

SECTION 4. RISK ASSESSMENT

This section provides a profile and vulnerability assessment of the invasive species and harmful algal blooms hazard in Camden County.

4.3 Hazards of Concern

2022 HMP Changes

- Invasive Species and Harmful Algal Blooms is a new hazard for Camden County.
- Previous events between 2015 and 2020 were researched.

4.3.10 Invasive Species and Harmful Algal Blooms

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 the purpose of this HMP update, the invasive species hazard profile will include the following: Emerald Ash Borer, Gypsy Moth, Hemlock Woolly Adelgid, Mosquito, Spotted Lanternfly, Asian Swamp Eel, Canada Geese, White-Tailed Deer, and Harmful Algal Bloom (HAB).

Emerald Ash Borer



Source: NJDA 2020

Emerald Ash Borer (EAB) was first discovered in New Jersey in Somerset County in 2014 and first detected in Camden County in 2018 in both Cherry Hill Township and Haddonfield Borough. In 2019, EAB was detected in Haddon Heights Brough. 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).

Gypsy Moth

The gypsy moth is one of most devastating forest pests in the United States and the most destructive forest insect pest to infest New Jersey's forests. Gypsy moths have a large appetite and can cause defoliation of trees. The gypsy moth feeds on a variety of trees, which include oak, maple, birch, beech, willow, and hickory. The larger caterpillars have been known to feed on pine, spruce, hemlock, and many common ornamentals. The gypsy moth develops in four stages: egg, larvae (caterpillars), pupa (transformation stage), and adult (moth). Only the larval stages are destructive. It is not uncommon to observe large numbers of migrating caterpillars crossing roads and on the sides of dwellings and other stationary objects. Migrating caterpillars can stain paint on houses and if handled, their body hairs may irritate the skin of susceptible people. The entire State is now considered to be infested by the gypsy moth (NJDA 2019).



Source: NJDEP 2020

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).

Mosquito

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 Section 4.3.3 (Disease Outbreak and Pandemic).

Spotted Lanternfly



Source: NJAES 2020

The spotted lanternfly (*Lycorma deliculata*) is an invasive planthopper native to China, India, and Vietnam. 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 Camden County, as well as Burlington, Gloucester, Hunterdon, Mercer, Salem, Somerset, 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).

Asian Swamp Eel

The Asian swamp eel is not a true eel. They are scaleless and have an elongated body with a tapering tail and blunt snout. Their teeth are bristle-like and they have one V-shaped gill located beneath the head. Similar in appearance to an American eel, however the Asian the swamp eel has no fins. Unlike the American eel, the Asian swamp eel life cycle takes place exclusively in freshwater. All young hatch as female. As adults, some females develop into males, however, males can change back to females if female densities are low. Reproduction can occur year-round (NJDEP 2009).

Canada Goose

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).

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.

Harmful Algal Bloom

A harmful algal bloom (HAB) is an algal bloom that can be dangerous to people, animals or the ecology. 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. 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 2019).

4.3.10.1 Location and 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 Camden 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. Due to the diversity of landscape in Camden County, the entire County has the potential to be impacted by each of the species identified above. Bodies of water, including lakes, rivers, and ponds have the potential to be impacted by HABs.

Emerald Ash Borer

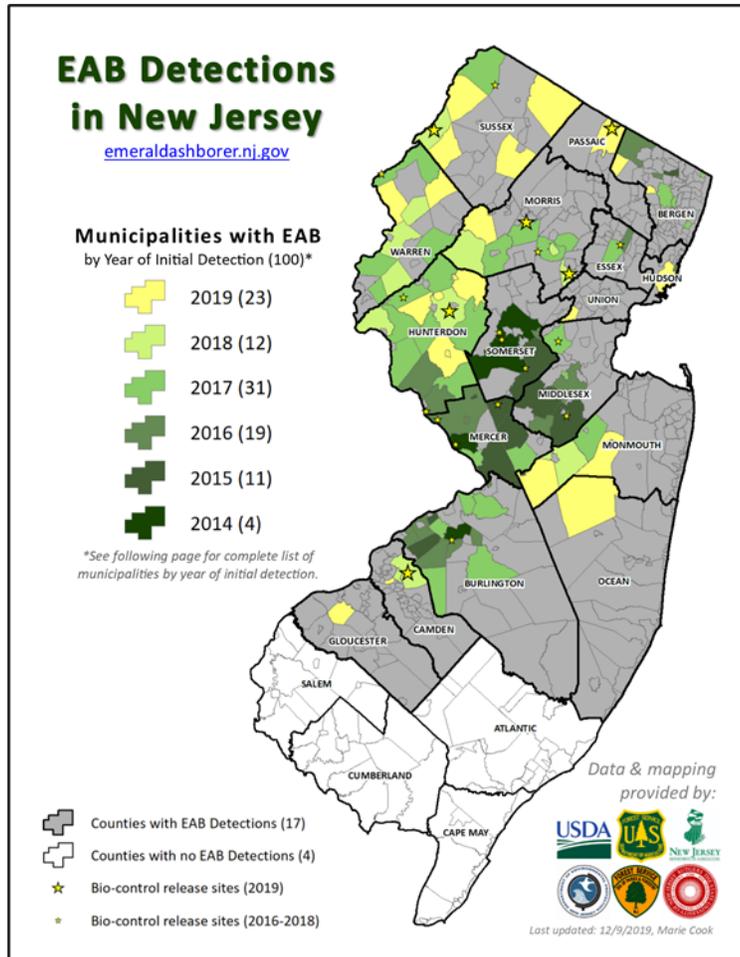
Three species of ash are native to Camden County and all are susceptible to EAB: white ash (*F. Americana*), green ash (*T. pennsylvanica*), and black ash (*F. nigra*). EAB was first detected in New Jersey in 2014. The New Jersey Department of Agriculture (NJDA) is coordinating New Jersey's EAB biocontrol program. Municipalities in Camden County that have had EAB populations detected include the Township of Cherry Hill, Borough of Haddonfield, and Borough of Haddon Heights (NJDA 2020).

The NJ Emerald Ash Borer Task Force and other experts predict a 99-percent 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 Camden 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

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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).

Figure 4.3.10-1. Emerald Ash Borer Detections in New Jersey



Source: State of New Jersey Department of Agriculture 2020

Gypsy Moth

In New Jersey, municipalities with heavy infestations of gypsy moths, as delineated by a summer aerial defoliation survey, are contacted in writing by the NJDA in early fall. The municipalities are asked, if they wish, to have a gypsy moth egg mass count. This is done to determine if the infestation will continue and what areas qualify for the spray program. If the area has an average of more than 500 egg masses per acre, and is at least 50 acres in size, it may qualify for participation in the cooperative gypsy moth suppression program. Municipal participation is voluntary (NJ DEP 2018).

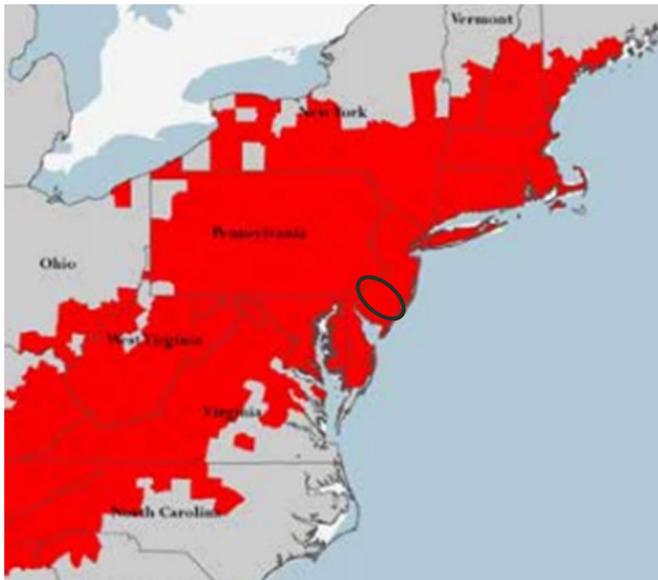
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In 2016, the NJDA's spray program included 20,355 acres in 27 municipalities and one county park system in Cape May, Salem, Hunterdon, Morris, Passaic, Sussex and Warren counties. In 2017, the NJDA's spray program included 4,500 acres in 11 municipalities in Cape May, Morris, Ocean, Passaic, Sussex and Warren counties to combat the tree-killing gypsy moth caterpillar. Both treatments and defoliation are down due to a combination of effective treatments in 2017 and sporadic *E. maimaiga* (gypsy moth fungus), reducing the populations especially in the northern counties of the state (NJ DEP 2018)

Hemlock Woolly Adelgid

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

Figure 4.3.10-2. Hemlock Woolly Adelgid Distribution in the Northeastern United States



Source: USDA 2019

Note: The approximate location of Camden County is within the black oval.

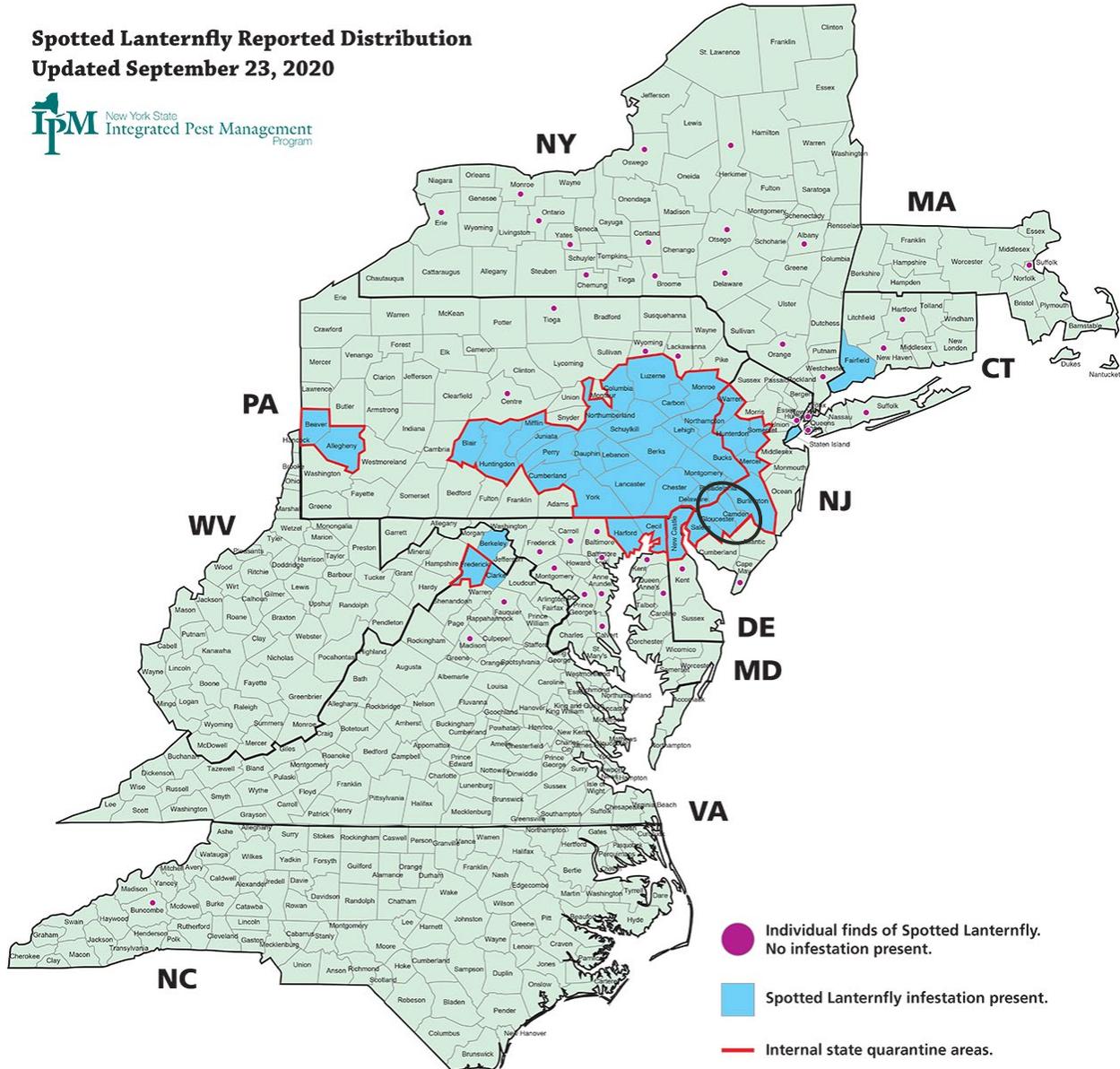
Spotted Lanternfly

According to NYS Integrated Pest Management (IPM), Camden County is located within the internal state quarantine area for the Spotted Lanternfly, and infestations are present, as of September 2020. Refer to Figure 4.3.10-3 which displays a map of the distribution reported in the Northeast.

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).

Figure 4.3.10-3. Spotted Lanternfly Distribution as of September 2020

**Spotted Lanternfly Reported Distribution
Updated September 23, 2020**



Source: NYS IPM 2020

Note: The approximate location of Camden County is within the black oval.

Asian Swamp Eel

These invasive eels are nocturnal and rarely observed by people. Their preferred habitat includes shallow wetlands, stagnant waters, marshes, streams, rivers, ditches, canals, lakes, reservoirs and ponds. It is likely the Asian swamp eel was introduced to North America by aquarium release, stocking as a food source or escaping from fish farms during flooding events. The origin of the fish in Silver Lake in the Borough of Gibbsboro is unknown (NJDEP 2009).

Canada Geese

Canada Geese are found throughout Camden County and New Jersey. Canada Geese are most commonly found near water bodies.

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 geese damage in agricultural systems can be severe (Rutgers 2013).

White-Tailed Deer

White-Tailed Deer are found throughout Camden County and New Jersey. White-Tailed Deer are most commonly found on the edge of wooded areas.

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).

Harmful Algal Bloom

Harmful algal blooms have the potential to impact waterbodies throughout Camden County and New Jersey. 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. Between July 7, 2021 and August 17, 2021, there have been 31 HAB Watches and 33 HAB Advisories reported by the NJDEP throughout the State. On July 14, 2021, a HAB Watch was indicated at Bellmawr Lake in the Borough of Bellmawr, however public beaches were not closed.

Figure 4.3.10-4. HAB Alert Levels

HAB Not Present	HAB reported and investigated. No HAB present.	None
<p>WATCH <i>Suspected or confirmed HAB with potential for allergenic or irritative health effects</i></p>	<p>Suspected HAB based on field survey OR Confirmed cell counts $\geq 20K$ - $< 80K$ cells/mL AND No known toxins above public health thresholds</p>	<p>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</p>
<p>ADVISORY <i>Confirmed HAB with moderate risk of adverse health effects and increased potential for toxins above public health thresholds</i></p>	<p>Lab testing for toxins Microcystins: ≥ 3 $\mu\text{g/L}$ Cylindrospermopsin: ≥ 8 $\mu\text{g/L}$ Anatoxin-a: ≥ 27 $\mu\text{g/L}$ OR Confirmed cell counts $\geq 80K$ cells/mL</p>	<p>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</p>
<p>WARNING <i>Confirmed HAB with high risk of adverse health effects due to high toxin levels</i></p>	<p>Toxin (microcystins) ≥ 20 - < 2000 $\mu\text{g/L}$</p>	<p>Public Bathing Beaches Closed Cautions as above May recommend against secondary contact recreation.</p>
<p>DANGER <i>Confirmed HAB with very high risk of adverse health effects due to very high toxin levels</i></p>	<p>Toxin (microcystins) ≥ 2000 $\mu\text{g/L}$</p>	<p>Public Bathing Beaches Closed Cautions as above. Possible closure of all or portions of waterbody and possible restrictions access to shoreline.</p>

Source: NJDEP 2021

4.3.10.2 Past Occurrences

Many sources provided information regarding infestations in Camden County; however, specific events and/or losses pertaining to the species discussed above were not identified. As described in earlier in this section, a HAB Watch was indicated in Bellmawr Lake in the Borough of Bellmawr.

Based on information stated earlier in this profile, Camden County has been and will continue to be impacted by infestations and invasive species. Between 1954 and 2020, FEMA included the State of New Jersey in one infestation-related emergency (EM) classified as a virus threat (EM-3156 in November 2000). Camden County was included in this declaration (FEMA 2020). For details regarding West Nile Virus in Camden County, refer to Section 4.3.2 (Disease Outbreak).

The New Jersey Department of Agriculture the Department conducts aerial defoliation and Gypsy Moth ground egg mass surveys, monitors the application and evaluates the efficacy of the spray material. The results of the Aerial Defoliation Surveys in Camden County is presented in Table 4.3.10-1 below.

Table 4.3.10-1. Aerial Defoliation Survey from Gypsy Moth in Camden County, 2015 to 2020

Municipality	Moderate 25-50%	Heavy 51-75%	Severe 76-100%	Total
2015				
Berlin Borough	0	16	0	16
Berlin Township	0	25	0	25
Gloucester Township	0	27	0	27
Voorhees Township	0	76	0	76
Waterford Township	12	0	312	324
Winslow Township	0	147	0	147
Total	12	291	312	615
2016				
Total	0	0	0	0
2017				
Waterford Township	0	55	0	55
Total	0	55	0	55
2018				
Waterford Township	0	34	0	34
Total	0	34	0	34
2019				
Total	0	0	0	0
2020				
Winslow Township	0	13	N/A	13
Total	0	13	N/A	13

Source: NJ DOA, 2021

Note: There were no data for Gypsy Moth Suppression in Camden County in 2016 and 2019. Data for severe suppression was not included in the 2020 survey.

4.3.10.3 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 Camden 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. Based on these historical records and input from the Steering Committee and Planning Committee, the probability of occurrence for infestation and invasive species in Passaic County is considered "frequent".

4.3.10.4 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.

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2017). Most of this warming has occurred since 1970. The State of New Jersey has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010. Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual

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temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Northern New Jersey's 1971-2000 precipitation average was over five inches (12-percent) greater than the average from 1895-1970 (Sustainable Jersey Climate Change Adaptation Task Force [CATF] 2011). The heaviest 1% of daily rainfalls have increased by approximately 70% between 1958 and 2011 in the Northeast (Horton et al. 2015). Increased rainfall and heavy rainfalls increase the risk of flooding events.

Annual precipitation for New Jersey has been about 8 percent above average over the last 10 years. The number of extreme precipitation events has also been above average over the last 10 years. During 2010–2014, the state experienced the largest number of extreme precipitation events (days with more than 2 inches) compared to any other 5-year period, about 50 percent above the long-term average. Winter and spring precipitation are projected to increase for the 21st century; extreme precipitation is also projected to increase. The projections of increasing precipitation are characteristic of a large area of the Northern Hemisphere in the northern middle latitudes, as well as increases in heavy precipitation events. This may result in increased flooding risks throughout the state (NCEI 2019).

The following provides information on different infestations impacting Camden County and how they may be affected by climate change.

Gypsy Moth

Gypsy moths are cold-blooded insects and are particularly sensitive to climate changes. Gypsy moths require a climate warm enough for the adults to emerge, have time to mate, and lay eggs and have the eggs develop. The winter temperatures are also important for egg development. A changing climate has the potential to impact the population of gypsy moths, either be increase their population or decreasing (Center for Coastal Resources Management 2015).

Emerald Ash Borer

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 impact of the emerald ash borer 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).

4.3.10.5 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. For the infestation and invasive species hazard, the entire County is exposed. The following discusses Camden County's vulnerability, in a qualitative nature, to the invasive species and harmful algal blooms hazards.

Impact on Life, Health and Safety

The entire population of Camden County is vulnerable to invasive species and impacts from harmful algal blooms. According to the 2019 American Community Survey (ACS) 5-year Estimate, Camden County had a population of 506,738 persons. 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 77,791 persons over the age of 65 in Camden 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 (NJ OEM 2018). This destruction of crop may include consumable resources that are sold to persons in the County. Section 4.3.4 (Drought) discusses the number of farms that are operating in the County (i.e., 197 farms). Based on the Department of Agriculture's study, it is reasonable to assume that the farms in Camden 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.

Impacts of HABs 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 a HAB. Routes of exposure include consumption, inhalation, and dermal exposure. 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. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but visitors to Camden 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 (CDC 2021).

Cyanobacteria blooms are one of the most common freshwater HABs and have been identified by NJDEP as being present in blooms throughout the State of New Jersey. Cyanobacteria are known to produce toxins from the following classes (NJDEP 2020):

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

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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.

The presence of these toxins has led to utility guidance to protect users of public and private water supplies. 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. Locations in Camden County that rely on surface water intake for drinking water are most exposed to the impacts of HABs. Purchasing water may make some users more vulnerable if the utility has less control over the quality of the source. Coordinating with the supplier to ensure that the water is clear of harmful algae, thus maintaining the safety of users of the purchased water, is recommended.

Impact on General Building Stock

Structures are not anticipated to be directly affected by infestation or invasive species; however, the Emerald Ash Borer 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

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.

Impact on Economy

Impacts of infestation and invasive species and infestations 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 9,298 acres of cropland in Camden County, and 4,609 acres that was harvested (USDA 2017). Therefore, it is reasonable to believe that Camden 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 emerald ash borer attacks (NJDEP 2016). The emerald ash borer 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 Camden County would largely focus on the recreation sector. News of a closure of a body of water or beach 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 purchasing backup water sources and costs to implement advanced drinking water treatment.

Impact on the Environment

As previously discussed, Camden County's parks, forests and neighborhood trees are vulnerable to gypsy moth, spotted lanternfly 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 the emerald ash borer 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).

Harmful algal blooms can release toxins that can kill fish and invertebrate. 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 and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. The Pinelands Commission has identified Pinelands Management Area Boundaries, including regional growth areas and rural development areas that may also provide insight to where development and growth may occur in the County. In addition, each community was requested to provide recent and anticipated new development and infrastructure projects; summarized in Section 9 (Jurisdictional Annexes). Overall, there are 89 recent and anticipated new development projects in the 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.

Projected Changes in Population

Camden County has experienced population decline since 2010. According to the U.S. Census Bureau, the County's population has decreased 1.3-percent between 2010 and 2019 (U.S. Census Bureau 2020). Even though the population has decreased, any changes in the density of population can impact the impacts infestations and harmful algal blooms can have on persons in Camden County.

Infestation to cropland and nurseries can have a wider impact on persons outside of Camden 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 Camden 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 (NRDC 2019).

Vulnerability Change Since the 2015 HMP

Infestations and invasive species is a new hazard section added to the County's HMP. More frequent events of infestations and blooms have made this hazard an area of interest that will be monitored more frequently in municipalities throughout the County, particularly those that contain major bodies of water that are used for drinking water, recreation, and economic purposes.

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