



REVIEW

The incident command system: a framework for rapid response to biological invasion

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Abstract The incident command system (ICS) is a framework for organizing and directing on-site, tactical responses to a particular event or series of events. ICS provides a command structure for coordination, information flow, analysis, decision-making, communications, and implementation in an authoritative and standardized manner. The ICS framework has been used for emergency response in a variety of situations where the environment, human health, or other resources are at risk, including wildfires, natural disasters, terrorist attacks, oil and chemical spills, infectious disease outbreaks, and invasive species. This paper outlines the key components of ICS, as well as major elements for building ICS capacity. It concludes with a list of considerations for applying ICS in the invasive species context.

Keywords Early detection and rapid response (EDRR) · Emergency response · Incident command system (ICS) · Invasive species · Rapid response

Introduction

The ability of federal agencies to rapidly respond to a newly detected invasive species is substantially enhanced by pre-planning and coordinated action (Reaser et al. 2019a, this issue). Recognizing this, Presidential Executive Order 13751 expressly calls upon the National Invasive Species Council (NISC) to “advance national incident response, data collection, and rapid reporting capacities that build on existing frameworks and programs and strengthen early detection of and rapid response to invasive species (EDRR), including those that are vectors, reservoirs, or causative agents of disease” (Executive Office of the President 2016). Similarly, the *2016-2018 NISC Management Plan* calls for building the capacity of federal agencies and partners to implement EDRR programs (NISC 2016).

The Incident Command System (ICS) is a framework for directing on-site, tactical responses to a particular event or series of events (US Department of Homeland Security 2017). The federally mandated model for incident response is embodied in the National Incident Management System (NIMS) developed by the Federal Emergency Management Agency (FEMA) and used throughout government (US Department of Homeland Security 2003, 2017). From the federal perspective, ICS provides a command structure for coordination, information flow, analysis, decision-making, and implementation in an

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authoritative and standardized manner. This framework has been used for emergency response in a variety of situations where human health, the environment, or other resources are at risk, including from natural disasters (Lutz and Lindell 2008), wildfires, terrorist attacks, oil and chemical spills (Moynihan 2007), infectious disease outbreaks (California Emergency Medical Services Authority 2014; Animal and Plant Health Inspection Service 2015), and invasive species. It should be noted that emergency response activities can also present a risk for the introduction and/or spread of invasive species (e.g., movement of hitchhiker species on vehicles, disposal of infested debris). The ICS process can facilitate the analysis of mitigating measures, such as the use of protocols to address those risks (e.g., firefighting equipment, watercraft). ICS standardizes the on-scene incident response process to provide an integrated organizational structure that can address the complexity and demands of an emergency where multiple agencies share management responsibilities or contribute to actions.

This paper provides guidance for applying ICS for effective, cost-efficient response to biological invasions, in keeping with the principle of EDRR (Reaser et al. 2019a, this issue) and relevant US government frameworks (Executive Office of the President 2016; NISC 2016; US Department of the Interior 2016). In view of the comprehensive principle of EDRR discussed by Reaser et al. (2019a, this issue), ICS comes into play as the response measure that is planned and executed on the ground after risk and feasibility screening identify this need. Once a potential invasive species has been detected, identified, and management (eradication or containment) measures are deemed warranted and feasible, ICS can be used to strategically guide on-scene actions, providing the structure by which government agencies and their partners cooperatively make decisions and mobilize resources. Ideally, ICS's on-site focus is complemented by the broader approach to incident management outlined in the NIMS and more specific sectoral guidance (e.g., FEMA's Emergency Support Functions).

The ICS Approach

The National Response Framework (Framework) provides guidance for national responses to all types

of disasters and emergencies. The Framework recognizes NIMS as the defining standard for the conduct of command and management structures responding to emergencies (US Department of Homeland Security 2016). Recognizing that there are a wide variety of emergency incidents, as well as a variety of potentially relevant agencies and partners, NIMS is designed to provide a common framework to achieve a common response goal (US Department of Homeland Security 2017). Within NIMS, ICS serves as the model for effective cross-jurisdictional coordination when an incident requires response from multiple emergency management and response agencies.

As described in NIMS,

ICS is a standardized approach to the command, control, and coordination of on-scene incident management that provides a common hierarchy within which personnel from multiple organizations can be effective. ICS specifies an organizational structure for incident management that integrates and coordinates a combination of procedures, personnel, equipment, facilities, and communications. (US Department of Homeland Security 2017, 24)

Employing ICS as a standard protocol helps establish, develop, and maintain skills, processes, and roles necessary for coordination across different types of institutions. When incident management responders from different organizations come together to address an issue, they know what to expect and how to act according to their particular role in the ICS system.

The five major functional areas of ICS activities include Command, Operations, Planning, Logistics, and Finance/Administration (see Fig. 1). Each of these areas defines key personnel and their role within the response framework.

- *Command* includes the incident commander in charge of the overall incident, as well as command staff that consist of a public information officer, safety officer, and liaison officer. If the response encompasses multiple jurisdictions or authorities over a situation, a “unified command” structure is established to jointly manage and direct incident activities under a common set of objectives, strategies, and incident action plans.

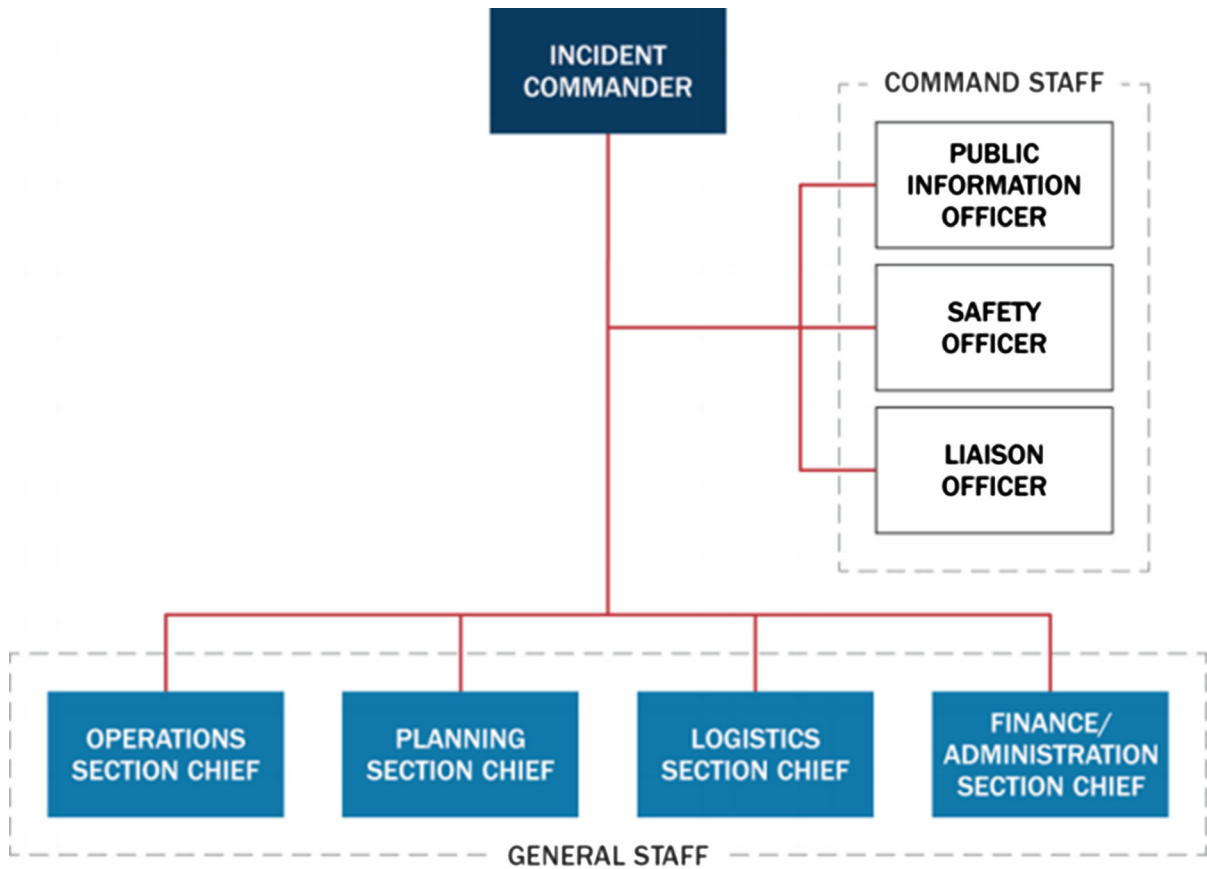


Fig. 1 Example of ICS organization with a single Incident Commander. This model represents the leadership components for an ICS operation. The incident commander serves as the overall lead (where multiple agencies are involved this would be a unified command unit). Additional command staff officer roles are designated for public information, safety, and liaisons.

- *Operations* is responsible for managing tactical operations at an incident within the context of the incident action plans.
- *Planning* collects and evaluates information on the situation and resources, and then processes it for use in developing action plans. This can be in the form of incident action plans, briefings, and map and status board displays.
- *Logistics* is responsible for providing facilities, transportation, communications, supplies, equipment maintenance and fuel, food services, medical services, and other off-incident resources.
- *Finance/Administration* manages all of the financial aspects of an incident. Not all incidents will

General staff chiefs oversee the discrete areas of operations, planning, logistics, and finance and administration. Depending on the size of an ICS action, these roles can be held by separate individuals (in the case of a large response) or they can be combined under a single individual (for a small response) (US Department of Homeland Security 2017)

require this support, so this section may only be activated if there is a particular need.

Other elements of NIMS, including the use of Multi-Agency Coordination Centers, Emergency Operations Centers, and Joint Information Centers, also support the implementation of ICS (US Department of Homeland Security 2017). Effective use of ICS and more broadly NIMS is critically dependent on reliable, up-to-date information (Reaser et al. 2019b, this issue).

Standardization of the ICS organizational chart and associated terms does not limit the flexibility of the system. A key principle of ICS is its flexibility, given that there will always be unique aspects to any incident (e.g., situation itself, resource and staffing availability,

applicable laws). The standardization of the ICS framework and roles does not limit this flexibility. For example, the ICS structure can vary in scale from a small routine operation up to a larger operation for addressing major catastrophic events (FEMA 2008). ICS has also been routinely applied outside of the emergency context as a means to coordinate planned activities.

The description above is a cursory overview of ICS, and more detail and documentation on its operation are available at <https://training.fema.gov/emiweb/is/icsresource/index.htm> (accessed 25 September 2019).

Application of ICS to invasive species

When is it appropriate to apply ICS as a means to improve invasive species response capacity? ICS is particularly appropriate when multiple agencies are addressing a complex situation under temporal and other constraints. However, the benefit that ICS offers in terms of clear roles and terminology can also support operational- and cost-efficiency as a standard operating procedure in more routine applications, especially for organisms that can spread (or be spread) quickly. Criteria or triggers for engaging ICS in an emergency context need to be clear and detail what does (or does not) constitute an invasive species emergency. These criteria and triggers can also be linked to the development and operation of detection programs.

Core concepts of ICS include

- common terminology,
- integrated communications,
- modular organization,
- recognized command structure,
- manageable supervisory structure,
- consolidated action plans,
- comprehensive resource management,
- pre-designated incident facilities.

An ICS action needs to have concrete objectives that can be broken down into discrete operational periods designed to meet those objectives. Those periods generally have their own incident action plan to describe the operational period outline, structure, and goals for appropriate action. Those incident action plans typically include the incident objectives, health and safety information, staff assignments,

communications plan, meeting schedules, contact information, as well as maps and other important field data.

ICS can be used across a range of scales from resource-intensive exercises involving hundreds of personnel and multiple jurisdictions to much smaller incidents confined within a single agency and/or management unit. To assist in the appropriate scaling of ICS, the process of incident complexity analysis can provide guidance on incident management requirements. FEMA has a generic complexity assessment template and more specific assessments have been developed to evaluate wildfires, which could serve as a possible analog for detailing an invasive-species focused complexity analysis (FEMA n.d.; National Interagency Fire Center 2018). It is also important to note that ICS has been used in more routine, non-emergency actions to address invasive species.

Based on information provided by federal agencies in their responses to a survey of federal EDRR capacities (Reaser et al. 2019a, this issue), ICS has been used by federal agencies and partners in a number of cases involving invasive species. For example, federal and state agencies on the Asian Carp Regional Coordinating Committee (ACRCC) used ICS in actions to address the risk of Asian carp in the Chicago waterway system (Tetra Tech 2010a, b). The US Department of Agriculture's (USDA) Animal and Plant Health Inspection Service's (APHIS) Plant Protection and Quarantine (PPQ) branch uses ICS and NIMS as core elements of their response programs (e.g., Asian longhorned beetle [*Anaplophora glabipennis*], fruit fly [*Rhagoletis cerasi* (Linnaeus)]) and incorporates those elements into a series of New Pest Response Guidelines targeting high risk plant pests (APHIS 2008, 2017a, b). APHIS also uses ICS when responding to invasive animals, most recently in collaboration with the US Fish and Wildlife Service to eradicate the New World screwworm (*Cochliomyia hominivorax*) from Florida (APHIS 2017c). Protocols to address potential introductions of aquatic invasive species on marine debris resulting from the 2011 Japanese tsunami detailed the need for deployment of the ICS framework in joint agency responses to help address jurisdictional boundaries and other policy concerns (National Oceanographic and Atmospheric Administration et al. 2012). Additionally, many of the National Park Service Exotic Plant Management Teams and US Fish and Wildlife invasive species

strike teams employ ICS in conjunction with their partners as a standard operating procedure (T Hogan, J Klavitter pers. comm).

Coordination

The broader set of structures outlined in NIMS along with ICS help to facilitate coordination across different agencies and organizations pursuing a mutually agreed upon, time-sensitive objective. While this system details the command functions, a number of additional aspects of coordination are critical to ICS's effective operation. ICS and associated incident action plans are crucial for guiding activity during an emergency and can be greatly facilitated by having a contingency or response plan in place beforehand.

Depending on the operation, a single incident commander may be appropriate for a single agency exercise, whereas a more developed unified command may be needed when multiple agencies are involved. Where there are multiple actors, agreements and memoranda of understanding developed prior to an incident are critical for establishing commitments and procedures related to resources and authorities. Mutual aid agreements, such as the Great Lakes–St. Lawrence River Basin Water Resources Compact, provide an assurance that funding and other resources will be available in an emergency and outlines how such resources are requested and funded as well as the roles of each party. Such agreements can also address triggers for activation, permitting, communication protocols, as well as the roles and responsibilities of involved parties.

State agency partners are an integral player in using ICS. Given their particular authorities, expertise, and resources, they often serve as the lead in an incident/unified command structure. For example, the Illinois Department of Natural Resources served as the lead agency for the major ICS actions focused on Asian carp in the Chicago area waterway system in 2009 and 2010, as well as subsequent smaller responses. Such invasive species activities can also be connected to broader all-hazard emergency response systems or state emergency operation plan.

The physical layout of the response is also important for coordination. In complex incidents, an incident command post is used to facilitate rapid communication with responders and field teams, and includes meeting spaces, computers, wireless and

satellite connectivity, and other onsite facilities and logistical details, which are important enabling factors for coordination. Systems for checking in and out personnel, vehicles and equipment, and chemicals/treatments are critical for ensuring safety and smooth operations and for meeting resource tracking and fiscal responsibilities.

While focus is predominantly given to carrying out the response to the detected invasive threat, attention also needs to address demobilization and concluding an ICS operation. This includes orderly cessation of operations, finalizing accounting and data summaries, conducting post-exercise evaluations and debriefing sessions to secure feedback for optimizing future responses, and ensuring that all ICS personnel have formally signed out.

Preparedness and planning

Preparedness and planning are fundamental to the effective implementation of ICS actions. It is important that responders have introductory training in ICS, while those in leadership positions receive more advanced, position- and team-specific training (e.g., ICS 300 and 400 level; see <https://training.fema.gov/emiweb/is/icsresource/trainingmaterials.htm> and <https://training.fema.gov/emi.aspx>, accessed 15 March 2019). FEMA and others also provide training opportunities to teams designated to support response actions, including through tabletop exercises or simulations and shadowing opportunities for live support actions when practicable. Lack of training can result in communication breakdowns across the chain of command given the specific nature of ICS roles, terminology, and execution.

Regular mock exercises, both tabletop and in the field, that cover a variety of scenarios are essential for establishing and retaining skills, building coordination and relationships across agencies and involved entities, and identifying key aspects of response that require improvement. Discussion-based exercises can highlight potential gaps in regulatory policies for managing spread, gaps in knowledge about the invasive species itself, effective survey, detection and control methods, and some of the logistical and technological needs that could lead to a safe and successful response. When expertise is needed for training or actual events, agencies can seek guidance from standing incident management teams from other

governmental agencies or private entities to aid in developing functional programs and responses.

Broader emergency management or rapid response plans can guide ICS structure application for various scenarios, including priority geographies and target species. Such planning can incorporate the flow of information from a temporal (when to release information) and stakeholder (who is to receive information) perspective. As an example, federal and state agencies in the Great Lakes region develop an annual Asian Carp Action Plan, which is supplemented by an updated Asian Carp Monitoring and Response Plan (ACRCC 2018a, b). Figure 2 outlines the “Planning P” that the Monitoring and Response Working Group (MRWG) of the Asian Carp Regional Coordinating Committee uses to develop their incident response plan. In the Pacific Northwest, federal agencies, states and others have developed the Columbia River Basin Interagency Invasive Species Response Plan to address invasive mussels/Dreissenids (Columbia River Basin Team 2014). The state of Montana is also drafting its own Dreissenid Rapid Response Plan, which would align with the broader regional effort.

Use of data-based decision support trees, figures, and flowcharts can facilitate decision-making and overall understanding of operations further contributing to informed response management. Planning should include an understanding of logistical needs relevant to the scale and nature of the response action including site access, transportation, operations center, facilities for dining/housing/medical treatment, information system connectivity and communications, security, financial management, equipment storage, etc.

Planning also relies on and needs to secure relevant, reliable, and up-to-date information on a number of topics, including

- local geography, including maps of available access points (e.g., roads, boat launches) and logistical considerations (e.g., staging areas, transportation, housing),
- biological and ecological knowledge of high priority invasive species that might be targeted,
- available response tools for those high priority invasive species, including pertinent compliance information (e.g., for pesticide applications),
- available assets and resources from participating agencies to support the response effort,

Fig. 2 The Asian Carp Regional Coordinating Committee’s planning “P” for ICS actions. The Planning P represents the process that the Asian Carp Regional Coordinating Committee (ACRCC) uses to develop an incident action plan in response to an identification of Asian carp in the upper Illinois waterway. An identification triggers a number of initial activities by the Monitoring and Response Work Group including targeted assessment, initial response actions, and coordination with the broader ACRCC. This feeds into strategic planning activities to determine elements of a unified response plan. During the coordination, preparation and approval of the plan the Communications Work Group engages along with other ACRCC and stakeholder agencies. The final step is the execution of the plan and assessment of progress (Tetra Tech 2017)

- agency authorities over relevant geographies, facilities/resources, and compliance matters.

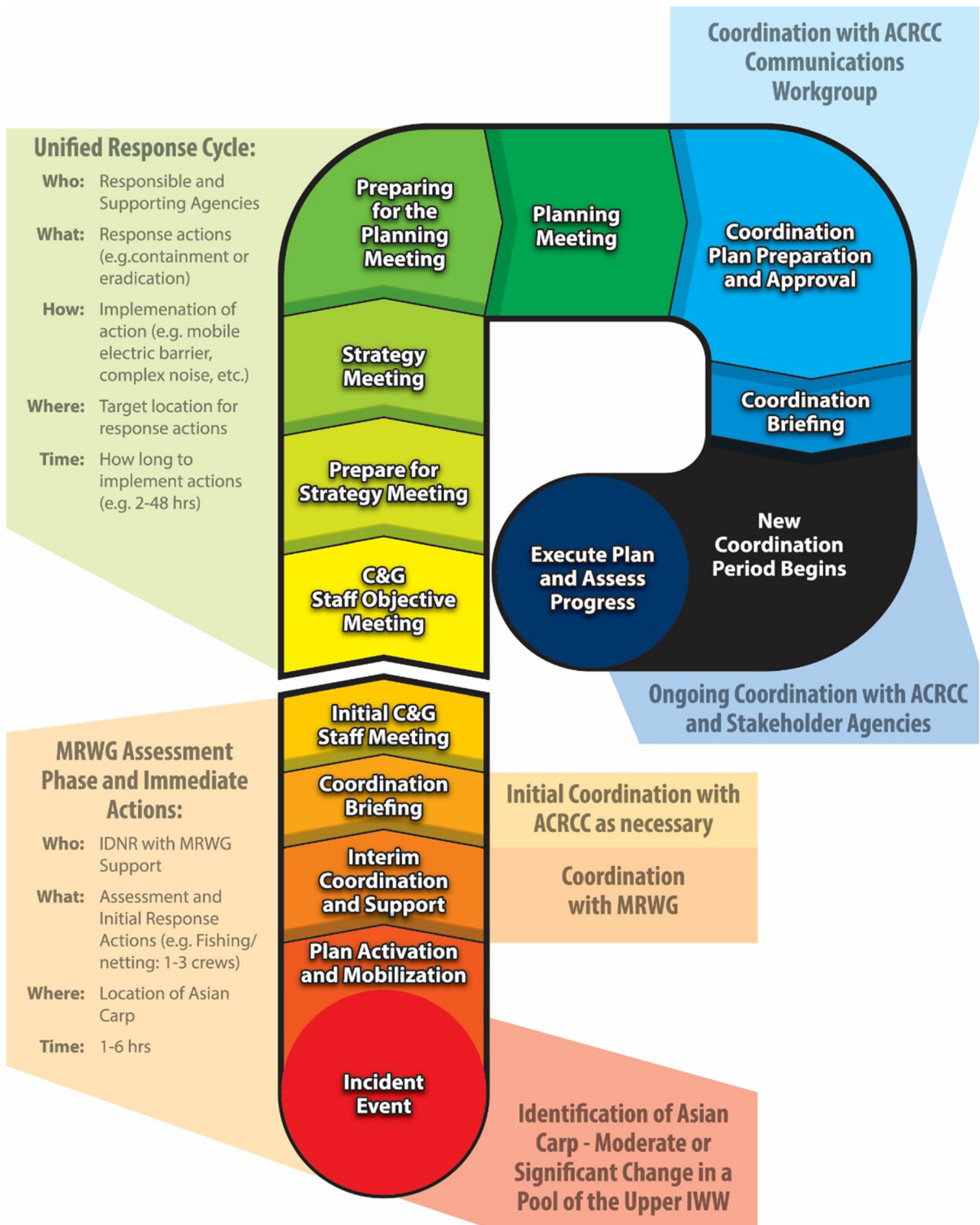
Finally, development of communication protocols, rapid response standard operating procedures, financial planning procedures, and other relevant guidance is particularly important for the effective and efficient performance of responders.

Communications

Clear communication is integral to all aspects of ICS from the perspective of internal operations, as well as external engagement with the public and media. Internal communications need to be concise, easy to understand, and use plain language especially when multiple agencies or disciplines are engaged. Ideally, agency communication staff are participants in the response exercise.

Generally, the initial alert or notification will come from the affected jurisdiction prior to the establishment of the ICS response. The ICS communications process incorporates the ability to activate and mobilize personnel, facilities, and resources for an ICS response. An initial mobilization briefing may be useful for clearly communicating mission objectives and relevant plans and protocols in use. Information on proper demobilization is also critical to ensure safety and a proper close to operations.

Information needs to flow both vertically and horizontally within the prescribed communication channels of the ICS organizational structure to ensure continuity of operations and safety, as well as to respect local, regional, state, and federal authorities and responsibilities. Relevant content includes



updates on key operational activities (e.g., safety considerations, weather, when pesticides are applied, when divers are in/out of the water). Regular operational briefings are important for communicating vital information about the response, as well as to ensure that information is being shared from the top down as well as from the bottom up.

An established communications protocol or framework can detail many of these aspects, including information on agency representatives and personnel contacts in key positions, a call tree/alert roster detailing communications flow, technical information on media in use (e.g., radios, WiFi), etc. The connectivity and technological support necessary to backstop communication requirements need to be considered (e.g., data access/transmission, GIS information, mapping/tracking tools).

An “incident” involving invasive species can increase public awareness, concern, and even alarm. From an external perspective, communications with and messaging to the public and media need to be incorporated early in the planning stages with a focus on gaining trust in and support for operations. NIMS details the use of Joint Information Centers, which play a major communications role in supporting incident response. A public information officer(s) can be designated in the command structure to handle external engagement. They would meet with other incident/unified command staff to inform the preparation of remarks and development of consistent messages. This also helps to ensure that agencies have situational awareness of ongoing communications activities.

Resources

Securing the necessary resources for ICS operations is a critical role and requires close coordination across those responsible for finance/administration, operations, planning, and logistics. Resources can take a number of forms including funding, personnel, vehicles and equipment, as well as technical knowledge and skills. Additional supporting elements for ICS operations specific to invasive species will vary upon location and event but may include

- specialist(s) to provide technical/scientific advice to the Command and General staff during the planning and operational phases of a rapid response (e.g. an environmental specialist/unit to consider potential environmental ramifications and regulatory requirements of treatment options),
- a Joint Information Center to support external communications to the public,
- an onsite mobile command unit as well as communication and computer facilities for support staff.

Building ICS capacity

While the previous sections are useful for detailing key topics related to ICS and incident response, they do not answer the critical question of how one starts to build ICS into response protocols. Fortunately, ICS is practiced in a range of other sectors at various jurisdictional scales (e.g., municipal, state, federal). Building on that experience can be an effective way to move forward. Integration of ICS into invasive species response includes the following elements:

- Planning: Response plans are critical for identifying key actors, geographies, potential threats, management measures, and resources. They can incorporate ICS as the command structure for responses designed to meet objectives outlined in response plans.
- Context: Usually a local, state, or federal agency may be involved in hazard response associated with other threats (e.g., wildfire, disease outbreaks). The plans and informational resources can be a useful template for building ICS capacity focused on invasive species. Given the standardization of the ICS format, joint training and sharing of personnel can also provide opportunities to rapidly build capacity.

- Training:** Basic training of personnel in ICS is essential to avoid communication and operational failures. Advanced training for invasive species focused staff is also helpful for facilitating implementation of ICS and communicating to decision-makers. Joint training with other hazard response teams can also sensitize additional personnel that could be engaged in an invasive species response.
- Exercises:** Mock exercises are critical for identifying gaps and obstacles. Initially, tabletop exercises can help with identification of key personnel and other informational needs. Field exercises can be valuable for identifying logistical and resources challenges. Exercises thereby provide key lessons learned to improve response capacity and to keep personnel versed in ICS.
- Criteria:** Clear criteria for what triggers an ICS response are essential to ensure efficiency in its initiation as well as confidence in the decision-making process. This might include specific geographical areas or species prioritized by jurisdictions and their broader stakeholder community.
- Resources:** A range of resources are required to properly implement ICS including personnel, administration, communications, logistics, equipment and supplies, etc. At a basic level this implies sufficient funding, potentially from a dedicated source, as well as the political support to use it to address an invasive species incident. Such resources can be leveraged through the exploration of resource sharing agreements with surrounding jurisdictions and other relevant state and federal agencies.

Key findings and conclusion

Within the broader scope of a national EDRR program, ICS can play a more instrumental role in

standardizing the conduct and management of on-site response activities to invasive species. ICS application would facilitate cooperation among government agencies and their partners, improving the effectiveness and cost-efficiency of interventions. The following elements provide a checklist for improving ICS application to invasive species EDRR:

- *Rapid Response Plans* Develop response or contingency plans that incorporate ICS to enable rapid response to high priority invasive species.
- *Personnel and Training* Require emergency response training for appropriate field-level and management staff and take advantage of co-training opportunities with other all-hazard response teams.
- *Exercises* Regularly conduct tabletop and in field exercises to identify gaps, obstacles, and other needs, including clarification of issues around authorities, resources, communications, and logistics.
- *Cooperative Mechanisms* Explore options for developing and supporting cooperative arrangements with other federal agencies, as well as with states and local partners. Such interagency arrangements could include details on resource-sharing, delineation of authorities, communications protocols, and sharing of personnel and subject matter experts.
- *Incident Management Teams* Consider formation of an on-call incident management team that can implement ICS-structured response operations in their mission areas (e.g., Dreissenid mussels in the West, Asian carps in the Great Lakes).
- *Clearinghouse* Collate information on agency ICS and response resources to improve coordination, information sharing, and identification of lessons learned. Materials could include key agency contacts, staff resources and expertise, rapid response plans, interagency agreements, hotwash (after-action review) summaries from previous exercises, species- and geographic-specific information related to agency priorities, and other resources related to the application of ICS and NIMS to invasive species. This could inform the development of additional guidance materials for use by federal, state, and local agencies and their partners.

Rapid response efforts designed to eradicate or contain a newly detected invasive species are often highly complex efforts, involving a multitude of agencies, authorities, and resources. Rapid response measures often need to be employed under challenging conditions that include logistically difficult geographies, incomplete information, limited budgets, substantial time constraints, and the scrutiny of the public and media. To make things even more challenging, invasive species are self-perpetuating and self-mobilizing; the problem can grow while responders get organized. The ICS structure, when coupled with appropriate training, planning, and cooperative arrangements, provides an organizational model for facilitating coordination under tough circumstances while heightening safety and efficiency. ICS has proven its effectiveness both generally across a wide array of emergencies and specifically in the context of invasive species responses. While the EDRR process encompasses a broader suite of activities, it is clear that ICS can help advance response capacity.

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