relevant government agencies (in particular land owners, state extension, natural resources) are aware right away.

Lessons learned – Identifying needs for prevention

- Each introduction is a failed prevention – learn from each introduction to identify ways to implement or supplement prevention efforts that would have stopped the introduction.

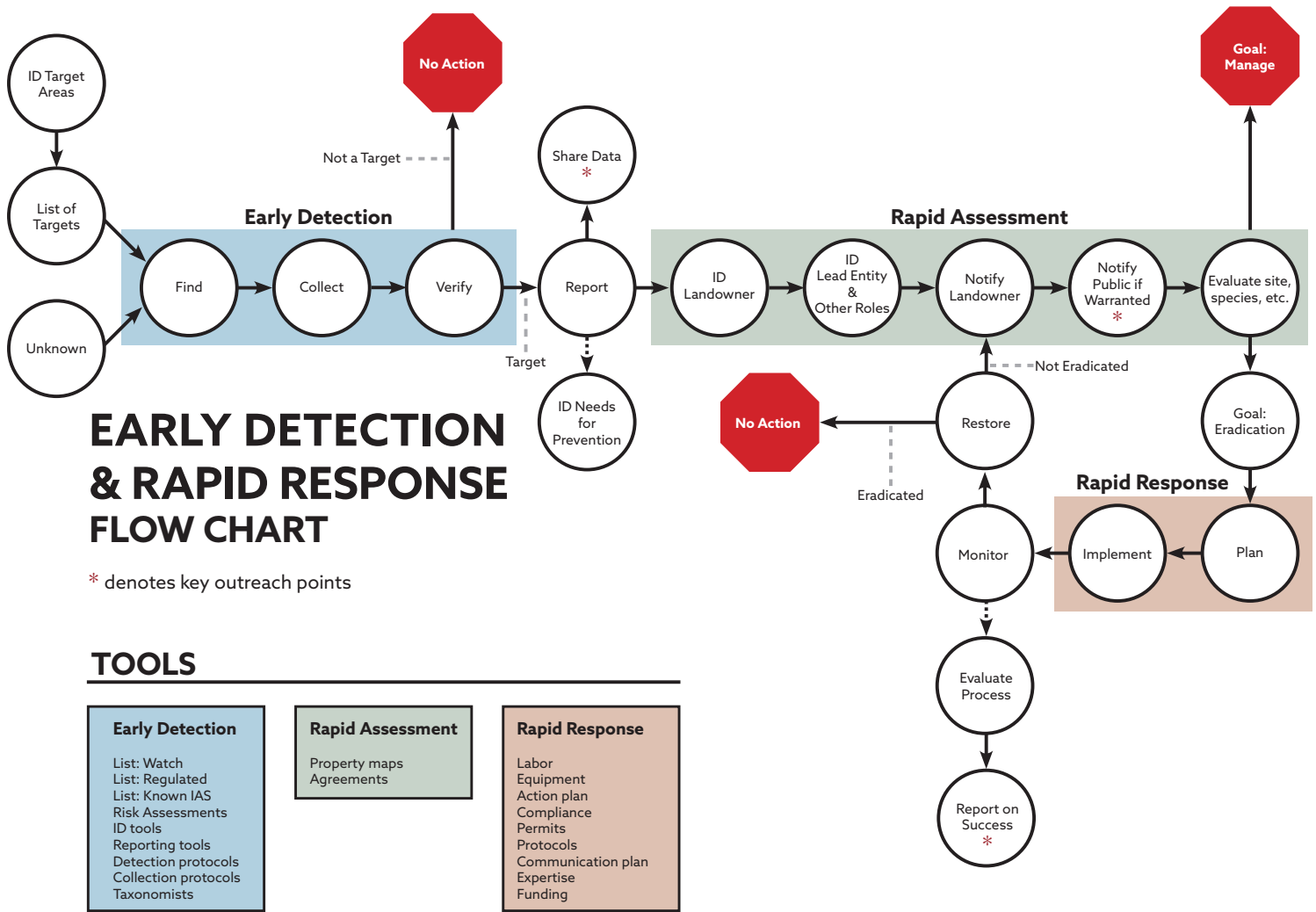
Lessons learned – Compliance

- Consult local specialists in each of the jurisdictions in your area.

Lessons learned – Technology

- Technological advances may provide new tools and resources to improve every step of the Invader Detectives effort.

22.2 Appendix B – EDRR Conceptual diagram



22.3 Appendix C – EDRR plans

Many states, tribes, and regions have produced plans outlining Early Detection programs or Rapid Response programs. These plans range in detail and in what actions they consider part of ED or RR. This list is a sampling of plans and is far from complete.

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22.5 Appendix D – Monitoring Guidance

This Appendix provides basic guidance on developing a monitoring plan for these key groups:

- Terrestrial plants
- Aquatic plants – floating/emergent
- Aquatic plants – submerged
- Aquatic invertebrates
- Aquatic vertebrates – fish
- Aquatic vertebrates – amphibians
- Aquatic vertebrates – mammals
- Terrestrial vertebrates – non-flying – small mammals
- Terrestrial vertebrates – non-flying – reptiles and amphibians
- Terrestrial vertebrates – non-flying – large mammals
- Terrestrial vertebrates – flying – bat
- Terrestrial vertebrates – flying – bird
- Terrestrial invertebrates

Each site, species, and goal will influence what a monitoring design will entail. In many EDRR cases the goals are simply to determine presence or absence and get a rough idea of extent– the methods below outline what a presence/absence survey would likely entail. To determine absence, multiple visits will be required in the year after any species are still found. Once no species are found for one year, the monitoring frequency can be slowly reduced first to once per year and then every other year.

Also keep in mind the potential to harm native species. If listed species might be impacted consultation of some sort will usually be required.

Terrestrial plants and Aquatic plants – floating/emergent

Tools: Site map, identification tools, datasheet and pencil, camera, and (for aquatic) boat.

Methods: If possible, traverse the site in a series of lines that are close enough together that you can see the species of concern at the size it is when you are sampling. For example, if you are looking for an aquatic macrophyte in July in clear water you can likely make your passes at least ten feet apart. But, if you are looking for forb seedlings in a grassland in May your passes may need to be only one or two feet apart. An evenly spaced line of investigators will improve morale, reduce the chance of getting off course, and reduce each individual's time spent searching. If a line of people is not possible, consider marking out both ends of each transect before searching. In large terrestrial areas marking the edge of the searched area with flagging tape provides a guideline for where to walk on the return transect. Sloped and forested sites can be particular disorienting.

If percent cover information is desired, the transects need to be systematically assigned and periodically assessed. See Elzinga et al. (1998) for guidance.

Aquatic plants – submerged

Tools: Site map, identification tools, datasheet and pencil, camera, boat, sampling rake, and viewing tube. An aquatic plant rake can be purchased or take two metal leaf rakes, remove the handles, bolt them back-to-back, and attach a rope where the handles were. It may be necessary to add weight in the form of a thin metal plate between the rakes. The viewing tube can be purchased at diver supply stores or made out of a section of 12-inch diameter PVC pipe and a clear Plexiglas circle glued over one end.

Methods: same as for Aquatic plants – floating/emergent

For deeper water with relatively good visibility or a more thorough survey divers can be employed. In this case, certified divers are also needed. Sampling can be sped up by towing divers by boat.

For details see Parson (2001).

Aquatic invertebrates

Tools: Site map, identification tools, datasheet and pencil, waders, shallow white tray, D-shaped aquatic sampling net.

Methods: Vegetation sampling, sweep netting, or kick sampling can all be used.

Vegetation sampling should be used for species clinging to vegetation. If the water is flowing, place the net downstream of the collection area to collect animals dislodged during plant collection. Collect samples throughout the area of interest and take the samples back to the lab to be carefully searched. In the laboratory use a shallow white tray to view and separate animals from the plants.

Sweep netting is best done in areas before they are disturbed. Use a 500 – 600 micron D-frame net and sweep through the water column for a distance of roughly one meter – bumping the substrate three times. After sweeping, turn the net so the opening is facing up and lift the net out of the water. Repeat in a handful of areas of the site – careful to sample different conditions. Transfer the material to the lab and use a shallow white tray to view and separate animals from the plants. More information in Franco (2014)

Kick sampling works best in shallow moving water. A D-shaped aquatic sampling net is ideal although other nets that can remain flush against the stream bed can be used. Place the net downstream of where you will sample. Disturb the sampling area by kicking or picking up rocks and rubbing them so that finer disturbed material flows into the net. Repeat in a handful of areas of the site – careful to sample different conditions. Transfer the material to the lab and use a shallow white tray to view and separate animals from the plants.

For invertebrates that are larger or sedentary (e.g., snails and mussels) methods are similar to those for submerged aquatic plants. See Duncan (2008) for more information.

Aquatic vertebrates – fish

Tools and Methods: Although searching with certified divers can provide some information electrofishing is typically required. Electrofishing guidelines can be found online. USFWS policies are outlined in Chapter 6 Electrofishing Safety (241 FW 6; <https://www.fws.gov/policy/241fw6.pdf>).

Aquatic vertebrates – amphibians

Detecting frogs and salamanders as larva, non-breeding adults, and breeding adults each poses different challenges. Gunzburger (2007) recommends the combined use of frogloggers, crayfish traps, and dipnets for an efficient and effective amphibian monitoring protocol. The following are taken from Gunzburger (2007).

Tools: Site map, identification tools, datasheet and pencil, specific tools listed in methods

Method 1: “A *froglogger* is an automated recording device that records sounds over a specified interval of time (Peterson and Dorcas, 1992; Peterson and Dorcas, 1994; Penman et al., 2005). The frogloggers in this study consisted of a tape recorder, microphone, timer with voice-time stamp, and 12 V battery (Dodd, 2003). . . . the microphone was pointed directly into the center of each wetland, and a plastic cone around the microphone served to reduce sound from surrounding areas. . . . The identity of each species of anuran calling on each tape was recorded by two separate listeners and any discrepancies were arbitrated by a third listener. “

Method 2: “*Crayfish traps*, designed for the commercial capture of crayfish, are large pyramid shaped mesh traps with three funnels at the bottom and a neck on top that allows captured animals to surface and breathe air.” Traps may be “purchased with a lining of smaller mesh size (mesh size = 5 mm) than standard commercial traps. The use of these traps has become an established technique for sampling amphibians, particularly large aquatic salamanders, that may be difficult to detect using other methods (Johnson and Barichivich, 2004; Sorensen, 2004).” Gunzburger (2007) “placed 10 unbaited crayfish traps at least 3 m apart at each locality. The bottom of each trap was pressed firmly into the substrate, and traps were held upright by a PVC pipe pushed into the substrate of the pond. Crayfish traps were set in the afternoon and checked in the morning at each locality, with an approximate deployment time of 14 h.”

Method 3: Gunzburger (2007) “evaluated two different types of dipnets, a D-frame sweep net (wooden handle, metal net frame, mesh size = 1 mm, mouth area 35 × 28 cm, Wards Natural Science) and a metal dipnet (metal handle and net frame, mesh size = 3 mm, mouth area 52 × 41.5 cm, Memphis Net and Twine). These two nets span the size range of dipnets used most often by aquatic ecologists in terms of mesh size and mouth area. [He] standardized each sweep to 1 m in length by using a floating meter stick for reference, and all net sweeps were performed by a single individual. Sweeps were separated by at least 1 m from the previous sweep, and [he] alternated between the two net types for a total of 10 sweeps of each net type. Most net sweeps were in shallow water, where the frame of the net was scraped along the substrate through aquatic vegetation. The contents of each sweep were sorted and counted prior to taking the next sweep.”

Aquatic vertebrates – mammals

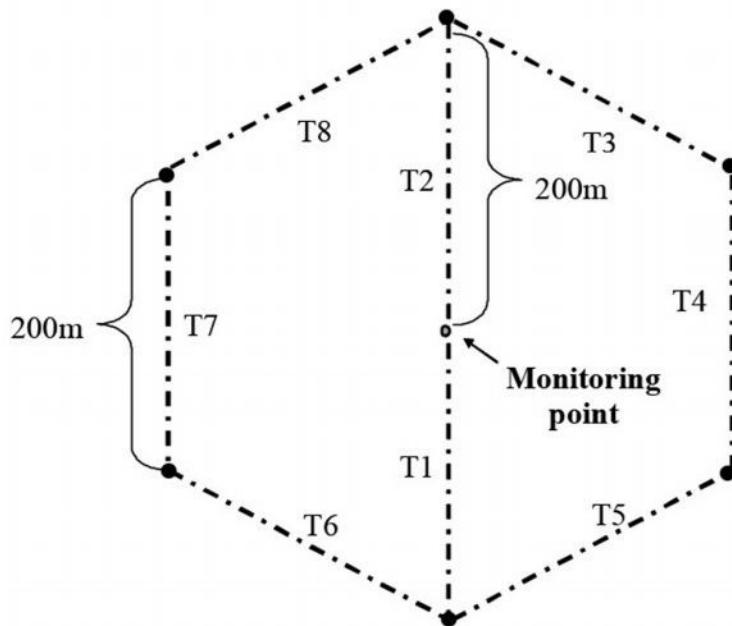


Figure A: Sherman trap layout. Taken from Manley et al. (2006).

Taken from Manley et al. (2006).

Tools: “Crews should bring boots or waders with felt soles or skid-proof soles, polarized sunglasses (for seeing through water surface), binoculars, dip net, clipboard, watch, field guides for individuals and signs of birds, amphibians, reptiles, and mammals.” Note that felt soled waders are no longer recommended or allowed in many streams.

Methods: “The entire perimeter of lake, pond, seep, and spring sites are surveyed, whereas wet meadows are surveyed throughout their extent. When two observers are present at a lake or pond, they begin at the same point and survey in opposite directions until they meet. In meadows, observers zig-zag from side to side, covering the entire width of the meadow with each new trajectory. In meadows, when standing water is too deep to walk through, observers walk the perimeter of the waterbody. When multiple observers survey a meadow, the meadow is divided among the ob-

servers so that the entire meadow is covered. Streams and rivers are surveyed by observers walking along the stream bank; in larger streams where both banks can not be surveyed simultaneously by one observer, one observer surveys each side of the stream.”

Terrestrial vertebrates – non-flying – small mammals

Taken from Manley et al. (2006).

Tools: “Sherman extra long (7.6 by 9.5 by 30.5 cm, model XLK) and extra large (10.2 by 11.4 by 38 cm, model XLF15) folding traps are sized to accommodate a range of small mammals including members of the families soricidae (shrews), muridae (mice, voles, rats), heteromyidae (kangaroo rats), and small-bodied sciurids such as chipmunks, ground squirrels, and tree squirrels (<http://www.shermantraps.com/default.html>).”

Methods: “The two sizes of Sherman traps are deployed alternately along eight transects, each 200 m in length, arrayed in a hexagonal pattern, and centered on the monitoring point [Figure A]. Transects connect point count stations around the monitoring point (see chapter 3, fig 3.1), with two additional transects passing through the center of the hexagon (400 m north to south). Traps are placed 20 m apart on a transect, starting at each point station and ending 20 m before the next point count station, for a total of 10 traps along each transect and 80 traps overall. Traps are placed within 2 m of the intended location at habitat features such as logs, burrows, the base of trees, runways, and always in areas that provide cover from weather (e.g., under shrubs, in tall grass). Transects and trap locations can be established and flagged as the traps are being set.

Efficiency can be gained, however, when the hexagon is first flagged for point count sampling by hanging flags every 20 m along the flag line between point count stations. These flags then mark where small mammal traps are to be placed.”

Terrestrial vertebrates – non-flying – reptiles and amphibians

Tools: Site map, identification tools, datasheet and pencil

Methods: Although many techniques can be used (e.g., pitfall traps, funnel traps, coverboards, transects) to search monitor amphibians and reptiles, Manley et al. (2006) recommends visual encounter surveys if only a single method is chosen. In general, observers systematically survey for individuals and sign by walking the sampling area.

Terrestrial vertebrates – non-flying – large mammals

Tools: Site map, identification tools, datasheet and pencil, trackplates, game cameras, mounting hardware

Methods: Manley et al. (2006) recommend three trackplate stations and three camera stations supplemented with visual encounter surveys. They recommend summer visual encounter surveys for terrestrial bird, mammals, and reptiles.

Terrestrial vertebrates – flying – bat

Tools: Site map, identification tools, datasheet and pencil, mist nets (bat-specific)

Methods: Mist netting is a standard bat sampling method and bat-specific mist nets should be used. Placement will vary by species but, in general, should be in travel corridors. Multiple locations over multiple nights are needed. Iowa DNR (2017) states: “Each area is surveyed at least three times during the summer season (May 15 through August 15), with at least a week separating the visits. Indiana bats, a federally endangered species, detected outside of this timeframe may be transient or migratory (USFWS 1999). Two to three ANA-BAT detectors should be deployed for 1–3 nights at each site. Detectors should be moved between suitable habitats each night, such that as many habitats as possible can be sampled during the 1–3 night timeframe. This process should be repeated 3 times during the summer season resulting in at least 6 nights and up to 9 nights of ANABAT deployment.”

Terrestrial vertebrates – flying – bird

Tools: Site map, identification tools, datasheet and pencil

Methods: Point counts are a standardized methods for bird detection. Sampling during the breeding season is ideal. Manley et al (2006) recommend seven point count stations per sampling point with 200m between points (six at the corners of a hexagon and one in the middle). Birders skilled in recognizing calls must conduct the survey.

Terrestrial invertebrates

Tools: Site map, identification tools, datasheet and pencil

Methods: A visual survey should be conducted on warm sunny days with no more than light winds. Visual surveys can be supplemented with quadrat sampling. Place a quadrat (often 0.5 m x 0.5 m) on the ground and intensively search within the quadrat for a few minutes. An aspirator may be needed to collect individuals for later identification.

More intense sampling should use Malaise traps for flying invertebrate and pitfall traps for non-flyers.

“Malaise traps are tent-like traps made of fine mesh material and used primarily for the collection of flies (Diptera) and wasps (Hymenoptera), although they also catch a great many other flying insects. Malaise traps are generally set out for long periods of time and checked at least weekly, or occasionally every other week. Basically, a malaise trap has two short end walls, one central wall, and a roof, which is only peaked

on one end, or in some styles, both ends. The walls are generally black and the roof is usually white. Poles, wooden or otherwise, are used to support the trap at each corner and at the peak in front. It is helpful if the front pole is adjustable so that the sample jar may be raised and lowered. The poles are in turn tied to stakes placed in the ground several feet away. If necessary, the ropes (or strings) may be tied to something. The traps we use are about 5 ft high at the front peak, 4 ft high in the back, about 6 ft long, and 3 feet wide. They are many variations on this basic design, but you get the picture. Insects hit the middle mesh wall and either fly upward or downward. Those insects that fly upward are funnel to the peak of the trap and eventually find their way into a jar with some sort of killing agent. We have found that alcohol works best for us because it preserves the insects over the course of a week well and also aids in keeping the inevitable lepidopteran scales from sticking to all of the other insects in the sample. Alternatively a dry killing agent such as no-pest strip (vaponax) can be used. If using a dry killing agent, one should check the sample more often, even daily.” (Mississippi Entomological Museum 2017a)

“One of the hardest parts of setting a malaise trap up is finding the ideal location and position to maximum the collecting. Typically, they are set up at right angles to an insect flight line. In some cases this is easy, because there is a natural or artificial opening that funnel insects through an area, but in other cases it is very difficult. If a hedge line, or thick forest edge is present, the trap may be placed next to it, especially on the north side of an edge running east to west. It is recommended that the bottle end be placed nearest the edge, but we have had luck either way. When searching for suitable spots, try to envision what the area will look like at different times of day. Many insects seem to gather in sun dappled spots, for example, and a spot that is in an area receiving sun more of the day will probably be better. Also, consider the extent of the undergrowth and how it may change through the course of time the trap will be out. Vegetation may grow so high that it restricts insect flight to and through the trap. For those insects that have a tendency to fall downward when hitting a barrier, pans containing a preservative can be placed below the central portion of the trap.” (Mississippi Entomological Museum 2017a)

“There are many variations of pitfall traps, but in its most basic form, a pitfall trap consists of some type of cup or other container (gallon bucket, for example) that is submerged in the soil and partially filled with a preservative. Insects and other organisms crawling about on the ground simply walk into the container and then cannot get out. Pitfalls can be covered to help prevent excessive rain from overflowing the cup, they can have guide vanes that may help guide organisms into the cup, and they may be baited to capture more specific types of insects.” (Mississippi Entomological Museum 2017b)

“The pitfall traps that we use consist of two plastic delicatesse cups, steel guide vanes, and a hexagonal steel cover. Each cup has an inner diameter of 11 cm at the top, an inner diameter of 8.8 cm at the bottom, and a depth of 7.8 cm. Cups are placed in holes in the ground that are dug with a golf course cup cutter, which minimizes impact to the surrounding area. Two cups, one inside the other, are placed in each hole so that any rain water will fill the bottom cup and float the top cup upwards to prevent loss of the trap contents. Each of the steel guide vanes used per trap measures 7.2 cm by 30.6 cm. We either use three guide vanes placed equilaterally around the cups and sunk in the ground approximately 2.0 cm, or one guide vane placed between two pitfall traps. A hexagonal steel cover, made by bending the corners of an equilateral triangle to form downward projecting points, is placed over the top of the nested cups to help divert rain. The trap cup is filled approximately halfway with a 50/50 mixture of propylene glycol and 70% ethanol, with a pinch of dentonium benzoate added to deter mammals from drinking the solution.” (Mississippi Entomological Museum 2017b)

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22.6 Appendix E – Watch List example

Watch Lists for ID-DC were created in Microsoft PowerPoint so that they would be editable by as many people as possible. A desktop publishing program would be more powerful and a good option if there is sufficient expertise and access to the software. The next two pages show a somewhat shrunken version of one of the paper Watch Lists. Once printed the document is folded on the long edge and then folded twice – using the dashed lines as guides. The result is a 4.25 x 3.67 in. booklet.



African Clawed Frog

Xenopus laevis



By Michael Linsenbach at the German Language Wikipedia, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?title=Xenopus_laevis

From: Southern Africa

Our area: Population removed from Arlington

Abundance: Rare or absent

Pathway: Perhaps released from laboratory or aquaria.

ID: Flattened, small head, 2-5 inches (snout to vent)

Impact: Predation

Timing: Unknown

How can I help?

You can report any

species with

www.Naturalist.org, the

Naturalist app,

www.EDDMaps.org, or

an EDDmaps app such

as MAEDN. The key

information you need is:

1) a good photograph,

2) location information,

3) the species name.

Which List area of interest



Created 8/21/2017 - Invader Detectives-DC is a project of the DC Cooperative Invasive Species Management Area and the National Invasive Species Council Secretariat.

These species were selected because they are not native to our region and are absent or uncommonly reported. In addition, the were identified as having a high potential for negative impacts on natural, agricultural, or commercial areas. Before taking any action the species must be verified by a taxonomic expert and permission must be granted to access the property and take action. We may learn that some of these species turn out to pose only minor impact.

For more information or to volunteer: Mark_Frey@nps.gov.

Aquatic

Vertebrates

Invasive Species to Watch for

DRAFT



Metropolitan Washington DC

Chinese soft shell turtle

Pelodiscus sinensis



CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?title=Pelodiscus_sinensis

From: Asia

Our area: Sporadic in MD and VA

Abundance: Rare or absent

Pathway: Aquaria, food

ID: U to 10 in long

Impact: Unknown

Timing: Unknown

Round Goby

Neogobius melanostomus



Center for Great Lakes and Aquatic Sciences, University of Michigan, Bugwood.org

From: Eurasia

Our area: None – only in Great Lakes

Abundance: Absent

Pathway: Ballast water / bait

ID: U to 10 in long. Distinct black spot on dorsal fin.

Single dorsal fin fused to form a suction cup on the belly.

Impact: Outcompete native fish. Eat native fish eggs.

Timing: Unknown

Asian eel

Monopterus spp.



M. Alou, Paul Stafford, Florida Fish and Wildlife Conservation, Bugwood.org

From: Asia

Our area: One 2014 record from Montgomery Co. MD

Abundance: Rare or absent

Pathway: Ceremonial releases

ID: Snake-like body shape, no pectoral fins, a single V-

shaped gill opening, no limbs.

Impact: Unknown

Timing: Unknown





Asian Carp

Hypophthalmichthys nobilis,
H. molitrix, *Mylopharyngodon piceus*



Silver carp, Lindsey Lorenz, U.S. Fish and Wildlife Service, Bugwood.org

From: Asia

Our area: Absent

Pathway: Stocked, aquaculture

Hypophthalmichthys ID: Laterally compressed.

Downward pointing geres, No scales on head.

M. Piceus ID: Darker than grass carp, large throat teeth, somewhat pointed snout

Impact: Eating native mussels, snails, etc.

Timing: Unknown

Nutria

Myocastor coypus



John and Karen Hollingsworth, U.S. Fish and Wildlife Service, Bugwood.org

From: South America

Our area: Once common on eastern shore of MD but perhaps eradicated, sporadic elsewhere.

Abundance: Uncommon

Pathway: Imported for fur farming.

ID: Larger than muskrat, smaller than beaver. Long round tails with fine hairs and orange teeth.

Impact: Overgrazing in marshes.

Timing: Unknown



Ide

Leuciscus idus



Yoshifumi, Creative Commons BY-NC-ND 2.0

From: Eurasia

Our area: Two records from 1999 in our area

Abundance: Rare

Pathway: Stocking, escaped ornamental, bait

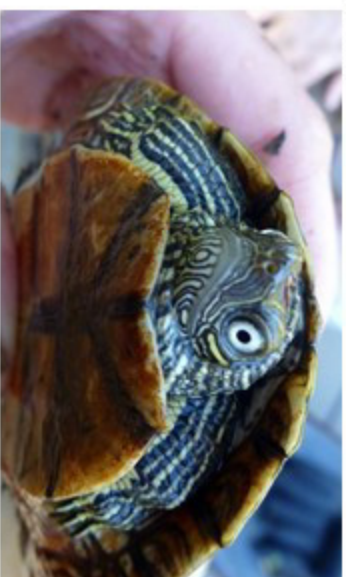
ID: All fins except dorsal with reddish tinge.

Impact: A population established in the 1800s may not have persisted.

Timing: Unknown

Mississippi map turtle

Graptemys pseudogeographica kohnii



© Mike, garten, Creative Commons BY-NC-ND 2.0

From: Central and southern US

Our area: 1960 record in Patuxent River, another in Adirington, VA

Abundance: Rare or absent

Pathway: Pet trade

ID: Tip to 10 in long, distinct skin pattern

Impact: Unknown

Timing: Unknown



Blue Catfish

Ictalurus furcatus



U.S. Geological Survey, U.S. Geological Survey, Bugwood.org

From: Mississippi River basin

Our area: In Potomac River and perhaps some tributaries.

Abundance: Perhaps common, need data to know.

Pathway: Stocking, aquaculture

ID: Similar to Channel Cat but with straight anal fin.

Impact: unknown

Timing: unknown

Flathead Catfish

Pylodictis olivaris



Todd Nelson, Department of Natural Resources, Bugwood.org

From: Lower Great Lakes and Mississippi River basin

Our area: Most rivers and some lakes.

Abundance: Perhaps common, need more information

Pathway: Stocking

ID: Lower jaw projects, tail fin with pale tip, short anal fin

Impact: Predation

Timing: Unknown

22.7 Appendix F – Permission Letter

Edit and copy this onto your letterhead:

Dear Land-owner,

My name is _____ and I am an _____ (Title) for _____ (Your Organization). _____ (Your organization), has initiated an effort to map and control _____ (species common name), a non-native invasive species, in our area. The goal of these efforts is to control the spread and possibly eradicate this species in our area. During surveys _____ (when) we noticed this species on or near your property. We believe controlling this species in this immediate area is key to stopping the spread into neighboring areas. Acting now will help reduce the impact to other land and reduce the cost to eradicate it.

I am writing to ask your permission to treat any _____ (species common name) which may be growing on your property. Our plan requires several years of follow-up surveys and treatments to ensure full control. To proceed with this plan, we need your permission. The permitting process may take several months to complete, thus we are now working to collect permissions in preparation for the necessary approvals (if applicable).

Please fill out the permission slip and return it to me as soon as possible. Thank you for your assistance and please feel free to contact me or stop by with any questions.

Sincerely,
Your Name
Your Title
Your Address

22.8 Appendix G – Permission Form

Edit and put this on your letterhead:

(Mail or email permission slips to land-owners for signatures.)

Date: _____

I _____ (owners name),

___ Give _____ (Your organization(s)) and their partners permission to control _____ (species common name) on my property using pesticides and other mechanical methods. I agree to hold harmless from any liability, the above named groups or individuals while they are applying invasive species treatments on my property. I understand that the intention for this invasive species control is for the benefit of myself and my property and am participating in said project in some capacity.

___ Give _____ (Your organization) and their partners permission to control this species on my property using only mechanical methods. I do not approve of the use of pesticides on my property.

___ Would like more information about this species. Please contact me at phone/email below.

___ Do not give _____ (Your organization) permission to enter my property.

Signature: _____

Phone or Email: _____

Address: _____

Please return this form to:

Your Name

Your Address



CONTRACTOR'S —REPORT—

National Invasive Species Council (NISC) Secretariat
U.S. Department of the Interior
Office of the Secretary
1849 C Street NW
Washington, DC 20240

Email: invasive_species@ios.doi.gov
Website: www.invasivespecies.gov

We can do this...

NISC

NATIONAL INVASIVE SPECIES COUNCIL
—SECRETARIAT—