

The Path Forward: An Invasive Arthropod Species International Management Plan

An Action Plan from the 2018 Summit on Invasive Arthropods

PREAMBLE

As invasive insects continue to spread around the globe, they are becoming a growing threat to the world's food supply, forest health, environmental quality, human and animal health, biodiversity, and fragile ecosystems. Managing this problem is a serious challenge. While much is known about how to attain solutions, there is still much to learn about insect invasions, their impacts, and the management needs. Therefore, in November 2018, the world's entomological community convened in Vancouver, British Columbia, Canada, to discuss invasive insect challenges and develop this management plan, which includes calls for action by global policymakers.

OVERVIEW

Invasive arthropod species, which include, but are not limited to quarantine pests, are a threat to our quality of life. They outcompete native species for scant resources, can transform ecosystems, and often travel within countries and over international borders undetected. The increasing number of speciesⁱ establishing in new environments every year across the Pacific Rim and elsewhere indicates this is an ongoing challenge for invasion prevention and management. It is clear that, as the risks and impacts of biological invasions grow, so do the economic and environmental costs.

Doing nothing is not an option.

The Entomological Society of America (ESA), the Entomological Society of Canada (ESC), and the Entomological Society of British Columbia (ESBC) convened a summit in Vancouver, British Columbia, Canada, November 9-10, 2018, of over xxxx leading researchers, government authorities, and influential stakeholders to develop this action plan.

The summit, titled “**Addressing the North American and Pacific Rim Invasive Insect and Arthropod Species Challenge**,” was convened by the ESA, ESC, and ESBC as part of the Grand Challenge Agenda for Entomology (GCAFE) initiativeⁱⁱ.

The primary outcomes sought from the summit were twofold: Collaboration and Concurrence.

- **Collaboration:** A major goal of the summit was to convene many of the primary stakeholders involved in the invasive arthropod challenge; assess the state of current knowledge, research, and management practices; and devise a collaborative path for sustainably addressing the challenge on an international scale. Leaders of international entomological societies, members of national invasive species task forces, policymakers, and leading researchers were all invited to participate. The summit was also designed to be a launching opportunity for formal and informal communication between stakeholders who want to make a meaningful and lasting impact on the ways that invasives are managed internationally.
- **Concurrence:** Addressing this challenge requires interagency and international agreement on the core needs and approaches both now and in the future. The goal is less about unanimity of opinion than it is about seeking broad agreement on areas where the scientific consensus is

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clear and the proposed actions are widely accepted as necessary to suppress or contain the harm caused by quarantine pests.

THE CHALLENGE:

Invasive species—arthropods in particular—pose global threats in ways that are neither widely understood nor commonly discussed by policymakers and the general public. National and international agricultural production, trade and economic development, human health, food security, and ecological stability are all threatened by invasive organisms that neither recognize nor respect geopolitical borders or agreements. However, the current agreements and systems in place to deal with the tsunami of invasive species are not sufficient.

Invaders may be plants, microbes, pathogens, or animals (including arthropods), and their presence has threatened agriculture and food security, trade agreements, forest health, ecosystem services, environmental quality, public health, and recreation. For the purposes of this document and discussion, invasive arthropod species (IAS) may be defined as alien or non-native arthropod species whose introduction causes (or is likely to cause) economic or environmental damage, negative impacts on the health of humans or domestic animals, and the weakening of infrastructure. However, putting an exact economic figure on the scale and scope of the IAS challenge is difficult, because the impacts often have cascading effects and many of the values impacted are difficult to quantify. For example, invasive species are a major threat to biodiversity—second only to habitat loss in impactⁱⁱⁱ. Approximately 42 percent of threatened or endangered species are at risk primarily because of invasive species^{iv}. Regardless, a widely circulated and accepted figure is that IAS alone incur control costs and agricultural losses (including crops, lawns, forests, and pastures) of nearly \$21 billion (USD) annually in the United States alone (citation needed). The annual global impact of IAS and other invasive species such as weeds, plant pathogens, and other animals is far greater and probably incalculable.

As a significant and growing problem recognized by scientists, non-government organizations, and governments alike, most countries have regulations to prevent the unintended introduction (consider word choice here, this has legal context per ISPM 5) of non-indigenous organisms. The spread of plant pests is addressed on a global level by international treaties such as the International Plant Protection Convention and regional plant-protection standard-setting bodies such as the North American Plant Protection Organization (NAPPO). A changing climate, expanding global trade, increasing human migration, urban expansion, and other pressures contribute to an unprecedented global movement of potential pest species. As a result, resources for current efforts to prevent the spread, or respond to the incursion, of potentially harmful invasive species within and between nations is already stressed to the limit. Given current funding, it is impossible for agencies to generate the financial and human resources necessary to exclude, monitor, and eradicate or manage all of these pests. Current policies and practices must be reassessed and new approaches devised.

IAS are predominantly transported by humans, most often inadvertently. Understanding the movement of invasive species and predicting their spread is a challenge. The impact of invasive species is felt particularly strongly along the Pacific Rim with its many international ports and ever-increasing movement of goods and people.

Invasion pathways (any means that allow for the entry or spread of a pest) are difficult to map but occur by land, sea, and air. Transportation of cargo by shipping is a major mechanism for invasive species movement, removing an otherwise substantial natural barrier. As an example, in a large port of entry

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such as Seattle or Vancouver, more than xxxx containers (number needed) may move through the port on a daily basis (citation will be needed). Interdiction efforts before invaders come ashore are critical. It is widely believed that inspections of people and goods at political borders are essential and effective in preventing exotic species entry. Yet, inspections alone are neither fully reliable nor a comprehensive solution. Inspection is only economically feasible for a very small percentage of the shipments (e.g., in Seattle, approximately xxxx (number needed) percent of cargo containers are inspected for invasives). Doubling, tripling, or even quadrupling the budget for inspections will likely have only a marginal impact on the entry of new species. The probability of detection is also limited due to human constraints and the difficulty in detecting and accurately identifying various life stages of potential pests that may be present in the commodity and the packing material or container. Other solutions to limit transportation and improve the scope and reliability of detecting potential invasive species must be found.

Furthermore, the general public is often unaware of the scale of the invasive species problem and its impacts; and, although often unintentional, the public contributes (via action or inaction) to the introduction and spread of invaders. Without learning about the impacts that invaders can have on their own livelihood and quality of life, people simply may not care or appreciate the consequences. However, the public are the “eyes and ears” needed for early detection and reporting if they can be properly engaged. Quantifiably improved efforts for outreach and education should be included as a goal of managing the challenge.

Although governmental efforts to enhance protocols and procedures for exclusion, detection, and elimination of invasive species continue to advance, there is a need to revisit the broad strategic framework for invasive species policy and operations. Achieving such a transformation represents another challenge. We hope that the outcomes of this summit that have resulted from discussion and proposals synthesized from participants who represent academia, industry, and government will provide a foundation for new action to address the invasive species crisis.

MOVING TOWARD SOLUTIONS:

The summit included intense discussion through plenary presentations, breakout discussion, informal networking, and panels. Many ideas, new and old, surfaced during the summit. It was agreed that quantifiable goals, based off of current benchmarks, need to be established for each of these solutions.

Over the course of the event, these points emerged as some of the most salient and most broadly agreed upon:

Opportunities to Improve Prevention Efforts:

Despite national and international efforts to limit their introduction and spread, environmental and human factors are creating additional pathways for the introduction of potentially harmful IAS and opportunities for them to thrive in new habitats. Many of the current approaches do not account for the changing political, economic, and ecological landscape in which IAS move and establish.

Summit participants agreed on the need to establish a scientific basis for developing policies to reduce the risk of introduction and spread of exotic pests. Improved pathway analysis needs to be conducted to inform quarantine policy. More attention needs to be devoted to pre-border exclusion of pests (i.e., reducing the number of species in shipments). Exclusion of potential invaders at borders through inspection of people and goods remains a monitoring tool, but cannot be relied upon as a primary invasion prevention solution. The primary procedures are quarantines and phytosanitary treatments.

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New and innovative approaches need to be employed to increase the likelihood of detection. Continued research for the technological improvement of inspection and detection tools is clearly needed. Areas to focus on include:

- Example one
- Example two
- Example three
- Example four

There is also need for strategic allocation of resources to better understand the process of invasion. For example, each exotic species interception provides a unique opportunity to apply informatics and genomics for analysis of its geographic origin and genetic composition. Routine genetic analysis of species interceptions can confirm their origins and contribute to the pathway analysis, and results can provide a more solid basis for decisions on appropriate intervention strategy.

Participants also agreed that increasing public awareness of the dangers of invasive species is crucial. If the public understands the dangers, they may embrace the opportunity as good citizens to prevent the entry and spread of invasive species. Innovative outreach campaigns (such as service announcements presented on all incoming airplanes and ships, and creative signs at border crossings) and proactive community engagement must be undertaken. (consider adding examples here)

Opportunities to Improve Early Detection Efforts:

In a perfect world, all potentially invasive species would be prevented from being transported or detected and intercepted before arrival at the border. But many slip through and the burden shifts to early detection. The first issue that needs to be addressed is the ability or capability to detect the metaphorical needle in the haystack. When an IAS enters a new environment, the invasion consists of one or just a few individuals which are difficult to detect. For species of known invasion risk, current monitoring systems consist of trapping grids or other early-detection systems, but these are generally inefficient and insufficient. Current methods can be improved and there is a need to develop national or international surveillance programs that are fully integrated among target pests. Second, though—at least in the U.S.—regulatory agencies reevaluate their surveillance programs annual, many IAS are still not monitored for in existing programs. Thus, early detection is often accidental. The haphazard detection of invasive species is inadequate for prevention. A primary mechanism to improve detection efforts is through public education and expansion of extension services. One possibility would be to establish networks of community “biosecurity champions.” The third issue is that, if collected in a trap or otherwise, IAS must be correctly identified, but we have declining human resources to meet these identification needs. It is critical to support education and employment opportunities and continued support of museums and other specimen repositories.

Opportunities for Improving Response Management:

Each new IAS requires a new management approach that may include new technologies to monitor and manage the species. Research is needed to develop strategies and tools for eradicating newly invaded populations using methods that have minimal adverse impacts on the environment and are socially acceptable. Coincident with this work, social science research is needed on how to best engage residence in eradication campaigns. Extension work is needed on how to better educate residents on the value of eradicating potentially damaging species and enlisting their assistance.

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Opportunities for improving management of IAS after they are established

It is essential to support and maintain systems to mitigate harm from IAS that become established. Ideally, the entomological community will foster and develop resilient systems (specificity needed) that can withstand IAS. Research, development, and capacity-building are foundational for evidence-based solutions, including areawide Integrated Pest Management (IPM) programs and habitat restoration efforts. With sufficient funding, legislative efforts, and increased public awareness, the economic impact of invasive species can be mitigated. Only through coordinated efforts among universities, private industry, non-government organizations, and state (provincial) and federal governments will we be able to prevent and manage invasive species. During the last few decades, capacity for biological control research has diminished in the U.S. (and Canada?). Funds are needed to counter this trend since classical biological control can provide uniquely effective solutions to mitigate the impacts of certain insect invasions.

Collaboration:

Invaders freely cross borders and efforts to contain and control them will require international collaboration. The challenge is often convincing national leadership of the peril. Efforts to harmonize approaches among neighboring countries, a NAPPO approach, can help in this respect.

With regard to IAS, we are frequently posed with threats that are difficult to detect and identify, and the biology may be poorly understood—particularly in the new environment. Entomologists must present a consistent and cohesive message to global leadership about the importance of the IAS challenge and be prepared to provide expertise to inform proposed actions. International sharing of scientific knowledge and data is particularly important for understanding and managing insect invasions; more options are needed for such sharing.

The network of those involved to seek solutions must be expanded. Invasive species threaten everyone: farmers whose crops are destroyed by invaders with no known control measures, office workers dealing with nuisance pest incursions, exporters losing money on shipments quarantined because of pests, and even pregnant women concerned about the health of their developing children because of insect-transmitted diseases such as the Zika virus. The list could go on and on: All of us are impacted by IAS, and the burden of prevention and management must be shared broadly.

National and International Policy Approaches to Explore:

Regulations in one nation can have a profound impact on control efforts in other parts of the world, and there are significant associated environmental and social justice issues. The entomological community must work together to influence policies on a global scale to recognize the threat of IAS and fund the fight. Cooperation and capacity-building among countries of varying economic resources can help reduce global spread of pests and benefit all nations. The legislative and policy focus must also shift from primarily plant and livestock pests and broaden to include IAS that impact human health and natural systems.

The world has never been more connected than it is today. While this level of connectedness has surely contributed to the IAS problem, it can also be a part of the solution by fostering increased collaboration. It is necessary to develop adaptive management partnerships involving federal, provincial, state, and municipal governments (including Invasive Species Councils); research institutions; private industry; non-government organizations; and other stakeholders, including international organizations, but the

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question as to how these become not only established but also functional and authoritative needs to be explored.

As with many other international challenges, the responsibility for action is greater than what can be borne by individual states, provinces, or countries, and requires extensive international cooperation and commitment. International treaties and agreements, such as the International Plant Protection Convention, the WTO Agreement on the Application of Sanitary and Phytosanitary Measures, and the Agreement Concerning Cooperation in the Quarantine of Plants and Their Protection Against Pests and Diseases^v, establish targets to which most of the world's governments are bound. However, some governments are less prepared with necessary expertise and resources to comply with agreements and meet the targets.

Most nations in the world have a National Plant Protection Organization (NPPO) charged with developing and enforcing regulations to prevent the introduction and spread of invasive pests. In the U.S. the NPPO is the USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA-APHIS-PPQ). USDA-APHIS-PPQ works together with other commissions, councils, boards or agencies in the management of invasive species. The National Invasive Species Council is one such entity in the United States, however, NISC has not met as a body since 2008, when the council was first formed by Executive Order^{vi} (validation needed). Further complicating the situation, communication is often lacking among and between agencies which negatively impacts efforts to streamline responses to IAS.

Development of policy has been left to the NISC Secretariat, which developed a management plan that identified five priority actions. These common goals are not solutions, but are meant to identify where scientific and management efforts should be directed. The goals, as identified by NISC, are:

1. Provide Institutional Leadership and Set Priorities
2. Facilitate Effective Coordination and Cost-Efficiency
3. Raise Awareness and Motivate High-Impact Actions
4. Remove Barriers
5. Assess and Strengthen Federal Capacities^{vii}

While these goals are U.S.-specific, they have resonance when considered in an international arena as well and can serve as a framework for developing an international response. Further, they can serve as a baseline for a truly global response to IAS. Development of an international organization (i.e., a partnership with the United Nations) that is charged with working with national partners on coordinating a response to invasives is one way to make progress toward a collaborative solution.

The entomological community must develop a structure with accountability measures for meeting targets defined in this document, either by continuing to convene summits like the Vancouver summit or through other means.

Foster Innovation:

Gaps exist in the tools and techniques needed to combat IAS. Invasion biology is just one such little-understood and significantly underfunded subject. We need to better understand the common patterns and principles that apply to many pest invasions. Invasion biology must be better understood so that we can better predict invasions before they occur. Risk assessment (example needed) provides focus in

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preventing invasions but is neither a complete solution nor an infallible safety net. As was mentioned earlier, we need to increase our ability to detect invasions early through continued research to improve traps, lures, barcoding, and molecular tools, as well as through increased training of monitoring and border control staff. As new invasion pathways develop, the tools needed to mitigate the threat must evolve to keep pace with changes in technology and be developed and deployed.

Sustained Funding:

Sufficient and sustained funding is instrumental for successful prevention, early detection, and rapid response programs for IAS. As national budgets on both sides of the Canada-U.S. border are constricting, increased pressures are placed on border control personnel to do more with fewer resources. This is equally true in other parts of the world.

Increased funding (both competitive and non-) for IAS research should be available for better understanding of the biology of IAS and all steps of the invasion process, and that research should include emphasis on systematics and identification (taxonomy), genomics, informatics, pathway analysis and management, ecology, evolution, demographics, risk assessment, pest management, economics, and social science. A large part of funding should create new research positions devoted to this work. Directing funding for this purpose is a win-win because it creates new jobs that have a direct benefit to the larger economies of all nations involved. Funding is also needed for universities, non-government organizations and those government agencies responsible for the prevention, detection, and rapid response to new incursions so that they will be able to effectively implement new technologies. Investments should be targeted toward research innovation and especially human resources. Entomological skill development is critical for the next generation of experts and to provide career paths for highly qualified personnel.

SUMMARY:

Arthropods are one of the world's most populous and diverse life forms and comprise a large part of overall invasive species problems. IAS are an international burden, causing negative impacts in known and unknown ways to the economy, human health, the environment, and property. While not every invasive species is equally harmful, the cascading impacts they have on biodiversity can wreak havoc in untold ways.

As international travel and trade increase, IAS will continue to be a vexing challenge for all citizens of the world. Finding solutions is everyone's responsibility, but entomologists, federal policy makers, and pest management professionals bear a special responsibility to outline solutions.

We, the undersigned, agree that the opportunities and goals highlighted by this summit are a worthy starting point for addressing the invasive species challenge (**online sign-on form to be provided at a later date**).

Consider adding an appendix or graphic (e.g., infographic or flow chart) of a successful model of IAS management and prevention that can show what a successful program for IAS could look like.

i http://cirs.ucr.edu/non-native_invasive_species_california.html

ii <https://entomologychallenges.org/initiatives/>

iii http://publications.gc.ca/collections/collection_2014/ec/CW66-394-2004-eng.pdf

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- iv Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52:273–288
- v <http://sedac.ciesin.org/entri/texts/quarantine.of.plants.1959.html>
- vi Executive Order 13112 (Invasive Species), February 3, 1999
- vii <https://www.doi.gov/sites/doi.gov/files/uploads/2016-2018-nisc-management-plan.pdf>

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