Regional Invasive Species & Climate Change Research to Practice Paper: Rock you like a hurricane: The perfect storm for an invasion

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Summary

Hurricanes (also called typhoons or cyclones) and other rare weather occurrences are increasing in intensity and frequency with global climate change. These extreme weather events can drastically alter ecosystems in ways that directly or indirectly facilitate the introduction, establishment, spread, and impacts of invasive species. For example, high winds or flood waters during hurricanes can disperse invasives and displace native species. Impacts could also occur after the main storm event; invasive species can invade during relief efforts or establish more easily in disturbed habitats [1,2]. Various possible mechanisms link hurricanes and invasive species (Figure 1). To identify shared challenges as well as region-specific dynamics and possible impacts, we highlight case studies from the Southeast, Pacific Islands, Caribbean, and Northeast regions of the United States (Table 1). By synthesizing examples across diverse ecological and management contexts, this summary can help practitioners anticipate common mechanisms of spread and consider strategies that could be implemented before and after hurricane events to manage vulnerable species, habitats, and ecosystems.

How do hurricanes exacerbate invasive species dynamics?

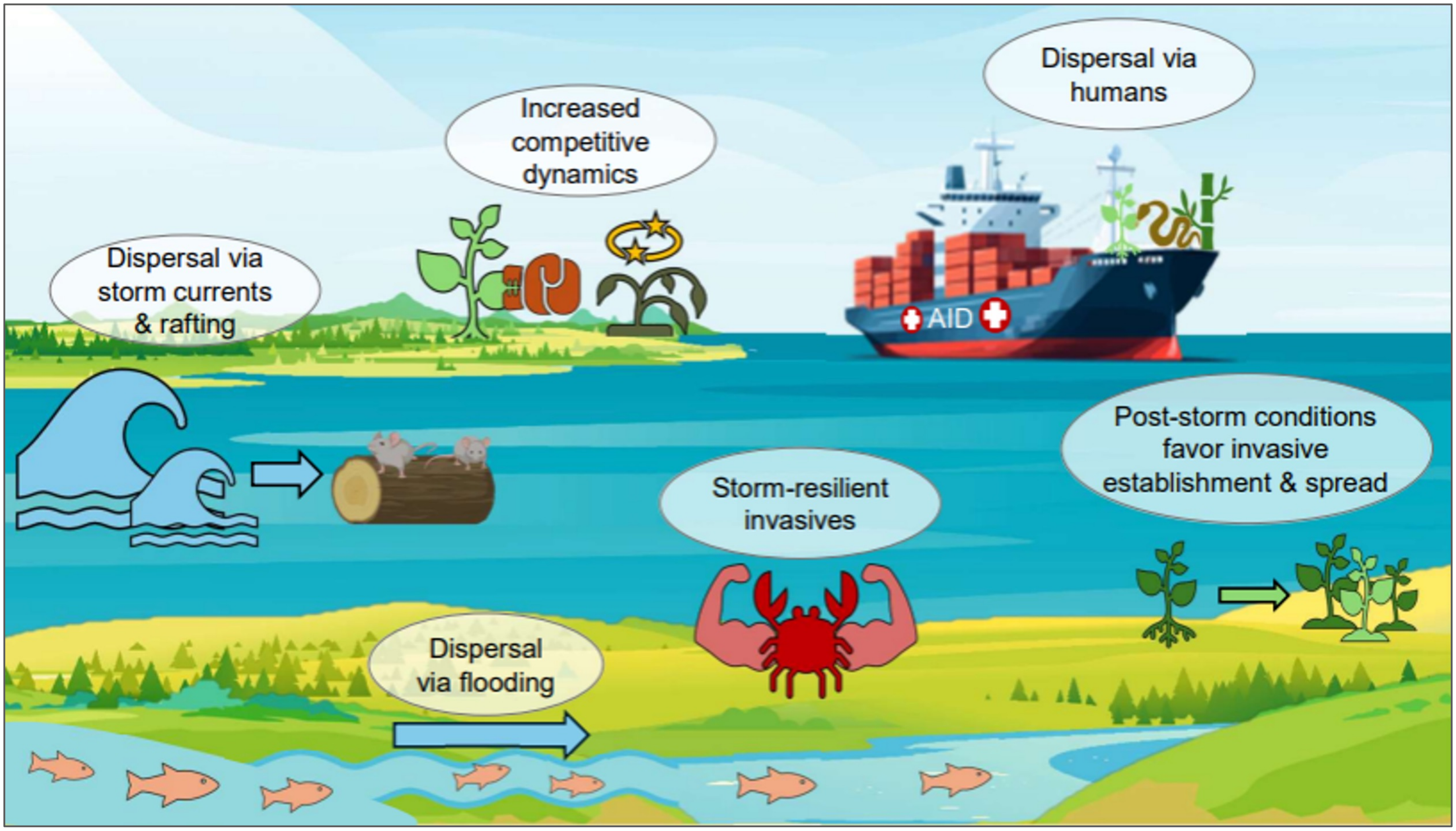

Figure 1. Mechanisms driving changes in invasive species introduction, establishment, spread, and impacts after major storm events such as hurricanes.

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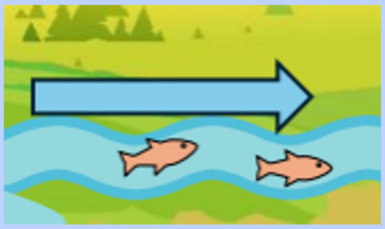
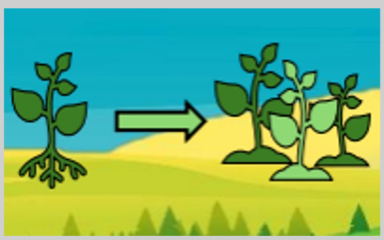
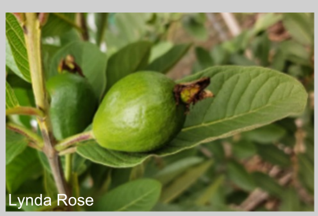
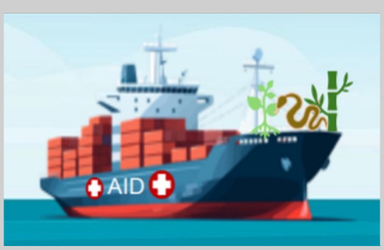
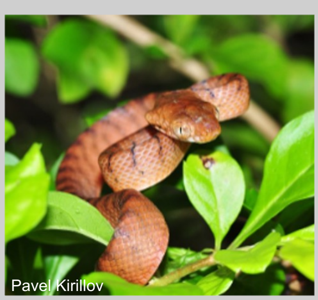
Region	Storm-Invasion Mechanism	Invasive Species	Scenario
Southeast	 Lower impacts to invasive species than native species	 *Halophila stipulacea*	**Hurricane Fiona (Cat. 1)** caused a significant decrease in percent cover, canopy height, and shoot density of the native seagrass (*Thalassia testudinum*). While the invasive seagrass (*Halophila stipulacea*) experienced little to no negative impact due to its shoot length and anchoring capacity. *Halophila stipulacea* also existed under the canopy of the native species, which likely buffered it from the direct negative effects of the hurricane [3].
	 Dispersal through connected waterways after flooding	 *Hemichromis bimaculatus*	**Hurricane Ian (Cat. 4)** facilitated the continued spread of African Jewelfish (*Hemichromis bimaculatus*) through post-hurricane flood water connections among previously disconnected drainages in central Florida, including systems linked to Lake Okeechobee and Indian River Lagoon Preserve State Park. Storm-driven hydrological connections enabled dispersal into new waterways, and warmer winters associated with climate change may further facilitate northward expansion by reducing the frequency of lethal cold-temperature events [4,5,6].
	 Post-storm conditions favor spread and increase of invasive species	 *Mus musculus*	**Hurricane Maria (Cat. 3-5)** produced winds causing extensive canopy damage, increasing light availability to the understory. The resulting growth of understory grasses attracts invasive rodents like the black rat (*Rattus rattus*) and the house mouse (*Mus musculus*). Following hurricane disturbance in Puerto Rico, these species shift foraging behaviors, exploiting damaged forests for seed and fruits. Invasive rodents impose significant ecological and economic costs, with damages reaching up to $19 billion in the United States alone, affecting agriculture, human health, and natural resources [7,8,9,10].
Pacific Islands	 Invasive species more resilient to storms than native species	 *Psidium guajava*	**Hurricane Iniki (Cat. 4)** hit the Island of Kauai, Hawai'i causing significant damage to native forests. After one year, adults and seedlings of the invasive yellow guava tree (*Psidium guajava*) had much higher survival than the native a'ali'i (*Dodonaea viscosa*) in the subcanopy. This work suggests that invasive plants may be more resilient to hurricanes than native species, and may increase in dominance in the understory afterward storm events [11].
	 Increased likelihood of human-mediated spread of invasive species	 *Boiga irregularis*	**Typhoon Mawar (Cat. 4)** caused damage to the Antonio B. Won Pat International Airport in the U.S. Territory of Guam forcing aircraft to park overnight. After one aircraft flew to Saipan (Northern Mariana Islands) and returned, a brown tree snake (*Boiga irregularis*), invasive in Guam, was found in the wheel well. The snake had likely accessed the aircraft as it was stranded overnight near adjacent forest land and snake traps had been removed ahead of the storm. This highlights how storm-related disruptions can increase pathways for invasive species to disperse [12].

Table 1: Case studies highlighting how different severity storm events (e.g., on the Saffir-Simpson wind scale) have affected invasive species in marine (teal), freshwater (blue), and terrestrial (gray) ecosystems across the Southeast, Pacific Islands, Caribbean Islands, and Northeast regions of the United States.

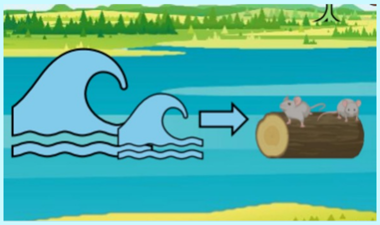
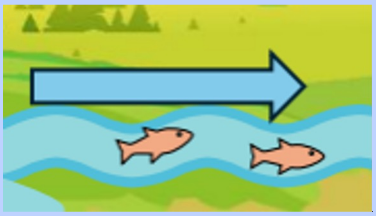
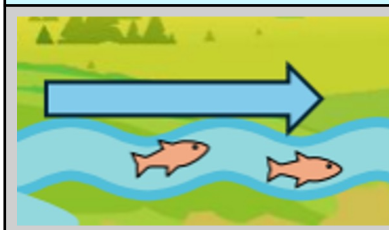
Region	Storm-invasion mechanism	Invasive Species	Scenario
Caribbean	 Dispersal via storm currents and rafting	 *Rattus rattus*	**Hurricane Irma & Maria (Cat. 3-5)** likely facilitated the introduction of invasive Black Rat (*Rattus rattus*) to Green Cay National Wildlife Refuge in the U.S. Virgin Islands following the 2017 storms. After the hurricanes, rats were detected on the previously rat-free island, likely rafting on storm debris or swimming from the nearby island of St. Croix (~1,400 ft away) after being displaced by storm impacts. Such storm-driven dispersal can introduce invasive mammals to new islands, where they may threaten native wildlife through predation on eggs, juveniles, and other vulnerable species [8,10].
Northeast	 Dispersal through connected waterways after flooding	 *Potamopyrgus antipodarum*	**Hurricane Ida (Cat. 4)** caused severe flooding along the North Atlantic Coast, temporarily connecting more than 300 distinct hydrological basins. Prior to the storm, the invasive New Zealand Mud Snail (*Potamopyrgus antipodarum*) had been documented in 13 hydrological basins in the Mid-Atlantic region. These temporary hydrological connections increased the risk of spread from invaded to previously uninvaded systems, potentially enabling *P. antipodarum* to disperse into eight additional basins [4].
	 Invasive species have faster recovery rates than natives	 *Grateloupia turuturu*	**Hurricane Barry (Cat. 1)** reduced both native and invasive seaweed cover from 35% to just 1%. After the storm, the invasive red algae *Grateloupia turuturu* recovered more rapidly than the native *Chondrus crispus*. Compared to the more structurally complex native species, *G. turuturu* has simpler morphology that provides less habitat and food for invertebrate grazers, many of which avoid the invasive algae. These differences can alter competitive interactions and affect species interactions and biogeochemical processes in coastal ecosystems [13].
	 Invasive species spread during and after flooding	 *Reynoutria* species	**Tropical Storm Irene** Tropical Storm Irene caused major flooding in Vermont that dispersed rhizome fragments of invasive knotweeds (*Reynoutria spp.*) across floodplains. Research found that stem and rhizome fragments remained capable of regeneration for up to 13 months after the storm. Most new plants (86%) established from propagules buried under less than four inches of soil, demonstrating how storm-driven sediment movement can transport and bury viable fragments that later regenerate and expand infestations [14,15].

Table 1 continued: Case studies highlighting how storm events have affected invasive species.

Climate change and adaptive invasive species management

Climate change may not only alter invasion dynamics across a landscape (see Figure 1 and Table 1) but may also affect management strategies and decision-making. Climate change is already impacting the timing, frequency, and effectiveness of chemical, mechanical, biological, and cultural control strategies. This may lead to shifts in decisions regarding if and when to manage and current best practices for invasive species. Following storm events, some species may become more challenging to manage (e.g., Table 1), requiring reevaluation of management strategies and restoration goals, while other species may become easier to manage following storm events, as described in the case study below.

Giant salvinia (*Salvinia molesta*) is a free-floating aquatic fern that is widely distributed and invasive across the southeastern United States, including Alabama, Mississippi, Louisiana, Georgia, and Florida. Giant salvinia quickly overtakes nutrient rich freshwater bodies, causing issues with irrigation, water flow, recreation, and threatening native biodiversity. In the lower Pascagoula River of Mississippi, Giant salvinia populations were too widespread and dense for eradication to be considered feasible. **Hurricane Katrina (Cat 3.)** killed most plants through saltwater intrusion into the river or by depositing plants on land. After **Hurricane Katrina**, the remaining isolated patches of this aquatic fern were now able to be effectively managed via chemical control [16].

Management Considerations

Before storm events:

Collect baseline data (e.g., ecosystem structure and functioning, community diversity, and population genetics) to compare with post-storm data.

Identify the ecosystems or areas most likely to be affected by storms.

Identify and manage invasive species most likely to be spread by storms or have increased impacts.

Enhance or maintain ecosystem biodiversity to increase ecological resilience in storm-prone areas affected by invasive species.

Conduct public outreach and education to assist with invasive species detection and reporting.

Meet with members of the state's emergency management agency, ESF-11, or APHIS representatives to discuss invasive species risks and how to reduce them.

After storm events:

Identify human-mediated pathways of spread during or after storms (vehicles, airplanes, ships, etc.), and work to reduce risks.

Conduct surveillance, Early-Detection and Rapid Response in areas most impacted by storms to find new invasive species individuals and populations.

Assess if control methods and timing are still effective for invasive species in storm-affected areas.

Request federal/state emergency funds to support post-storm invasive species management.

Collect post-storm/flood ecosystem data for both native and invasive species to compare with baseline data.

Conduct rapid ecological restoration actions in impacted areas affected to prevent or limit biological invasions.

Northeast RISCC Management Network
NE CASC Northeast Climate Adaptation Science Center
SOUTHEAST Climate Adaptation Science Center
University of Massachusetts Amherst
Southeast RISCC Management Network
Pacific RISCC Management Network
Pacific Islands Climate Adaptation Science Center
USGS science for a changing world
University of Saint Joseph Connecticut
UIC University of Illinois Chicago
Antioch University Uniting Passion & Purpose
PennState
University of Maryland
University of Michigan

References: [1] Murphy & Metcalfe (2016), [2] Diez et al. (2012), [3] Sánchez-González et al. (2025), [4] Pfingsten et al. (2024), [5] The Nonindigenous Aquatic Species Flood and Storm Tracker Maps. USGS, [6] Nico et al., (2019), [7] Lietold et al. (2022), [8] Shiels et al. (2022), [9] Pimentel et al. (2000), [10] Shiels et al. (2020), [11] Harrington et al. (1997), [12] Parsons & Mazurek (2024), [13] Kraemer et al. (2017), [14] Colleran & Goodall (2017), [15] Colleran (2015), [16] Meyerson & Mooney (2007).