4.3.9 Infestations and Invasive Species

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the infestation and invasive species hazard in Sussex County.

2021 HMP Changes

- This is a new hazard of concern for Sussex County.

Profile

Hazard Description

An infestation is defined as a state of being invaded or overrun by parasites that attack plants, animals and humans. Insect, fungi and parasitic infestations can result in destruction of various natural habitats and cropland, impact human health, and cause disease and death among native plant, wildlife and livestock. An infestation is the presence of a large number of pest organisms in an area or field, on the surface of a host, or in soil. They result from when an area is inhabited or overrun by these pest organisms, in numbers or quantities large enough to be harmful, threatening or obnoxious to native plants, animals and humans. Pests are any organism (insects, mammals, birds, parasite/pathogen, fungi, non-native species) that are a threat to other living species in its surrounding environment. Pests compete for natural resources or they can transmit diseases to humans, crops and livestock. Human populations are generally impacted by insect or animal infestations that can result in health impacts and can lead to potential epidemics or endemics. For more information on health impacts caused by infestations, refer to Section 4.3.2 (Disease Outbreak).

For the purpose of this HMP update, the infestation and invasive species hazard profile will include the following: Hemlock Woolly Adelgid, mosquitos, Emerald Ash Borer, Spotted Lanternfly, White and harmful algal bloom.

Hemlock Woolly Adelgid

Source: NJDA 2020

The Hemlock Woolly Adelgid, a tiny aphid-like insect from Asia, was first discovered in the Pacific Northwest in the 1920's. By the early 1950's it was discovered in Virginia and has since been found as far north as Rhode Island. Its preferred host tree is hemlock, but it may also attack spruce. A tree infested with Hemlock Woolly Adelgid will exhibit gray-green needles and cotton-like wool tufts under the needles. By frequently inspecting trees for signs of Hemlock Woolly Adelgid, a homeowner can intervene in a timely manner and possibly prevent the tree from dying (NJ DEP 2020).

Mosquitoes

Mosquito infestations can result in the spread of disease such as West Nile Virus, Eastern Equine Encephalitis (EEE), and Zika virus through bites from infested mosquitoes. Mosquitos typically lay eggs in or near standing water. For more information on infectious disease spread by mosquitoes, refer to 4.3.2 (Disease Outbreak).

Emerald Ash Borer

Source: NJDA 2020

Emerald Ash Borer (EAB) was first discovered in Somerset County in 2014 and has spread through the northern half of the state. This Asian beetle infests and kills North American ash tree species, including green, white, black and blue ash; making all native ash trees susceptible to this insect. The insect is typically present from late May through early September and is most common in June and July. Signs of infection include tree canopy dieback and yellowing and browning of leaves. Most trees die within two to four years of becoming infested (NJDA 2020).

Spotted Lanternfly

Source: NJAES 2020

The spotted lanternfly (*Lycorma deliculta*) is an Asian plant hopper. The adults are quite colorful with a black head, grayish black spotted forewings, and reddish black spotted hind wings. Adults are approximately 1" in length and a 1/2" in width and are present from mid-July through the fall. During this time, SLF adults are mating and laying eggs. Egg masses are laid on smooth surfaces and appear like a patch of mud.

In the USA, spotted lanternfly is an invasive species that could be very devastating to some New Jersey crops and hardwood trees. This insect was accidentally introduced into Pennsylvania and was confirmed in September 2014. In 2018, spotted lanternfly populations were found in New Jersey and a state quarantine encompassing Mercer, Hunterdon, and Warren counties has been established by the NJ Department of Agriculture (New Jersey Agricultural Experiment Station [NJAES] 2020).

The spotted lanternfly can feed on more than 70 plant species including cultivated grapes, fruit trees, and hardwood trees. One tree of particular importance is *Ailanthus altissima* or the Tree of Heaven which is abundant in New Jersey. Tree of Heaven typically grows in clumps in sunny areas along highways or disturbed habitats such as the edges of crop fields, open spaces, or parks. Other key tree hosts include black walnut; red maple; and agricultural crops such as grapes, hops, apples, and peaches.

As with all plant hoppers, the spotted lanternfly has sucking mouthparts that it inserts into plant tissues to remove the fluids it needs to survive. Adults and nymphs are phloem feeders that feed in large congregations on woody tissue. Although there are no numbers or estimates on the economic impact of the spotted lanternfly—because this insect feeds in large numbers it can quickly cause damage. Feeding occurs on the trunk and limbs of plants, not on the fruit or leaf tissues. During feeding, the insect excretes significant amounts of honey dew (or sugar water). Honey dew deposits provide a food source for a sooty mold fungus that can grow on plant surfaces and fruit leading to reduced photosynthesis and plant vigor, leading to additional plant damage (NJAES 2020).

White-Tailed Deer

White-Tailed Deer can be found from southern Canada to South America. In summer months, they typically live in fields and meadows and during the winter, the deer generally keep to forests. White-tailed deer are herbivores and graze on most types of plants. There are not many natural predators to white-tailed deer which causes the

deer population to grow too large for their environment and some areas may experience an overpopulation of deer (National Geographic 2015).

White-tailed deer are a major component throughout the State, with the exception of the most urbanized areas, affecting forests, farms, gardens, backyards and roadways. They can have negative impacts on humans, including car accidents, depredation of agricultural and ornamental plantings, and the potential for harboring diseases that are transmissible to man or domestic animals. The size of the deer population in New Jersey is managed through controlled sport hunting, with the main goal being to maintain healthy deer populations at a density tolerable to residents. In Sussex County, the white-tailed deer population have a history of impacting agriculture in the County.

Canada Geese

One of the most widely distributed waterfowl species in the United States is the Canada goose (*Branta canadensis*). After near extinction, the species bounced back to numbers far exceeding historic estimates, due to regulatory actions, habitat restoration, species conservation initiatives, and increased man-made habitat such as mowed lawns, golf courses, and stormwater detention basins. Two classes of Canada geese exist in the U.S. Migratory Canada geese (considered the Atlantic population) are those that breed north of the continental U.S., in Alaska, Canada, Newfoundland, and Labrador. These birds spend the nonbreeding season in the U.S. and northern Mexico and are present typically between October and February. Resident Canada geese are those that spend the entire year within the continental U.S. Considered a nuisance by some and a culturally important species by others, resident geese significantly affect both human and ecosystem health (Rutgers 2013).

Harmful Algal Bloom

A harmful algal bloom (HAB) is an algal bloom that can be dangerous to people, animals or the ecology. HABs can occur in both the freshwater and marine water environments. There is no scientifically sound treatment to eliminate HABs from water bodies, so advanced and continuous monitoring is the key element in protecting health and assessing when the lake is safe for swimming and recreational activities (NJDEP 2020).

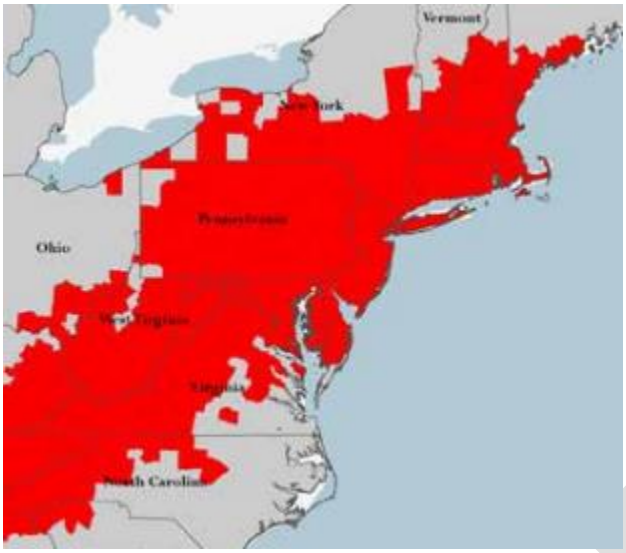
Location

Due to the diversity of landscape in Sussex County, the entire County has the potential to be impacted by each of the species identified above. Bodies of water, including Lake Hopatcong have the potential to be impacted by HABs.

Hemlock Woolly Adelgid

Hemlock Woolly Adelgid are found throughout New Jersey and many areas throughout the northeast and Appalachian Mountain.

Figure 4.3.9-1. Hemlock Woolly Adelgid Distribution in the Eastern United States

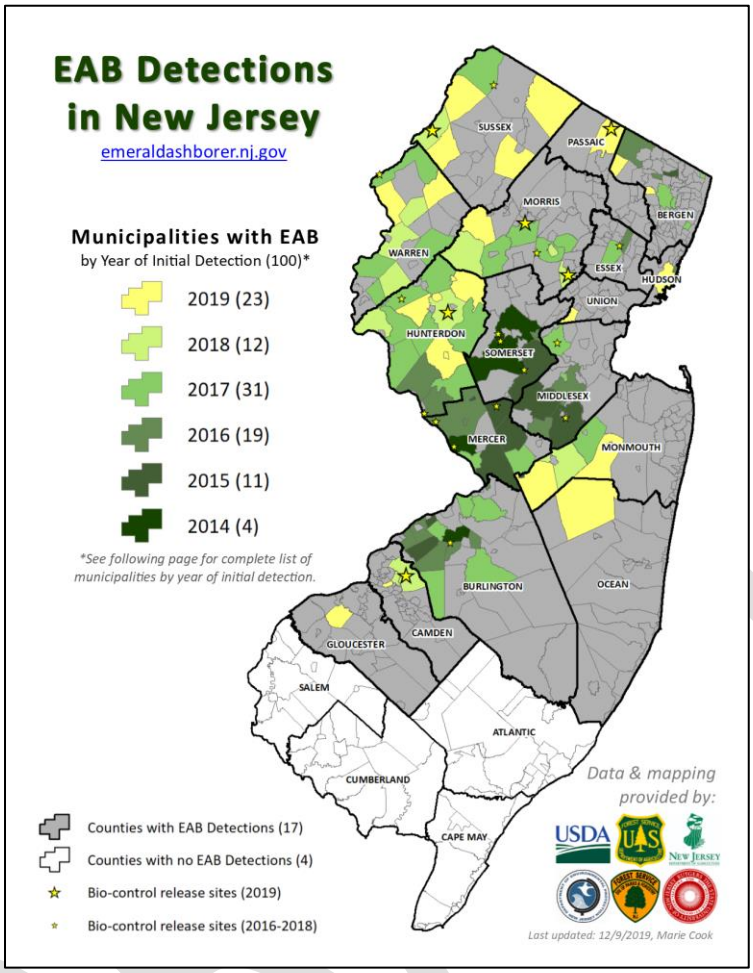


Source: USDA 2019

Emerald Ash Borer

Three species of ash are native to Sussex County an all are susceptible to EAB: white ash *(F. Americana)*, green ash *(T. pennsylvanica*), and black ash (*F. nigra*). EAB was first detected in New Jersey in 2014. The New Jersey Department of Agriculture (NJDA) is coordinating New Jersey's EAB biocontrol program. Municipalities in Sussex County that have had EAB populations detected include the Township of Montague, the Township of Walpack, the Township of Sparta, the Township of Vernon, the Township of Stillwater, and the Township of Sandyston (NJDA 2020).

Figure 4.3.9-2. Emerald Ash Borer Detections in New Jersey

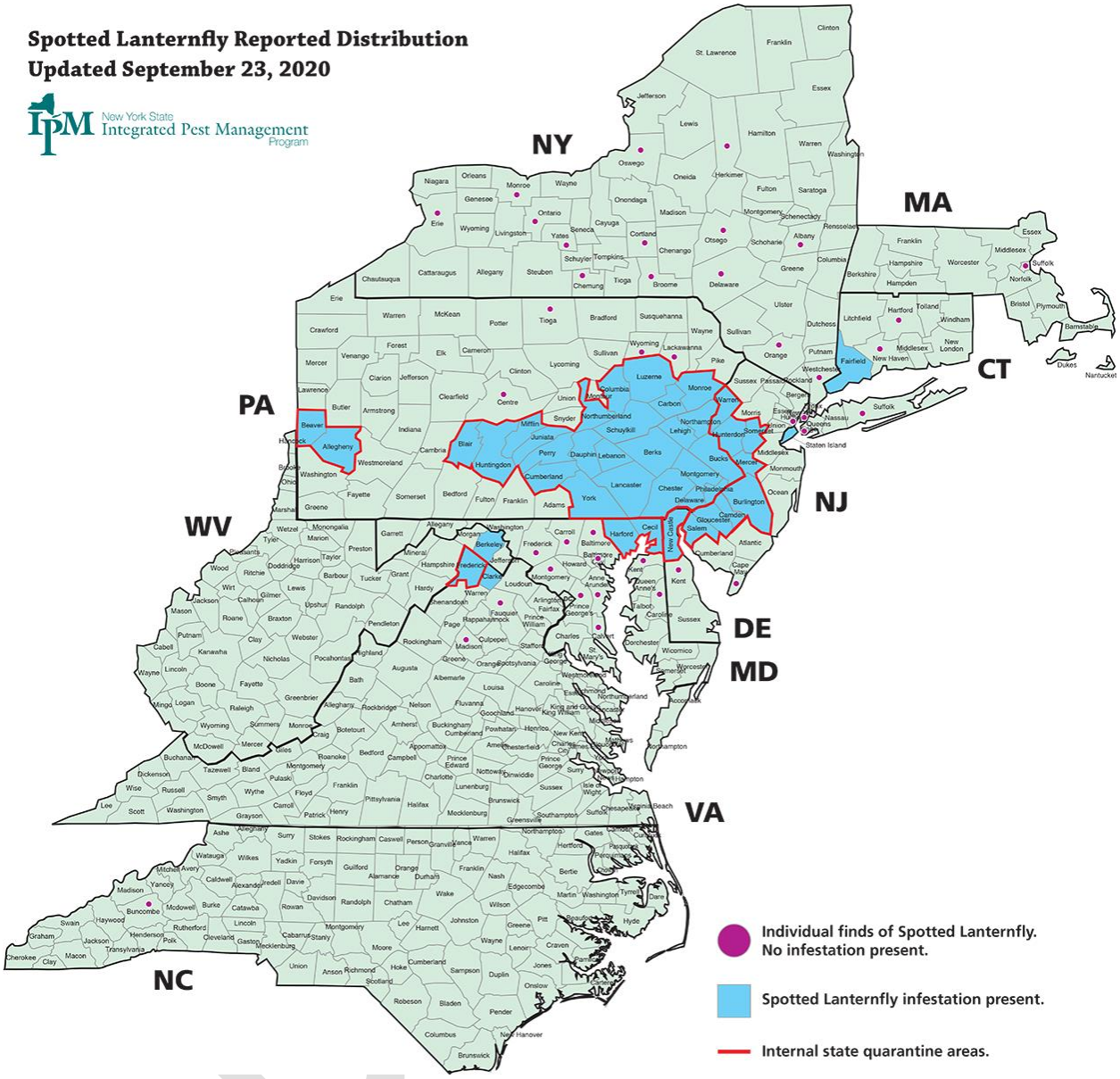


Source: State of New Jersey Department of Agriculture 2020

Spotted Lanternfly

According to NYS Integrated Pest Management (IPM), there is no spotted lanternfly infestation present in Sussex County as of September 2020; however, spotted lanternflies have been identified within the County during the fall of 2020. Refer to Figure 4.3.9-3 which displays a map of the distribution reported in the Northeast.

Figure 4.3.9-3. Spotted Lanternfly Reported Distribution as of September 2020



Source: NYS IPM 2020

White-Tailed Deer and Canada Geese

White-Tailed Deer and Canada Geese are found throughout Sussex County and New Jersey. Canada Geese are most commonly found near water bodies. White-Tailed Deer are most commonly found on the edge of wooded areas.

Harmful Algal Bloom

HABs have the potential to impact waterbodies throughout Sussex County and New Jersey.

Extent

The extent and location of infestations and invasive species depends on the preferred habitat of the species, as well as the species' ease of movement and establishment. However, each of these threats can impact many areas of Sussex County. The magnitude of infestations and invasive species ranges from nuisance to widespread. The threat is typically intensified when the ecosystem or host species is already stressed, such as periods of drought. The already weakened state of the ecosystem causes it to more easily be impacted to an infestation.

Hemlock Woolly Adelgid

The Hemlock Woolly Adelgid nymphs and adults feed on sap from the tree's twigs. The tree drops its needles and, if left uncontrolled, the adelgid can kill a tree within a year. Treatment involves manual removal of infected tree branches or spraying of horticultural oils (NJ DEP 2020).

Mosquitoes

The extent of mosquito-borne viruses is described in Section 4.3.2 (Disease Outbreak). Disease impacts can result in flu-like symptoms, brain damage, or death.

Emerald Ash Borer

The NJ Emerald Ash Borer Task Force and other experts predict a 99% mortality rate for untreated ash trees. Peak die off of trees is likely to occur 9 to 10 years after the initial infestation. This suggests that Sussex County will be dealing with large volumes of tree deaths in the next 15 years. Management options for EAB include tree removal, treating with insecticides, and biological controls (the release of wasps which act as parasitoids for egg and larvae). The United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA, APHIS, PPQ), operates the biological control production facility in Michigan which was designed to produce EAB parasitoids for release. In order to be considered for inclusion in the parasitoid release program, release sites must meet a certain criteria to be eligible: the site must be forested at least 40 acres in size; the site must contain no less than 25 percent ash of varying age classes; ash trees must be relatively healthy; and EAB must be detected in close proximity to the release site and be in low to moderate densities (NJDA 2020).

Spotted Lanternfly

Spotted Lantern Fly damages plants through the extraction of plant sap. Infestations of Spotted Lanternfly can result in decimation of crops, forest habitat, and landscaping (NJDA 2020).

White-Tailed Deer

White-Tailed Deer can have negative impacts on humans, including vehicle collisions, depredation of agricultural and ornamental plantings, and the potential for harboring parasites which can transmit diseases to man or domestic animals. Deer are selective browsers, and over time, herds can eat some plants out of existence and reduce the populations of other plants. Because tree seedlings are especially vulnerable to hungry deer, the future species composition of forests can be determined by deer browsing. While trees eventually grow out of a deer's reach, many other plants never do. Because deer browsing can significantly change habitat composition, it also exerts a strong influence on other animal populations (NJ DEP 2019).

Canada Geese

Canada geese are carriers of several bacteria and parasites that may be pathogenic to humans. The bacterium most commonly associated with Canada goose droppings is the fecal coliform, *Escherichia coli* (*E. coli*). High

levels of *E. coli* can result in closure of recreational waterways. Canada geese can be a threat to aircraft and can result in air strikes. Aggressive behavior of nests and protection of goslings can result in attacks on humans and pets in areas commonly used for recreational purposes. Canada goose damage in agricultural systems can be severe (Rutgers 2013).

Harmful Algal Bloom

Some, but not all, HABs produce chemicals that can be toxic to humans and animals if ingested, inhaled, or if contacted by skin or mucous membranes. These toxins can also accumulate in fish and shellfish which can cause illness when either are consumed (NJDEP 2020). NJDEP now has an algal bloom sampling dashboard (HAB Interactive Map Reporting and Communication System) available online with samples categorized in accordance with alert levels as displayed in Figure 4.3.9-4.

Figure 4.3.9-4. HAB Alert Levels

HAB Not Present	HAB reported and investigated. No HAB present.	None
WATCH *Suspected or confirmed HAB with potential for allergenic or irritative health effects*	Suspected HAB based on field survey **OR** Confirmed cell counts ≥20K - <80K cells/mL **AND** No known toxins above public health thresholds	**Public Bathing Beaches Open** Waterbody Accessible: Use caution during **primary contact (e.g. swimming) and secondary (e.g. non-contact boating)** activities Do not ingest water (people/pets/livestock) Do not consume fish
ADVISORY *Confirmed HAB with moderate risk of adverse health effects and increased potential for toxins above public health thresholds*	Lab testing for toxins Microcystins: ≥3 µg/L Cylindrospermopsin: ≥8 µg/L Anatoxin-a: ≥27 µg/L **OR** Confirmed cell counts ≥80K cells/mL	**Public Bathing Beaches Closed** Waterbody Remains Accessible: Avoid primary contact recreation Use caution for secondary contact recreation Do not ingest water (people/pets/livestock) Do not consume fish
WARNING *Confirmed HAB with high risk of adverse health effects due to high toxin levels*	Toxin (microcystins) ≥20 - <2000 µg/L	**Public Bathing Beaches Closed** Cautions as above May recommend against secondary contact recreation.
DANGER *Confirmed HAB with very high risk of adverse health effects due to very high toxin levels*	Toxin (microcystins) ≥2000 µg/L	**Public Bathing Beaches Closed** Cautions as above. Possible closure of all or portions of waterbody and possible restrictions access to shoreline.

Source: NJDEP 2021

Previous Occurrences and Losses

Infestation and Invasive Species events that have impacted Sussex County between 2015 and 2020 are discussed below. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Hemlock Woolly Adelgid is now common throughout the state. Emerald Ash Borer was first identified in Sussex County in 2017 and has continued to impact additional municipalities in the last several years. Many species of mosquitos are native to Sussex County but additional species such as the Asian Tiger Mosquito have been

introduced or expanded their range into the state and Sussex County in recent decades. Spotted Lanternflies have recently entered Sussex County as of fall 2020.

White-tailed Deer and Canada Geese overpopulation continue to impact agriculture throughout Sussex County.

In 2019, recreational use of Lake Hopatcong was severely limited due to harmful algal blooms. Freeholder boards in Sussex and Sussex counties have agreed to allocate a total of $50,000 in matching funds to support an application by the Lake Hopatcong Commission for a potential $500,000 state grant to study and reduce harmful algal blooms (HABs) (Sussex County 2020). New algal blooms took place in 2020 (Northjersey.com 2020). In 2020, Lake Neepaulin and Swartswood Lake were placed under HAB watches (NJDEP 2020).

According to the NJDEP HAB Interactive Map Reporting and Communication System, samples were collected and categorized on the 'watch' alert level in the fall 2020 for Lake Hopatcong, Lake Owassa, Lake Neepaulin and Lake Musconetcong (NJDEP 2021).

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2020, Sussex County was included in one emergency declaration related to infestation or invasive species for West Nile Virus. For more information regarding the impacts of West Nile Virus, refer the Section 5.4.13 (Disease Outbreak).

Table 4.3.9-1. Infestation or Invasive Species-Related Disaster (DR) and Emergency (EM) Declarations 1954-2020

Declaration	Event Date	Declaration Date	Event Description
EM-3156	May 30 -November 1, 2000	November 1, 2000	West Nile Virus Threat

Source: FEMA 2020

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the USDA is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2015 and 2020, Sussex County was not included in any infestation or invasive species related agricultural disaster declarations.

Probability of Future Occurrences

Based on historical documentation, increased incidences of infestation throughout the State of New Jersey and the overall impact of changing climate trends, it is estimated that Sussex County and all its jurisdictions will continue to experience infestation events that may induce secondary hazards and health threats to the County population if infestations are not prevented, controlled or eradicated effectively.

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for infestation and invasive species in the county is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the infestation and invasive species hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation. Changes in winter temperatures could result in a change in the frequency of ice jam events.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

The following provides information on the different infestations impacted Sussex County and how they may be affected by climate change.

Hemlock Woolly Adelgid, Emerald Ash Borer, Mosquitoes, and Spotted Lanternfly

A warmer climate would extend the active insect season and allow for species that are not as cold tolerant to move north and expand their range. This increases the extent of invasive insects and their related impacts.

Harmful Algal Bloom

The projected increase in precipitation is expected to occur via heavy downpours and less in the form of light rains. Rising air temperatures intensify the water cycle by increasing evaporation and precipitation, which can cause an increase in rain totals during storm events, with longer dry periods between those events. Alternating periods of drought and heavy rainfall increase the likelihood of nutrient runoff into waterways, which can fuel algal blooms (EPA 2017a).

Warmer temperatures could lead to an increase of the length of the algal growing season and increase the likelihood of algal blooms. In addition to warmer temperatures and heavy precipitation events, carbon dioxide

levels are forecast to continue to increase. Higher levels of carbon dioxide in the atmosphere and water can lead to increased algal growth, particularly for cyanobacteria that float at the surface (EPA 2017a).

White-Tailed Deer and Canada Geese

White-Tailed Deer and Canada Geese are cosmopolitan species and are found in a wide variety of climates. As such, neither species is likely to be significantly impacted by climate change.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. All of the County is considered exposed to infestations and invasive species, with waterbodies potentially vulnerable to the harmful algal bloom hazard of concern. The following text evaluates Sussex County's vulnerability in a qualitative nature.

Impact on Life, Health and Safety

The entire population of Sussex County is vulnerable to infestations, invasive species, and harmful algal blooms. According to the 2018 American Community Survey (ACS) 5-year Estimate, Sussex County had a population of 142,298. Of that total population, the elderly population and people with suppressed immune systems are most susceptible to the effects of infestations such as West Nile Virus. The ACS has identified that there are 22,889 persons over the age of 65 in Sussex County.

As discussed earlier, infestations can have an impact on agricultural commodities. The NJDA has indicated that New Jersey farmers lose $290 million annually in direct crop loss or damage caused by agricultural pests (New Jersey Department of Agriculture n.d.). This destruction of crop may include consumable resources that are sold to persons in the County. Section 4.3.2 (Drought) discusses the number of farms that are operating in the County (i.e., 1,008 farms). Based on the Department of Agriculture's study, it is reasonable to assume that the farms in Sussex County also experience losses in crops. This not only impacts the livelihood of the farmers; it also affects the community that relies on these crops for food or other commodities.

Additionally, the impacts of harmful algal blooms on life, health, and safety depend on several factors, including the severity of the event and whether citizens and tourists have become exposed to waters suspected of containing toxins associated with cyanobacteria. Routes of exposure include consumption, inhalation, and dermal exposure. The population living near or visiting waterbodies is at risk for exposure as well as those that use those waterbodies for recreation, fishing, and water supply. Contact with water containing harmful algal blooms can cause various health effects including diarrhea, nausea or vomiting; skin, eye, or throat irritation; and allergic reactions or breathing difficulties (CDC 2020).

Further, the population living near waterbodies is at risk for exposure to HABs as well as those that use those waterbodies for recreation, fishing, and water supply. Therefore, exposure should not be limited to only those who reside in a defined hazard zone, but visitors to Sussex County waterbodies as well. Contact with water containing HABs can cause various health effects including diarrhea, nausea or vomiting; skin, eye, or throat irritation; and allergic reactions or breathing difficulties (NJDEP 2020).

Cyanobacteria blooms are one of the most common freshwater HABs and have been identified by NJDEP as being present in Sussex County blooms. Cyanobacteria are known to produce toxins from the following classes:

Endotoxins: Endotoxins associated with cyanobacteria have been tied to fever and inflammation in humans that have come in contact with water that contains cyanobacterial blooms.

Hepatotoxins: Hepatotoxins are commonly tied to animal poisonings that are associated with cyanobacterial blooms. Animals may exhibit weakness, heavy breathing, paleness, cold extremities, vomiting, diarrhea, and bleeding in the liver. In humans, hepatotoxins have been indicated to promote tumors and may lead to increases in liver cancer. Some types of hepatotoxins, such as microcystin, can persist in fresh water for up to 2 weeks before being naturally broken down (algae).

Neurotoxins: Neurotoxins act to block transfers between neurons. Extreme cases can result in paralysis (EPA 2014).

The EPA has established an incident checklist for HAB incidents impacting water utilities (EPA 2017). This tool is available to help utilities detect, identify, and monitor a bloom. The County is recommended to coordinate with the supplier to ensure that the water is clear of harmful algae, thus maintaining the safety of users of the purchased water.

Impact on General Building Stock

Structures are not anticipated to be directly affected by infestation, invasive species, or harmful algal blooms. However, the EAB may cause a catastrophic loss of ash trees throughout the County, which could result in stream bank instability, erosion, and increased sedimentation, impacting ground stabilization and possibly cause foundation issues for nearby structures. Additionally, with an increased number of dead trees, there is an increased risk of trees falling on roadways, power lines, and buildings.

Some invasive plants have been shown to destabilize soil due to high densities and shallow root systems, negatively impacting nearby buildings and septic systems. Other invasive plant species have been known to clog culverts and streams, increasing flooding risk.

Impact on Critical Facilities and Lifelines

Water treatment plants could be impacted by infestation and invasive species because of similar issues that the general building stock may experience. Water that becomes polluted due to increased sedimentation and erosion will require additional treatment. If the system becomes clogged with these pollutants, the ability of water treatment plants to operate may become impaired. Additionally, soil that becomes unstable due to decaying vegetation can impact critical facilities that are built on or around these soils.

The typical impact harmful algal blooms have on critical facilities are shutdowns of water intakes from the surface waters that are impacted by blooms and their toxins. Water treatment plants can remove variable amounts of microcystin from drinking water depending on the active removal process used by the water treatment plant (EPA 2020). However, applying the wrong treatment process at a specific state in treatment could damage the facility and release cyanotoxins rather than remove them. The EPA has summarized the effectiveness of treatment options for harmful algal blooms (refer to Table 4.3.9-2).

Table 4.3.9-2. Assessment of Treatment Options for HABs

Treatment Process	Relative Effectiveness
Intracellular Cyanotoxins Removal (Intact Cells)	
Pre-treatment oxidation	Oxidation often stresses or lyses cyanobacteria cells releasing the cyanotoxin to the water. If oxidation is required to meet other treatment objectives, consider using lower doses of an oxidant less likely to lyse cells. If oxidation at higher doses must be used, sufficiently high doses should be used to not only lyse cells but also destroy total toxins present (see extracellular cyanotoxin removal).
Coagulation/ Sedimentation/ Filtration	Effective for the removal of intracellular toxins (cyanobacteria cells). Ensure that captured cells accumulated in sludge are removed frequently to release toxins. Ensure that sludge supernatant is not returned to the supply after sludge separation.
Membranes	Effective for removal of intracellular cyanotoxins (cyanobacteria cells). Microfiltration and ultrafiltration are effective when cells are not allowed to accumulate on membranes for long periods of time. More frequent cleaning may be required during a bloom event.
Flotation	Flotation processes, such as Dissolved Air Flotation (DAF), are effective for removal of intracellular cyanotoxins since many of the toxin-forming cyanobacteria are buoyant.
Extracellular (Dissolved) Cyanotoxins Removal	

Treatment Process	Relative Effectiveness
Membranes	Depends on the type of cyanotoxin, membrane material, membrane pore size distribution, and influent water quality. Nanofiltration is generally effective in removing extracellular microcystins. Reverse osmosis filtration is generally applicable for removal of microcystins and cylindrospermopsin. Cell lysis is highly likely. Further research is needed to characterize performance.
Potassium Permanganate	Effective for oxidizing microcystins and anatoxins. Further research is needed for cylindrospermopsin. Not effective for oxidizing saxitoxin.
Ozone	Very effective for oxidizing microcystins, anatoxin-a, and cylindrospermopsin. Not effective for oxidizing saxitoxin.
Chloramines	Not effective.
Chlorine dioxide	Not effective at doses typically used in drinking water treatment.
Free Chlorine	Effective for oxidizing microcystins as long as the pH is below 8. Effective for oxidizing cylindrospermopsin and saxitoxin. Not effective for oxidizing anatoxin-a.
UV Radiation	UV radiation alone is not effective at oxidizing microcystins and cylindrospermopsin at doses typically used in drinking water treatment. When UV radiation is coupled with ozone or hydrogen peroxide (called "advanced oxidation"), the process is effective at oxidizing anatoxin-a, cylindrospermopsin, and with high UV doses, microcystins.
Activated Carbon Adsorption	Powdered activated carbon (PAC): Effectiveness of PAC adsorption varies based on type of carbon, pore size, type of cyanotoxin, and other water quality parameters such as natural organic matter (NOM) concentration. Wood-based activated carbons are generally the most effective at microcystins adsorption. More research is needed to evaluate PAC's effectiveness at adsorbing cylindrospermopsin, anatoxin-a, and saxitoxin, however the limited research has demonstrated promising results. Doses in excess of 20mg/L may be needed for complete toxin removal, especially if NOM concentrations are high. Granular activated carbon (GAC): Effectiveness of GAC adsorption varies based on type of carbon, pore size, type of cyanotoxin, and other water quality parameters such as NOM concentration. GAC is effective for microcystins, and likely effective for cylindrospermopsin, anatoxin-a and saxitoxin. The condition of the carbon is an important factor in determining GAC's effectiveness for cyanotoxin removal. GAC may need to be regenerated more frequently to ensure adequate adsorption capacity for HAB season.

Source: EPA 2020

Impact on Economy

Impacts of infestation, invasive species, and harmful algal blooms on the economy and estimated dollar losses are difficult to measure and quantify. Costs associated with activities and programs implemented to conduct surveillance and address invasive species and infestations have not been quantified in available documentation. However, as indicated by the NJDA, farmers across the State may collectively revenue because of crop losses from invasive species and infestations (New Jersey Department of Agriculture n.d.). In 2017, there were 25,671 acres of cropland in Sussex County, and 20,441 acres that was harvested (USDA 2017). Revenues for Sussex County from crop sales and livestock stocks sales were approximately $10.8 million and $7.4 million, respectively. Therefore, it is reasonable to believe that Sussex County farmers have experienced monetary losses from infestations.

The New Jersey Forest Service has indicated that 9-percent of New Jersey forests are susceptible to EAB attacks (NJDEP 2016). EAB can infect nursery stock and mature trees, which could reduce the timber value of hardwood exports (CFIA 2014). In 2010, the USDA Northern Research Station conducted computer simulations of EAB spread to estimate the cost of ash tree treatment, removal, and replacement (re-planting of new trees) between 2009 and 2019. The simulations predicted an EAB infestation covering 25 states, and assumed

treatment, removal, and replacement of more than 17 million ash trees on developed land within established communities. The total costs were estimated at $10.7 billion. This figure doubled when the model was reset to include developed land outside, as well as inside, human communities (USDA 2013).

HAB-related economic impacts on Sussex County would largely focus on the agricultural and recreation sector. News of a closure of a body of water can result in visitors avoiding the area. Even after closures are lifted, negative public reaction can persist and continue to impact local revenue and property values. As mentioned, there is a price tied to programs that protect water bodies from harmful algal blooms. The cost to operate and monitor these programs will vary depending on the extent of the blooms. Additional costs may include money spent on nutrient reduction programs for agricultural commodities, purchasing backup water sources, and costs to implement advanced drinking water treatment. Agricultural producers may need to develop better strategies to reduce the nutrient runoff that cause harmful algal blooms, which may increase production costs for their commodities and overall costs for their buyers.

Impact on the Environment

As previously discussed, Sussex County's parks, forests and neighborhood trees are vulnerable to mosquitos, spotted lanternfly, Canadian geese, and EAB. Species that cause eventual destabilization of soil, such as invasive insects that destroy plants or invasive plants that outcompete native vegetation but have less effective root systems, can increase runoff into waterbodies. This can lead to increased harmful algal blooms and negative impact on drinking water supplies. Soil destabilization can also increase the likelihood of mudslides in areas with a steep slope.

The New Jersey Forest Service has indicated that EAB will first infest the top of the tree's crown. This leads to the crown dying, bark splitting, and exit holes are created on lower parts of the tree. Trees that are infested only live on average of 3 to 4 years (NJDEP 2016).

Furthermore, harmful algal blooms can release toxins that can kill fish and invertebrate (EPA 2019). Animals that prey on fish and invertebrates in surface waters, such as birds and mammals, may be affected if they ingest impacted prey. Both harmful and non-harmful algal blooms can have drastic impacts on oxygen levels in surface waters. When algae begin to die off following a bloom, bacteria begin to decompose the organic material. This decomposition consumes dissolved oxygen and releases carbon dioxide. If the bloom and die off is large enough, dissolved oxygen levels in aquatic systems can rapidly crash. Anoxic conditions connected to algal blooms have resulted in large fish and invertebrate kills.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development

As discussed in Sections 3 (County Profile) and 9 (Jurisdictional Annexes), areas targeted for future growth and development have been identified across Sussex County. Changes in land use have the potential to render some habitats more susceptible to invasive species, such as clearing the land and providing opportunities for invasive species to inhabit the area. Clearing the land may also reduce the habitat for predator species that could manage

the spread of invasive species naturally. As increased development is often associated with stormwater and runoff issues, harmful algal blooms may become more likely in areas of increased development. The specific areas of development are indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

Projected Changes in Population

According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the density of population nearby waterbodies can impact the number of persons exposed to harmful algal blooms. During summer months, there is an increase in visitors to the County's lakes and shorelines which can increase exposure to harmful algal blooms.

Infestation to cropland and nurseries can also have an impact on persons outside of Sussex County if the farmers within the County supply resources to neighboring communities. Being aware of trends occurring around the County may reveal that infestations within agricultural commodities provided by the County impacts a greater number of persons.

Climate Change

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Changing weather patterns could create a change in the migration patterns for when these species move into and out of Sussex County. If the species have a more prolonged existence in the County, there may also be a greater number of infestation events or a higher value of loss tied to infestation. Warmer temperatures could lead to an increase of the length of the algal growing season and increase the likelihood of algal blooms. Increased alternation of drought and heavy precipitation could result in additional nutrient runoff into local waterbodies, providing more fuel for algal blooms. Higher carbon dioxide levels in the atmosphere and surface waters could create a more favorable growing environment for HABs (EPA 2019).

Vulnerability Change Since the 2016 HMP

Harmful algal blooms, infestations, and invasive species are a new hazard of concern for Sussex County.