

Forum:	United Nations Environmental Programme
Issue:	Creating a Framework to Tackle the Problem of Invasive Species as a Result of Increased Human Activity
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Introduction

Invasive species can be defined as **living organisms** such as bacteria, plants, fish, fungi, insects, amphibians and the seeds or eggs of an organism that is foreign to an **ecosystem** and consequently causes harm to its delicate balance. These species are labelled invasive because of their rapid growth and reproduction. They have the ability to harm the economy, the environment and even human health. Currently, invasive species are among some of the greatest risks to native wildlife. Approximately 42% of **threatened or endangered** species are under threat as a result of these species. They also pose major economic damage, according to the UNEP: “Economic costs of invasive plants and animals in the USA are estimated at \$137 billion and in South East Asia at 33.5 billion per annum”.

The most important factor that creates an invasive species is the lack of **predators** in a new environment. Such situations occur when the predator and prey in an ecosystem do not **co-evolve**, when an animal or plant has entered a new environment, they will come across predators who have not been evolving with them and therefore will not be able to successfully exploit their weaknesses. Allowing the species to grow at a rapid pace as it no longer faces any major predators.

Invasive species are for the most part spread through human activity and interaction, generally unintentionally. As a result of **globalization**, we are constantly travelling around the world with our own good; this often results in the carrying and transportation of unwanted species. For instance, insects can find their way into wood, shipping pallets and crates that travel all around the world while boats and ships often carry unwanted aquatic organisms in their propellers or ballast water

In total according to the UNEP "It is estimated that **IAS** (Invasive Alien Species) have cost the global economy over 5% of global GDP in 2011". To put things into proportion, the GDP for climate change currently stands at 0.2-2% (International Panel on Climate Change, 2014).

Today invasive species continue to roam our earth wreaking havoc on our environment, economy and health, it is crucial that methods of eradication and prevention are developed before the situation is out of hand.

Definition of Key Terms

Invasive species (IAS)

Invasive species can be defined as living organisms such as bacteria, plant, fish, fungus, insect, amphibians and the seeds or eggs of an organism that are foreign to an ecosystem. Also known as IAS

Ecosystem

An ecosystem can be defined as a community of living organisms that share a habitation and interact with each other in their shared environment. They are linked and the balance of their interaction is what keeps their environment stable.

Endangered species

An endangered species is a species of animal or plant that is in danger of facing potential extinction in the wild.

Threatened species

According to the ESA (Endangered Species Act) a threatened species can be defined as "any species which is facing the possibility of becoming an endangered species within the foreseeable future throughout a significant portion of its population or potentially all."

Predators

A predator is an animal that survives off the process of killing and eating animals, also known as preying on animals.

Co-evolve

Co- evolution can be defined as the process in which different species mutually affect each other's evolution through their own adaptation to an environment and their surroundings. It is very important for a prey and predator dynamic.

Globalization

Globalization can be defined as the process through which society interacts and integrates through companies, people and governments of different nations. It is amplified by international investments and trade as well as the power of technology.

Food webs

Food webs are a type of depiction of how energy flows through an ecosystem. They show the different relations between organisms of an ecosystem in terms of food.

PAH's and PCB's

PHA's (Polycyclic Aromatic Hydrocarbons) and PHB's (Polyhydroxy butyrate) are both chemicals that can be very injurious to human health. Certain invasive species such as Zebra mussels collect and store these toxins.

Economic sectors

Economic sectors are the different major groups in an economy, divided by the type of labor that takes place. There are three significant sectors, primary, secondary and tertiary.

Cholera

Cholera can be defined as highly infectious and in many cases fatal bacterial disease. It affects the small intestine causing diarrhea and severe. The disease is waterborne.

Ballast water

Ballast water is fresh or saltwater that helps to stabilize a ship, it could however contain invasive aquatic species.

Food security

Food security, clearly defined by the United Nations' Committee on World Food Security refers to people having social, physical and economical access to safe, sufficient and nutritious food that is of an appropriate amount to maintain a healthy bodily state.

Biodiversity

Biodiversity refers to the variety of flora and fauna in a particular habitat or worldwide.

Biomass

Biomass refers to organic material or matter such as grass clippings, wood pellets, leaves of plants and even animal excrement.

Key Issues

Threats to native wildlife as well as humans health

Invasive species can be very harmful to the native wildlife of an area. They could potentially cause habitat loss, kill native plants and trees, outcompete the native species and in most cases, these impacts have a ripple effect which can result in the destruction of an ecosystem as a whole. With over 41,415 species currently on the **IUCN red list** and 16,306 of them considered endangered and facing possible extinction it is imperative that we conserve all wildlife from invasive species as they are one of the leading causes of endangered and threatened species.

Habitat loss & destruction

A major impact that invasive species bear on the environment is the widespread loss and destruction of habitats. A prime example of this scenario would be the hemlock woolly adelgid, an invasive species originally from Asia. These insects feed on and kill infested hemlock trees resulting in their rapid depletion. When invasive species destroy a plant or tree which is inhabited by or relied on by another species, they may face extinction.

Risk of species extinction

Another damaging impact the issue at hand is creating is the risk of extinction of endangered, threatened and endemic species. When an invasive species enters a new ecosystem, as mentioned before the predator and prey do not co-evolve and they are unaware of each other's strengths and weaknesses and therefore will be unable to exploit them. Since it has no natural predators in the area and the native wildlife have not evolved defenses, it is able to grow rapidly and prey on the native wildlife without any obstacles, leading to their potential

extinction. In doing so not only are these invasive species wiping out a species, but it is also altering and damaging the food webs in the ecosystem.

Impact on human health

Invasive species are also a potential risk to human health, because they can be vectors for disease. Certain invasive species such as Zebra mussels collect and store toxins such as **PAHs and PCBs** in their tissue. These toxins then continue to move up the food chain as they are consumed by different animals and eventually end up in humans. In other cases, harmful bacteria such as **cholera** can be transported and later transmitted through the **ballast water** from ships.

Economic impact

Each year over 100 billion US dollars go towards repairing the damage that non-native species cause toward the environment, the economy and human health. Some of the costliest repairs include clogging of water facilities and waterways, crop decimation, threats to fisheries, disease transmission of humans and animals, unfavorable impacts towards ranchers and farmers, and lastly increased fire vulnerability as a result of the change in conditions of an ecosystem by invasive species.

There are countless current examples of these consequences, such as the zebra mussels in the Great lakes which are rapidly clogging up power plants and water intakes at water intake facilities. The annual removal of the zebra mussels in the Great lake's totals to an estimate of \$500 million. Another example would be the Kudzu vines which grow at an aggressive speed and have managed to cover a large amount of the power lines in America. Power companies spend an estimated \$1.5 million in attempts to tame the wild plant.

Invasive species also inflict a great deal of damage to the different **economic sectors**. Such as the damage it causes to the primary sector by decimating fish populations, killing crucial tree species, and causing great damage to crops.

Impacts on tourism

Not only do invasive species cause costly damages to the economy, but they also impact tourism further harming it. For instance, invasive aquatic species are currently threatening the health and sustainability of the Great lake region, which happens to be a major tourist attraction.

Food security concerns

Another major impact that IAS is causing globally is reduced agriculture production and consequently low **food security**.

For example, in India, the Lantana Camera invaded a large number of pasturelands, approximately 13.2 hectares, and left the cattle poisoned. Australia is facing the same issue, which led to the death of 1,500 animals, loss of pasture, and reduced productivity.

Or in Europe and Africa a pest known as the Tomato Leaf miner, which is rapidly growing, is severely damaging the local tomato production. The pest was initially unintentionally brought in from South America and has been forcing countless tomato factories to close down, once again impacting global food security.

The unintentional spreading of aquatic organisms

And lastly one of the most significant issues with invasive species is the ease at which they are able to travel around the world, infecting different countries, as a result of watercraft such as ships, boats, and vessels. Invasive Aquatic species are easily dispersed in the world due to waterway connections, organisms in trade, ballast water, and lastly trailered boats and watercraft. As boaters' travels through different bodies of water it is quite common for species to cling to the anchor, hull, motor props and even the license plate.

Waterway connects refers to the places where waterways meet, for instance, the connection of the Great Lakes to other watersheds such as the Mississippi River, these connections are very vulnerable to the spread of invasive species. In the Great Lakes countless amounts of species have entered through waterway connections and are now threatening its biodiversity.

Organisms in trade refer to non-native species being sold in aquariums, pet stores and bait shops which have the potential to become a very destructive invasive species. For instance, if a pet store was to sell an exotic fish and the said fish was deliberately or accidentally let out into the great lakes, this fish could breed millions of offspring and cause environmental and economic issues.

Ballast water is fresh or saltwater that helps to stabilize a ship, it could however contain invasive aquatic species. The ballast water in a ship is filled at the starting location of their

voyage and emptied at their destination, this allows all of the aquatic species that were taken in the start of the trip to be emptied into a new location, this can disrupt the ecosystem.

Major Parties Involved and Their Views

Australia

Australia is one of the most affected countries by the impacts of invasive species. In 1935 the government introduced the cane toads to the Australian **biodiversity** in attempts to eliminate the Grey back cane beetle (another invasive species) which was decimating Queensland's sugar cane crops by eating the roots of the plants. The cane toads were initially introduced in the mid 1930's and have now multiplied to over 200 million.

However, the plan entirely backfired, and it turned out that the cane toads were not good predators for the cane beetles as they could not jump high enough. As a result, instead of going for the beetles, the toads started going after everything and anything else in sight, native frogs, bird's eggs, and insects. The death toll on Australia native species has been massive since the toads are actually poisonous and began killing off any potential native predators.

As mentioned before invasive species can cause a region immense amount of environmental and economic damage, and the cane toads in Australia have proven to do just that. Since the cane toad was a foreign species to the native wildlife of Australia, they were unaware of the cane toad poison, and the toad was at a major advantage as both a predator and prey. Other species that consumed the tadpoles or adult cane toad would die, while animals that had no direct contact with the toads could die indirectly had the toads poisoned bodies of water. As a result of their impressive breeding capacity (females cane toads can lay up to 8000-35000 eggs at a time), they grew rapidly and quickly took over Australia.

And lastly, they have managed to invade ecologically sensitive areas in Australia which capacitate some of the few remaining strongholds for native endangered frog species such as the Yellow and Green bell frog.

In hopes to help not only the national crisis but the world-wide invasive species crisis, Australia has donated large amounts to the cause. Over the next 15 years the Australian Government plans to spend between five and seven million dollars in attempts to combat the much-hated cane toads. In 2004 the government established a national Cane Toad Task to help

with the taming of the species. In addition, the Australian government is also supporting a multimillion-dollar campaign to stop or better yet entirely eradicate the toads that bred all over the country, which now occupy more than 500,000 square kilometers ranging from Queensland to the northeast corner of New South Wales.

And lastly, Australia has also invested in another government project whose aim is to send Australian ecologists to the natural habitat of the cane toad to attempt to understand the reason why the toad was not a pest in its native environment.

United States of America

The US is yet another victim of the consequences that invasive species can have on our environment and economy. The Great Lakes ecosystem in America has been damaged almost beyond repair by over 180 different non-native aquatic invasive species and plants that have been brought in through Trailered Boats and Watercraft, Ballast Water, Organisms in Trade and Waterway Connections as previously mentioned.

Mentioned below are a few of the most prominent invasive aquatic species and plant life that are currently threatening the biodiversity and ecosystems of U.S waters and the measures the U.S government is taking to combat them.

The Asian carp is a species of aquatic invasive species that are largely contributing to the Great Lakes crisis. The economic and environmental costs of the Asian carp stand at an estimated total of \$5.7 billion per year, in addition, the local fishing industry has suffered losses up to \$4.5 billion. The carp are a major threat to the ecosystems throughout the US, outcompete native fish, consume native vegetation, introduce new pests and disease, and lastly disrupt local ecosystems. Similar to most invasive species the Asian carp were introduced unintentionally.

In the US several states have formed multi-state coalitions to help curb the spread of the Asian carp. To prevent the spread of Asian carp and the spread of similar invasive species the Asian Carp Regional Coordination Committees (ACRCC) have been working towards the goal of implementing control programs.

Similar in appearance to each other, the zebra and quagga mussels are yet another invasive species that is damaging the biodiversity in the American Great Lakes. These tiny

mussels first entered the Great Lakes through the ballast water of ships in the late 1980s. Now there are over 10 trillion Zebra and quagga mussels in habitats in the Great lakes. These pests have cost over \$500 million per annum for repairs to water systems, power plants, industrial complexes as well as boats and docks in the Great lakes. Not to mention the damages they have wreaked on the native aquatic species and ecosystem.

However, according to the National Conference of State Legislatures (NCSL) a few of the states that attended the 2015 legislative session, have enacted legislations such as but not limited to:

Montana: Authorizes entities to operate check stations that, to the greatest extent possible, will be coordinated with the Department of Transportation and the Department of Fish, Wildlife, and Parks.

Maryland: Prohibits an owner of a vessel from placing it in a lake at a public ramp or dock if the owner has not taken certain actions, including cleaning the vessel and removing all visible organic material.

Nevada: Prevents a person from operating a boat in state waters unless the owner has paid a fee and attached an aquatic invasive species decal to the watercraft.

Oregon(pending): Implement alternative ballast water management strategies for vessels when they empty their ballast tanks (another potential pathway for the introduction of aquatic invasive).

The invasive species center (ISC)

The invasive species center is a non-profit organization (NGO) located in Sault Ste. Marie, Canada. They have been working towards combatting and taming invasive species in hopes to protect the environment and economy of the province. The invasive species center has been developing strategies of prevention, rapid response and early detection for invasive land and aquatic species.

Since 2011, the invasive species center has helped support over 131 projects to overcome the battle to eliminate invasive species and end the damage they are having on our economy and environment. Since globally the cost of invasive species is estimated to be at \$1.4

trillion, which is seven times the cost of natural disasters and five percent of the global economy.

The ISC also has many goal and priorities set for 2020 and 2021 to further help contribute.

South Africa

South Africa is another country that is a victim to the destruction of IAP's (Invasive Alien Plants). Invasive species cost South Africa tens of billions of rand every year in costs spent on management, repairs and losses. At the moment there are over 559 invasive species overrunning South Africa's native flora and fauna. These invasive species are depleting the country's water supply (lowered the mean annual water runoff in South Africa by 1.4 billion m³), destroying the biodiversity of the nation (over 2000 of said species are in risk of extinction), and greatly contributing to intense fires across the land (an increase in biomass by 300%). They are majorly impacting the economy and environment of South Africa.

A few dominant invasive species currently roaming South Africa include the Pompom weed, the lantana camera, the famine weed, bug weed, and water hyacinth.

Invasive species as mentioned previously have lowered the mean annual water runoff in South Africa by 1.4 billion m³ (3%), which is equivalent to 577, 600 Olympic sized swimming pools. This is because the IAS that has entered South Africa use significantly more water resources than the native species resulting in a massive shortage. Working for water, a local organization, has demolished over 50 hectares of pine plantations which has resulted in saving up to 1 million liters daily. However, this is only a short-term solution, a much larger clearing would be necessary for the gains to be significant enough.

South Africa is a beautifully biodiverse nation with an extensive variety of flora and fauna, it is celebrated for being so concentrated in plant and animal species. With over 9000 plant species and only 2/3 of which are found elsewhere of the earth South Africa is remarkably diverse. However, over 2000 of said species are currently under risk of extinction since the invasion of non-native species. The IAS are so successful in their destruction because of the ability to out-compete the native wildlife as well as alter the environment for their own benefit. For example, certain species alter the soil chemistry making the soil unsuitable for indigenous species.

At the moment, in South Africa many of the local vegetation is dependent on fire, however IAS are altering the original fire regimes with changes to the produce of flammable biomass. Since many of the IAS have larger surface areas as a result of greater root depth and height, they have caused an increase in the **biomass** present by 300%. Such drastic changes in the environment has led to the natural South African wildfires to greatly intensify to an extremely dangerous level.

WFW (Working for Water)

Working for water is a program situated in South Africa, it focuses on the wellbeing of South African forestry, fishery, and environment. Since its initiation in 1995 the program has managed to demolish over 1 million hectares of IAS. In doing so they have successfully provided jobs and training to roughly 20,000 citizens per annum, of which 52% were women.

At the moment Working for Water is running over 300 projects in the 9 provinces of South Africa focused on the methods to control and eradicate invasive alien plant species. WFW is researching mechanical, chemical, biological, and integrated methods of removal and control. In addition, they have a variety of new projects planned for the coming years.

According to their site, their main objective still remains “To reduce the density of established, terrestrial, invasive alien plants, through labor-intensive, mechanical and chemical control, by 22% per annum.”

Development of Issue/Timeline

Date	Event	Outcome
1593	The Eurasian boars commonly referred to as wild boars were first introduced to northern America, at the time identifying as domestic pigs.	The Eurasian boars caused immense damage to North American crops and habitat as well as threatened the native wildlife. They have been found in at least 35 states, and their population is currently estimated to be over 6 million.

1800 and 1900	From 1800-1900, there was an era of increased immigration, trade, and colonization in Canada	This resulted in an extreme and rapid increase in non-native invasive plant species
1869	The separation of biota between the Mediterranean and Red sea was once again reconnected after being separated for over a million years by the construction of the Suez Canal.	After the reunion of the biota over 250 new species had traveled to the Red sea from the Mediterranean. Of these new species, many were invasive and are responsible for the widespread loss in the biotic community.
1876	The first of the Japanese kudzu was introduced to the United States at the Centennial Exposition in Philadelphia, Pennsylvania.	They threatened local vegetation that the native animals thrive off of and heavily disrupted the food chains and ecosystems. In addition, the Kudzu covered the surface of many power lines resulting in power companies spending an estimated \$1.5 millions in attempts to tame the wild plant.
1910	The European common reed was first recognized in Nova scotia.	The European Reed harmed the functioning of the local ecosystems because it reduced biodiversity and

		excluded many of the native species.
1985	The Lantana Camara, which is a species of flowering plant, invaded the majority of the Indian pasturelands, approximately, 13.2 million hectares.	This event resulted in a major death toll of up to 1,500 animals and led to a massive reduction in productivity and loss in grazing land.
1990s	Major flooding in Mississippi and Missouri along the Mississippi and Missouri rivers.	After the flooding in the 1990s, in the Mississippi River, the carp escaped into the river. Since the carp have been systematically progressing to the north and can now be found in the Illinois River. Which is now still a relevant issue causing local fishing industry losses of up to \$4.5 billion.
2001	The West Nile virus which is transmitted through a range of wild bird species and mosquito species was detected in Canada after being transported to North America from Afro-Eurasia.	The virus manages to kill off thousands of corvids such as magpies, jays and crows as well as non-corvid bird species. When the virus first appeared in New York over 5,500 crows died in roughly 4 months.
2006	The Tomato Leaf miner, also known as the Tuta absoluta, was brought to Europe and Africa from South America.	These pests proved to be very fast spreading and damaging to the tomato farming and production in Nigeria. It

		caused an abundance of tomato factories to close.
2006	It was announced in accordance with the 2006 ballast water regulations that all maritime vessels were required to empty their ballast water at sea before entering the port in St. Lawrence, North America.	This newly introduced regulation helped massively reduce the risk that invasive aquatic species such as zebra mussels were inciting in Northern America.
2015	It was announced in line with the EU regulation passed by the European Union that it was forbidden to transport, possess, sell or grow species deemed as invasive by the EU.	This regulation helped to curb the spread of rampant invasive species in Europe such as Milkweed and Hogweed.

Previous Attempts to Solve the Issue

Ballast water management (BWM) treaty

As mentioned previously ballast water is fresh or saltwater that helps to stabilize a ship. One of the previous attempts towards solving the invasive species dilemma was the Ballast water Management treaty, which was introduced by the International Maritime organization (IMO).

According to the IMO “The Convention requires all ships to implement a ballast water management plan. All ships have to carry a ballast water record book and are required to carry out ballast water management procedures to a given standard.”

This treaty successfully ensures that all ballast water tanks have been decontaminated before release in a new destination, risking the well-being of that ecosystem. However, it has not managed to reach all parties, especially ones at high risk of irreversible damage. Even if

only a few nations who have not joined the BWM treaty, the impact their transport of Invasive species have will be counterintuitive to the rest of the nation's efforts.

At the moment the treaty has over 52 committed parties which is a major accomplishment and step in the right direction. It has significantly helped to decrease the presence of non-native species in heavily invaded areas such as the Great Lakes.

Promoting the harvest of invasive species

Another past attempt was the promotion of harvesting invasive species to the public, which had some success. For instance, the python hunt that took place in Florida in 2013, cash was awarded to those who successfully hunted and killed a python. In doing so a high number of pythons were eradicated from the Floridian ecosystem.

Some have even found new and innovative ways to remove and use invasive plants, such as with the Kudzu vines. Individuals are using Kudzu to craft and weave items such as baskets.

Another example of promoting the harvest of invasive species to the public to help in their elimination would be in Argentina with beavers. The Argentinian government trained over a hundred locals on how to trap beavers, place bounties of each beaver, as well as encouraging local restaurants to serve beaver-meat. However, the bounties only had short term impact.

Such methods prove to be successful because they provide the public with incentive and motivation to help out with the issue and such a large crowd can be more effective at times than a few committed environmentalists.

However, a major issue with this method is that in past cases many efforts of the public have been pointless, as they were not properly prepared with the correct equipment.

Possible Solutions

Stricter Biosecurity laws

Biosecurity laws refer to measures that were introduced to aid in preventing the introduction or spread of destructive organisms to animal, human and plant life. Introducing stricter biosecurity regulations with higher, more severe consequences would effectively motivate visitors or locals to ensure that they are safely entering the country without intentionally or unintentionally bringing in harmful organisms.

It should become a requirement that certain policies are implemented around the world such as that all food, plant material and animal products should be declared upon entry with a biosecurity officer at airports.

As well as that more countries sign the Ballast water management treaty to ensure the utmost safety for the country's own bionetwork. Together with a closer inspection of containers, pallets and other shipping materials at ports of arrival and departure. This could uncover any hidden and unknown organisms that could be a threat.

Integrate IAS into school curricula

Another act that could help to decrease the amount of IAS roaming the globe is to incorporate sections on IAS into school curricula, which would be greatly beneficial for numerous purposes.

Most importantly, educating the youth on the current issues that we face globally can help the next generation to be more self-aware of their actions and how they could potentially be harming their own homes.

It would be of utmost importance that these kids are taught of the proper procedures to follow in different circumstances. For example, to educate them on organisms in trade so that they are aware of how to properly take care of their pets so that to ensure they don't unintentionally spread an invasive species.

Or to stress the importance of following biosecurity laws when travelling and the consequences they may face for violating the regulations, to guarantee that they are more self-aware and mindful.

Should IAS be integrated into school curricula it is vital that certain crucial learning topics are discussed such as but not limited to;

- Methods of prevention for Invasive species
- Environmental, and economic and health impacts
- Major methods of dispersion

For such action to be successful it would also be essential that all teachers and educators at teaching facilities have a strong understanding of the topic at hand to deliver accurate information to their students. Furthermore, educators and teachers should be supplied with the necessary learning materials to deepen their own understanding of Invasive species.

Implement Incentive programs

Similar to previous attempts in Argentina and Florida a potential solution to the issue could be the implementation of incentive programs intended to further promote the harvest of invasive species. To ensure that these programs are effective it is important that there are different programs for different audiences such as but not limited to:

Bounty programs: A program in which a predetermined sum of money is paid to an individual based on evidence of the collection of the specified organism.

Contact Operation: A program in which a direct payment is made to the public for the removal or harvest of a species.

Using these programs, we will see a reduction of the presence of non-native species in highly invaded areas. Such programs provide the harvester, who will be properly equipped, with motivation/incentive in the form of money creating an efficient system in which many people can contribute.

Bibliography

“Cane Toad.” *National Geographic*, 21 Sept. 2018,
www.nationalgeographic.com/animals/amphibians/c/cane-toad/.

“Cane Toads Increasingly a Problem in Australia.” *Mongabay Environmental News*, 17 Apr. 2005,
news.mongabay.com/2005/04/cane-toads-increasingly-a-problem-in-australia/.

“Combating Invasive Species.” *National Wildlife Federation*,

www.nwf.org/Our-Work/Environmental-Threats/Invasive-Species.

“Default Ballast Water Management // .” *Ballast Water Management*,

www.imo.org/en/MediaCentre/HotTopics/BWM/Pages/default.aspx.

Enviro Editor. “Alien Invasive Plants List For South Africa.” *Environment News South Africa*, 13 Feb. 2019,

www.environment.co.za/weeds-invaders-alien-vegetation/alien-invasive-plants-list-for-south-africa.html.

“Five Worst Invasive Plants in South Africa.” *Life Is a Garden*, 9 Oct. 2019,

www.lifeisagarden.co.za/five-worst-invasive-plants-in-south-africa/.

“Great Lakes Aquatic Invasive Species.” *The Nature Conservancy*,

www.nature.org/en-us/about-us/where-we-work/priority-landscapes/great-lakes/great-lakes-aquatic-invasive-species/.

“Great Lakes Region.” *Great Lakes Region RSS*,

www.regions.noaa.gov/great-lakes/index.php/great_lakes-restoration-initiative/invasive-species/.

Greentumble. “Why Are Invasive Species a Problem?” *Greentumble*, 4 Sept. 2019,

greentumble.com/why-are-invasive-species-a-problem/.

“Invasion Timeline.” *Invasive Species Council*, 13 June 2020,

invasives.org.au/our-work/invasion-timeline/#2002.

“Invasive Alien Plant Alert.” *SANBI*,

www.sanbi.org/resources/infobases/invasive-alien-plant-alert/.

“Invasive Species Threaten the Great Lakes Economy and Ecosystem.” *Ocean Action Agenda*,

oceanactionagenda.org/story/invasive-species-threaten-great-lakes-economy-ecosystem/.

“Invasive Species Timeline.” *Prezi.com*,
prezi.com/wtfdxnn2mi64/invasive-species-timeline/.

“Invasive Species Timeline.” *Timetoast*, 1 Jan. 1800,
www.timetoast.com/timelines/invasive-species--2.

“Invasive Species.” *National Wildlife Federation*,
www.nwf.org/Educational-Resources/Wildlife-Guide/Threats-to-Wildlife/Invasive-Species#:~:text=Invasive%20species%20are%20primarily%20spread,carry%20them%20on%20their%20propellers.

“Invasive Species: What You Can Do.” *The Nature Conservancy*, 8 July 2013,
www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/invasive-plant-species-invasive-species-education-1/.

Jacob Hill Jacob Hill is a field and conservation biologist with an M.S. in Biology from Purdue University. He has worked extensively with nesting sea turtles and studied diving behavior and population genetics of hawksbill turtles for his Masters research. “Jacob Hill.” *EnvironmentalScience.org*,
www.environmentalscience.org/invasive-species.

“Key Priorities for 2020 |.” *Invasive Species Council of British Columbia | ISCBC Plants & Animals*, bcinvasives.ca/about/what-we-do/key-priorities-for-2020.

Lundstrom, Jim. “Timeline of Lake Michigan Invasive Species.” *Door County Pulse*, 27 Feb. 2015, doorcountypulse.com/timeline-of-lake-michigan-invasive-species/.

Mercer, Phil. “The Rapid Spread of Australia’s Cane Toad Pests.” *BBC News*, BBC, 22 Mar. 2017, www.bbc.com/news/world-australia-39348313.

Schultz, Jennifer. *State Action on Invasive Species*,
www.ncsl.org/research/environment-and-natural-resources/displaced-by-invaders-state-action-on-invasive-species.aspx.

Steenkamp, Elise-Marie. "Impacts and Control of Invasive Alien Plants in South Africa." *Hortgro*, Hortgro, 21 May 2018, www.hortgro.co.za/news/impacts-and-control-of-invasive-alien-plants-in-south-africa/.

Steenkamp, Elise-Marie. "Impacts and Control of Invasive Alien Plants in South Africa." *Hortgro*, Hortgro, 21 May 2018, www.hortgro.co.za/news/impacts-and-control-of-invasive-alien-plants-in-south-africa/.

Stephen Cousins PhD student in Conservation Ecology, et al. "Invasive Alien Plants in South Africa Pose Huge Risks, but They Can Be Stopped." *The Conversation*, 28 May 2020, theconversation.com/invasive-alien-plants-in-south-africa-pose-huge-risks-but-they-can-be-stopped-94186.

Tennessen, Tina. *5 Invasive Species You Should Know*, 14 May 2018, ocean.si.edu/ocean-life/5-invasive-species-you-should-know.

UN Environment. "Invasive Species – a Huge Threat to Human Well-Being." *UN Environment*, www.unenvironment.org/news-and-stories/story/invasive-species-huge-threat-human-well-being.

"We Came over on The Mayflower, Too! A Timeline of North American Invasive Species." *Eat The Invaders RSS*, eattheinvaders.org/we-came-over-on-the-mayflower-too/.

What Is an Invasive Species and Why Are They a Problem?, www.usgs.gov/faqs/what-invasive-species-and-why-are-they-a-problem?qt-news_science_products=0#qt-news_science_products.

"What Is the Current Status of the 'Invasion' of Non-Native Zebra Mussels in the Great Lakes? Has the Invasion Been Stopped or Controlled? And What Ecological Damage Has This Creature Caused Other than the Clogging of Drainage Pipes?"

Scientific American, Scientific American, 21 Oct. 1999,
www.scientificamerican.com/article/what-is-the-current-statu/.

Wild, Sarah. "South Africa's Invasive Species Guzzle Water and Hurt the Economy."
Scientific American, Scientific American, 7 Nov. 2018,
www.scientificamerican.com/article/south-africas-invasive-species-guzzle-water-and-hurt-the-economy/.

"Working for Water (WfW) Programme." *Working for Water (WfW) Programme* |
Department of Environmental Affairs,
www.environment.gov.za/projectsprogrammes/wfw.