Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC)

PRIORITY INVASIVE FISH SPECIES ACTION PLAN FOR THE SUSQUEHANNA RIVER BASIN

Approved by the

Susquehanna River Anadromous Fish Restoration Cooperative

Policy Committee

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Cooperators

U.S. Fish and Wildlife Service
NOAA Fisheries
Susquehanna River Basin Commission
Pennsylvania Fish and Boat Commission
Maryland Department of Natural Resources
New York State Department of Environmental Conservation

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1. INTRODUCTION

The Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) has developed this Priority Invasive Fish Species Action Plan for the Susquehanna River Basin to provide a suite of actions that can be taken to reduce the likelihood that the Susquehanna River will be colonized by specific invasive fish species through the operation of the fish passage facilities at the hydroelectric dams in the lower river or through unauthorized stocking.

This plan is intended to support the SRAFRC vision with respect to migratory fish restoration and invasive fish management:

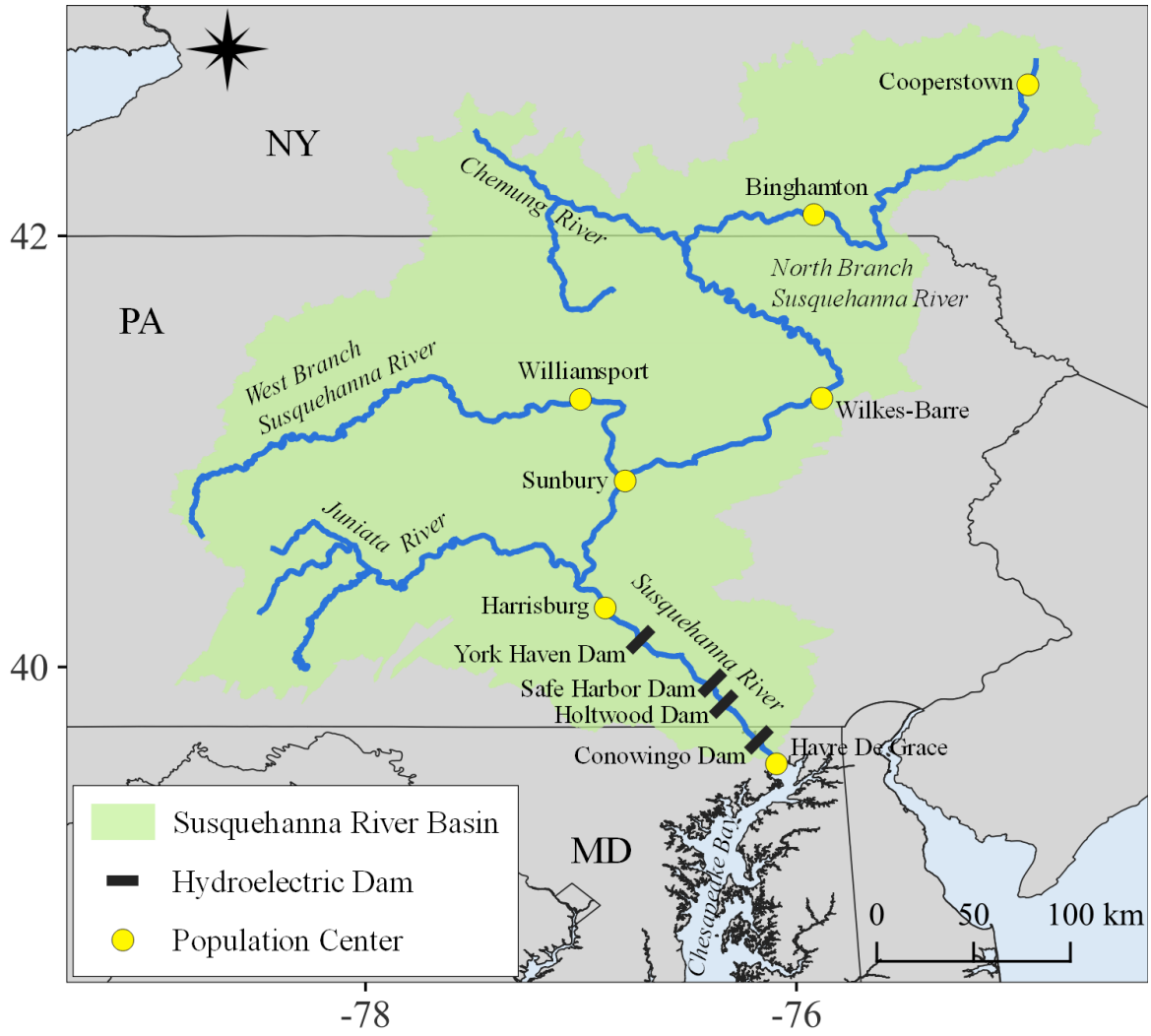
A Susquehanna River fishery that is safeguarded from invasive fish, where populations of resident and migratory fish thrive, and where natural resource agencies in partnership with hydroelectric facilities work to control unwanted species while affording the passage of those in need of restoration.

This aquatic invasive species (AIS) plan provides guidance regarding management of aquatic invasive fishes in the context of anadromous fish restoration. Each SRAFRC member agency is responsible for the stewardship and management of the vast array of fisheries and aquatic life in the Susquehanna River Basin. SRAFRC agencies are committed to working in partnership with the Susquehanna hydropower licensees to further study the interaction between these two separate, but related, management goals and develop a holistic, basin-wide management approach. This document recognizes the need for continued assessment and adaptive management in an environment, where the abundances and distributions of both native and invasive species are constantly changing. As such, this plan is intended to be reviewed each year, and updated as-needed, at the annual meeting of the SRAFRC Policy Committee to respond to changes in invasive fish species distributions and fish passage needs for restoration of American Shad (*Alosa sapidissima*), Alewife (*A. pseudoharengus*), and Blueback Herring (*A. aestivalis*) to the Susquehanna River. Prioritization of action items identified in this plan may change in future based on the status of migratory and invasive fish populations and any new and changing threats posed by existing or newly identified invasive fish species.

The SRAFRC has been working to restore migratory fish to the Susquehanna River Basin since the 1960s. Primary species for restoration include the American Shad, Alewife, and Blueback Herring, as well as American Eel (*Anguilla rostrata*). A key component of the current migratory fish restoration plan (SRAFRC 2010) is to provide safe, timely, and effective fish passage at the hydroelectric dams in the lower Susquehanna River. Nearly all available spawning and nursery habitat for migratory fish in the Susquehanna River occurs upstream of these dams; therefore, it is critical to provide upstream fish passage to support migratory fish restoration.

Conowingo Dam (river mile (RM) 10), Holtwood Dam (RM 25), and Safe Harbor Dam (RM 33) are the first three hydroelectric dams on the Susquehanna River, and they are all

complete barriers to upstream migration for fish. All three dams have fish lifts that have been working collectively to pass fish upstream since 1997. Beginning in 2017, the threat of spreading non-native invasive fish species through those fish lifts became a concern to SRAFRC when a single Northern Snakehead (*Channa argus*) was passed upstream at Conowingo Dam. Growth and expansion of both Northern Snakehead and Blue Catfish (*Ictalurus furcatus*) populations in the Chesapeake Bay and downstream of Conowingo Dam have spurred the SRAFRC, in cooperation with the hydroelectric companies, to modify operations of the fish passage facilities to continue to support migratory fish restoration while precluding the spread of invasive fish species through the fish lifts on the lower Susquehanna River.



Susquehanna River Basin with hydroelectric dams in the lower basin identified.

2. <u>BACKGROUND</u>

The Susquehanna River has had human-made barriers that have restricted fish movement for nearly 200 years. For large portions of the 1800s, canal dams impeded resident fish

movement and restricted anadromous fishes to the lower 50 miles of the river (Gerstell 1998). In the early 1900s, four hydroelectric dams were constructed within the first 55 miles of the river. Holtwood Dam, the first of the high dams, was constructed in 1910 with a fish ladder to allow for the upstream movement of fish. However, the fish ladder was largely ineffective. Conowingo Dam and Safe Harbor Dam were subsequently built without fish passage facilities in 1928 and 1931, respectively.

In the following 50 years, American Eels were the only migratory fish that had access to the Susquehanna River, because of intermittent trap and transport by the Pennsylvania Fish and Boat Commission (PFBC) from Conowingo Dam (SRAFRC 2010). In 1972, to restore populations of anadromous fish to the Susquehanna River, the Conowingo Dam West Fish Lift was constructed with the intention of capturing pre-spawned American Shad and river herring (a collective term for Alewife and Blueback Herring) for upstream transport. From 1982 to 2001, over 320,000 American Shad and river herring were captured at Conowingo Dam and transported to spawning grounds located upstream of the mainstem hydroelectric dams. In 1997, after construction of fish lifts at the three most downstream dams, all fish captured in these fish lifts were released directly upstream of the respective dams (i.e., volitional passage). The trap and transport program for shad and river herring was phased out by 2000, when a fish ladder was completed on the fourth hydroelectric facility at York Haven Dam. With the switch to volitional passage, all fish species, not just sea-run migratory fish could now have access as far as the Warrior Ridge and Raystown dams on the Juniata River, and to Binghamton, New York on the North Branch and Williamsport, Pennsylvania on the West Branch (SRAFRC 2010).

Populations of invasive fish species have been increasing downstream of Conowingo Dam since the mid-2010s. In 2017, a single Northern Snakehead was passed upstream through the fish lift at Conowingo Dam. In response to the concerns about the growing population of Northern Snakehead downstream of Conowingo Dam and the species using the existing fish lifts to expand their range into the Susquehanna River, SRAFRC developed a voluntary best management practice document with the owner of Conowingo Dam to be implemented beginning in the 2018 fish passage season. The plan specified that the agencies should be notified if Northern Snakehead were observed in the fish lifts, and if possible, Northern Snakehead should be removed. All Northern Snakehead removed or passed upstream would be counted. In 2018, no Northern Snakehead were observed at either the East or West Fish Lifts at Conowingo Dam. The best management practices were implemented again in 2019 and a total of 81 Northern Snakehead were removed from the West Fish Lift and none were observed in the East Fish Lift. In 2020, fish lift operations were delayed due to staffing restrictions associated with the COVID-19 pandemic and lift operations at Conowingo's East Fish Lift commenced on May 12 of that year. The lift operated a total of four days, collecting a total of 35 Northern Snakehead. One Northern Snakehead passed upstream on May 13, three on May 14, and 17 on May 15. The remaining 14 Northern Snakehead were removed by staff from the fish lift during that same time period. At the request of the resource agencies over concern of releasing Northern Snakehead upstream of Conowingo into the Susquehanna River Basin, fish passage

operations at Conowingo, as well as Holtwood and Safe Harbor, ended on May 15, 2020. No Northern Snakehead were observed passing Holtwood and Safe Harbor Dams.

In the 2021 fish passage season, only the West Fish Lift operated at Conowingo Dam. This was the only fish lift that had sorting capabilities to ensure no upstream passage of invasive fish species would occur. A total of 1,001 Northern Snakehead were removed from that facility during the 2021 season, while all American Shad and river herring were trucked upstream. In 2022, sorting the catch at the East Fish Lift at Conowingo Dam was possible and a total of 863 Northern Snakehead were removed from the two lifts at Conowingo Dam. In addition to Northern Snakehead, the first Blue Catfish were collected at Conowingo Dam in 2022, with a total of 32 removed in that year. Sorting and removal of invasive fishes continued in 2023 with 825 Northern Snakehead and two Blue Catfish removed from the Conowingo fish lifts and all American Shad and river herring were transported upstream. In 2024, 1,885 Northern Snakehead and 36 Blue Catfish were removed from the Conowingo fish lifts with continued trap and transport of migratory fish. Flathead Catfish (*Pylodictus olivaris*) were also removed from the fish lifts during this time period as means to limit their populations, despite the species already being present through the lower Susquehanna River. The Holtwood and Safe Harbor fish lifts have not operated since 2020.

For Northern Snakehead and Blue Catfish, as well as other invasive fish species in the upper Chesapeake Bay and lower Susquehanna River, these three hydroelectric dams are the only barriers preventing their natural dispersal upstream into the majority of the Susquehanna River Basin. Currently, 100% sorting and trap and transport of migratory fish at Conowingo Dam is facilitating migratory fish restoration and precluding upstream spread of invasive fish species. American Shad and river herring populations are presently at low numbers, with between 2,000 and 10,000 trapped and transported annually from 2021-2024. Although there are capacity limitations of the 100% sorting and trap and transport program, those limitations are likely offset by the benefits of transporting all the available American Shad and river herring directly to spawning habitats 50 miles upstream. As American Shad and river herring populations increase in the Susquehanna River, the current method of sorting the entire catch at Conowingo Dam with transport of all American Shad and river herring upstream will ultimately inhibit full restoration of those species.

Migratory fish restoration in the Susquehanna River will require improvements to catch efficiency at the lower mainstem hydroelectric dams. Improving catch efficiency at Conowingo Dam will increase the biomass of all fish species captured at the dam. Increased fish biomass will further complicate manual sorting. The time required to sort the fish lifted in a full hopper will dictate lift frequency. Increased biomass will ultimately reduce lift frequency and reduce the total daily catch and passage probability during the peak of the fish passage season. Further, the maximum holding and trucking capacity of the trap and transport program is limited to approximately 100,000 American shad and river herring per season, which is far less than the restoration goals of two million American Shad and five million river herring established by SRAFRC. This capacity is dictated by the number of tanks and trucks that can be filled and transported off-site from Conowingo Dam on a given peak

day of collection and extrapolated out to the typical number of catch days in a fish passage season. Capacity limitations of the trap and transport program will require a reduced number of fish lifts executed each day to allow more time for sorting and transporting the catch. The reduced number of lifts will reduce the total amount of American shad and river herring that can be captured on peak passage days and may increase the rate of predation in the project tailraces. If trap and transport is the only method used for migratory fish restoration in the future, the restoration cap for migratory fish will be dictated by the capacity of the trap and transport program. In future, if sorting and trap and transport programs near capacity, the goals of both limiting the spread of invasive fish species and fully restoring anadromous fish populations will become increasingly difficult to achieve under the current fish passage operation paradigm.

If migratory shad and herring populations exceed trucking capabilities, they will need to remain in the tailrace at Conowingo Dam or volitional passage will need to be reinstated at Conowingo Dam and operation of fish passage at Holtwood Dam and Safe Harbor Dam will need to resume to allow the additional fish access to spawning habitat. Currently, the fish passage facilities at Holtwood Dam and Safe Harbor Dam are not being operated as a strategy to preclude upstream dispersion of invasive species. The Holtwood and Safe Harbor fish passage facilities neither provide selective fish passage (a process that allows the passage of native species but excludes invasive species) nor the possibility to implement that technology without modifications to the fish passage facilities.

With 100% sorting in place at Conowingo Dam, invasive fishes are removed from the fish lifts as a means of limiting their population growth. During the spring anadromous fish migration period, predatory invasive fish species are attracted to the dam by both flowing water and the vast quantities of anadromous fishes that congregate downstream. Given the relatively high densities of invasive fish during this time, and the likelihood that they are feeding on already depleted migratory fish species, the removal of invasive fishes through the fish lifts is an effective way to reduce their populations in an area where they are particularly detrimental to native fishes.

While the hydroelectric dams on the lower Susquehanna River serve as migratory barriers to upstream dispersal of invasive fish species, there are other mechanisms by which invasive species can spread through the basin. The same hydroelectric dams that preclude upstream fish movement are not effective barriers to downstream movement. Fish can pass downstream through multiple passage routes at the hydroelectric dams, including through turbines, spill, and open gates. Although passage through turbines is known to cause injury and/or mortality for many fish species (Mueller et al. 2022), turbines alone do not serve as a full barrier to migration. Thus, the downstream dispersal risk of an invasive fish species at hydroelectric dams in the Susquehanna River Basin is extremely high.

In some cases, authorized stocking by state agencies has led to established populations of aquatic invasive species (AIS), such as Blue Catfish and Flathead Catfish. Unauthorized stocking by the public to create fisheries has also led to established populations of some

invasive fishes. Despite federal and state laws prohibiting transport of Northern Snakehead, some individuals have threatened to release Northern Snakehead illegally (see section 3.1). Though dependent on the number of introductions as well as the age class, it is possible that Northern Snakehead and Blue Catfish will be introduced by people and become established in the Susquehanna River upstream of Conowingo Dam. Additional efforts in education and enforcement will be necessary to reduce the likelihood of unauthorized public stocking of these species into the Susquehanna River Basin.

Another management issue to consider is that the Susquehanna River has many well-established non-native species, some of which were intentionally stocked to support recreational fisheries for the basin states. In the New York portion of the Susquehanna River Watershed, 38% of the fish species present are non-native (Carlson and Daniels 2004). In the Susquehanna River as a whole, 28% are non-native species (Snyder 2005). Important recreational fisheries include Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*M. nigricans*), Channel Catfish (*Ictalurus punctatus),* Walleye (*Sander vitreus*), Muskellunge (*Esox masquinongy*), Northern Pike (*Esox lucius*), and others. None of these popular recreational species are native to the basin but have become an established part of the ecosystem. Additional efforts in education on how agencies reach consensus on when non-native species become invasive and what aspects of invasiveness prompt concerns on changes in the ecosystem, specifically the Susquehanna River, are needed.

3. PROBLEM DEFINITION

There are now several recent invasive fish species that occur in the Chesapeake Bay and tributaries, including the lower Susquehanna River downstream of Conowingo Dam. Invasive species can cause disruption to the current ecosystem by out-competing existing species or increasing predation pressure on resident and juvenile migratory fish (Gozlan et al. 2010). This plan focuses on those species that are an imminent threat to colonizing the Susquehanna River as well as invasive carp species that are not currently in the Chesapeake Bay watershed but are also species of concern. The aquatic invasive fish species addressed in this plan include the Northern Snakehead, Blue Catfish, Flathead Catfish, Alabama Bass (*Micropterus henshalli*), Freshwater Drum (*Aplodinotus grunniens*), Silver Carp (*Hypophthalmichthys molitrix*), Bighead Carp (*H. nobilis*), Black Carp (*Mylopharyngodon piceus)*, and Grass Carp (*Ctenopharyngodon idella*). Although there are several different potential pathways of introductions for these invasive fish species, the two primary pathways highlighted in this plan are passage through the fish lifts on the hydroelectric dams in the lower river and through releases from unauthorized stocking by the public.

3.1. Species of Concern

These non-native species are considered invasive in the respect that they are known, or are likely, to cause ecological and economic harm to fisheries, species of conservation concern, and/or other aquatic natural resources in the Susquehanna River Basin. Many of these species have been introduced into portions of the Susquehanna River Basin and/or Chesapeake Bay (see species accounts below for further details) whereas some species, such Bighead Carp, Silver Carp, and Black Carp are not known to occur in the

Susquehanna River Basin or the Chesapeake Bay but may be of major concern if introduced in the future.

In addition to the species listed above, natural resource agencies and fish passage operators should be vigilant for novel, yet undocumented, invasive fishes that may threaten the Susquehanna River Basin. Therefore, this plan will be updated accordingly as new potential threats are documented. As mentioned earlier, several non-native fishes have been historically introduced and are well established in the Susquehanna River Basin and are considered desirable. For example, Smallmouth Bass are native to the Mississippi River Basin and were historically introduced into the Susquehanna River Basin in the late 1800s. Smallmouth Bass and several other introduced fishes (e.g., Channel Catfish) now constitute important recreational sport fisheries in the Susquehanna River Basin and are not considered aquatic invasive species in this region.

3.1.1. Northern Snakehead (*Channa argus*)

Northern Snakehead is an elongate fish (lengths of over 33 inches) with anal and dorsal fins that extend nearly to the origin of the caudal fin (Stauffer et al. 2016; Fuller et al. 2022). This species typically inhabits lentic or slow-moving waters typified by silty sediments and aquatic vegetation (Stauffer et al. 2016). Northern Snakehead was imported into the United States and sold in live-food fish markets in major cities up until their 2002 importation and interstate transport ban under the Lacey Act (Courtenay and Williams 2004, ANSTF 2014, Benson 2019, Chesapeake Bay Snakehead Plan 2023). The Lacey Act listing, and its continued enforcement, has substantially lowered the probability of new snakehead introductions into the U.S. via this pathway (ANSTF 2014, Benson 2019, Chesapeake Bay Northern Snakehead Plan Working Group 2023). At approximately the same time of the Lacey Act listing, jurisdictions of the Chesapeake Bay watershed also quickly moved to ban live possession. Unfortunately, several independent introductions into waters on the east coast occurred either before or slightly after these bans (i.e., Potomac River, Meadow Lake in Philadelphia, New York City) with fish that are either known or suspected to have originated from live-food fish markets. Natural reproduction and dispersal of Northern Snakehead in temperate waters of the United States resulted in range expansion of the species in the Chesapeake Bay watershed and beyond its introduction to Potomac River. Northern Snakehead exhibit intermediate salinity tolerance and make directed long-distance, primarily upstream, movement in the springtime (Lapointe et al. 2013). Between 2004 and 2010, the species expanded its range in Potomac River and was reportedly captured by anglers fishing for Largemouth Bass. Once the species expanded beyond the mouth of Potomac River into Patuxent River and then throughout the eastern shore of Maryland, agencies began noting increased angling enthusiasm. Additionally, interest in actions taken prior to and at the time of the bans had not disappeared in the general public. Northern Snakeheads were illegally reared in both aquaria by enthusiasts and in backyard ponds as food after 2010. Therefore, continued introduction of the species into the bay remained a

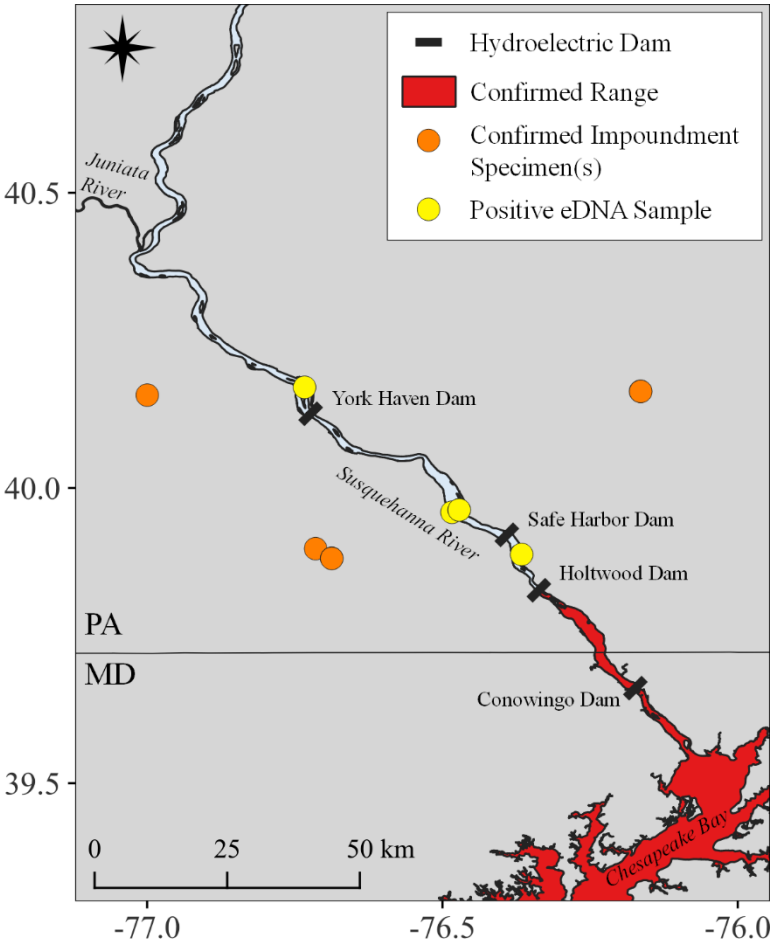
threat, requiring factual outreach and practical enforcement, which largely occurred between 2010 until today. Unintentional introductions through bait collection and release are not thought to be a significant introduction pathway for this species (Fuller et al. 2022).

Northern Snakehead inhabit all major and most minor tidal rivers of Chesapeake Bay watershed (Love and Newhard 2018) and have been unequivocally introduced to several major impoundments of Virginia, Maryland, and Delaware. These introductions to impoundments have occurred because of interest in the sportfish as well as interest in raising the fish for food.

Northern Snakehead (Credit: Pennsylvania Fish and Boat Commission)

Even though Northern Snakehead has become widespread and well established in many portions of the Chesapeake Bay, including the lower Susquehanna River downstream of Conowingo Dam, records are rare upstream of this dam. In 2020, 21 Northern Snakehead were inadvertently passed over the Conowingo Dam during fish passage operations. While some of these fish were subsequently captured and removed by natural resource agencies and anglers, several anecdotal and documented records (substantiated by positive eDNA results, voucher photographs, or specimens collected by resource agency personnel) of Northern Snakehead have subsequently occurred in the Conowingo Pond (downstream of the Holtwood Dam). Furthermore, in July 2023, PFBC staff documented reproduction in the Conowingo Pond near the Muddy Creek Access, York County, Pennsylvania, based on collections of young of the year individuals. However, no records are presently known from upstream of the Holtwood Dam, suggesting this species is currently absent in the Susquehanna River upstream of the Conowingo Pond. In addition to records in the Susquehanna River in the Conowingo Pond, Northern Snakehead has been collected in Lake Redman (York County) and within the Ephrata Township Community Park Pond in Lancaster County, the former having an outfall into a tributary of the Susquehanna River and the later within the Susquehanna River Watershed. Additionally, an adult Northern Snakehead was caught and released by an angler in a small public pond near Mechanicsburg, Cumberland County, in October 2023. Investigations by PFBC staff indicated this pond is currently hydrologically isolated from the Susquehanna River, and

containment measures were discussed with the local municipality which owns the pond. There have been several positive environmental DNA (eDNA) detections upstream of the Conowingo Pond, including above York Haven Dam; however, these samples have not been substantiated by or verified photographs or the collection physical specimens.



Current distribution of Northern Snakehead in the Susquehanna River Basin based on verified specimen collections and eDNA sampling. The data used to generate this map were provided by PFBC, SRBC, and MDNR. This map was generated on March 28, 2025, and may not reflect the current distribution of the species as its range changes through time.

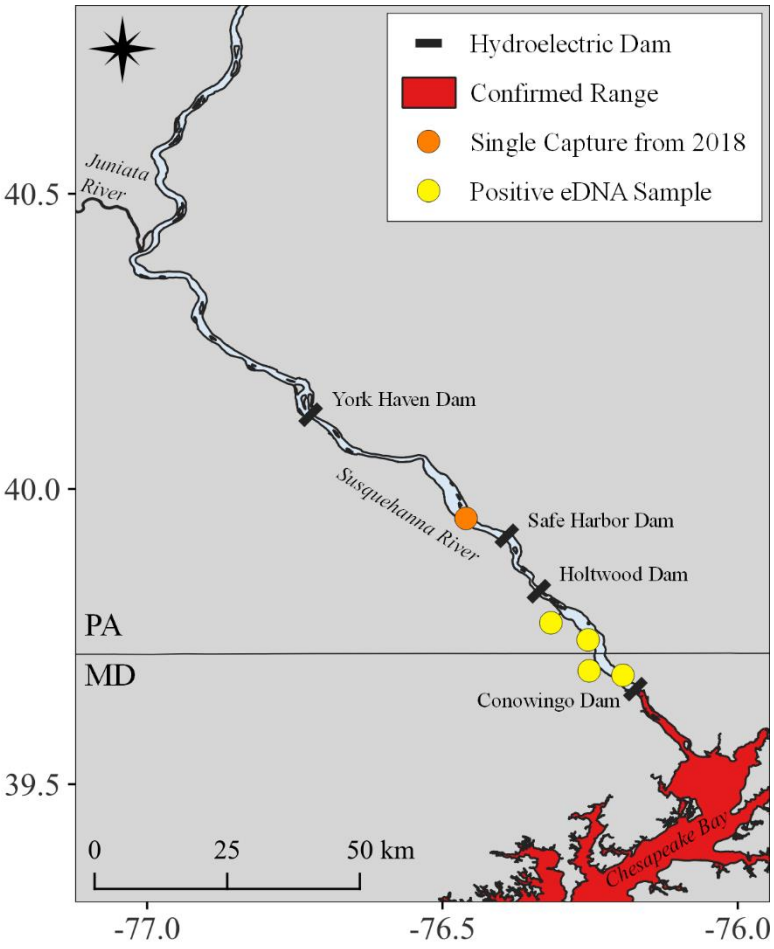
Studies on Northern Snakehead diet in the eastern United States reported that most prey items included sunfishes (*Lepomis spp*.), White Perch (*Morone americana*), Yellow Perch (*Perca flavescens*), topminnows (family Fundulidae), and aquatic invertebrates such as crayfishes (Saylor et al. 2012; Cohen and MacDonald 2016; Lapointe et al. 2019). Additional prey items also include frogs and putatively, ducks. The species is widely considered a generalist and omnivore, without specific prey preferences. Northern Snakehead have the potential to cause changes to fish

communities by predation or competition when introduced (Newhard and Love 2019); however, no direct studies appear to be available evaluating potential impacts of Northern Snakehead towards migratory fish species relevant to the Susquehanna River Basin. At present, staff from the Academy of Natural Sciences of Drexel University are conducting studies evaluating the potential impacts of Northern Snakehead establishment on American Shad, American Eels, and other fishes in the lower Delaware River Basin. These studies are presently ongoing, and no results are currently available, but upon completion may suggest risk level for migratory fishes and other freshwater resident fishes in the Susquehanna River Basin.

3.1.2. Blue Catfish (*Ictalurus furcatus*)

Blue Catfish are large omnivorous fish (lengths of over 60 inches and weight of over 100 pounds) native to parts of the greater Mississippi River Basin and several Gulf Coast basins (Fuller and Neilson 2023). This species inhabits large rivers with high flows and rocky substrates to silty floodplain lakes and reservoirs and may tolerate cold temperatures and salinities of up to 15 ppt. (Fuller and Neilson 2023). Blue Catfish was intentionally introduced into Virginia tributaries of the Chesapeake Bay in the 1970s attempting to establish a trophy fishery (Schloesser et al. 2011). This species has subsequently spread to nearly all tributaries of the Chesapeake Bay through natural dispersal and possibly, transport and repeated introductions. The species may widely disperse during periods of high freshwater flow, though it also has a high salinity tolerance (Chesapeake Bay Program 2020). Within the Susquehanna River Basin, Blue Catfish occur downstream of Conowingo Dam, but are not presently known to be established upstream of Conowingo Dam. There have been several positive environmental DNA (eDNA) detections upstream of the Conowingo Dam, including the Conowingo Pond, Muddy Creek, and Broad Creek, potentially suggesting the occurrence of this species in low abundance in these areas. Additionally, a single, verified angler capture of a Blue Catfish occurred in 2018 during a fishing tournament in Lake Clarke (Safe Harbor Dam pool). As a species with popular recreational and trophy fisheries, current introduction and spread pathways are likely similar to that of Northern Snakehead (see above) and include deliberate introductions by anglers as well as natural spread through connected waterways.

Blue Catfish (Credit: U.S. Fish and Wildlife Service)



Current distribution of Blue Catfish in the Susquehanna River Basin based on verified specimen collections and eDNA sampling. The data used to generate this map were provided by PFBC, SRBC, and MDNR. This map was generated on

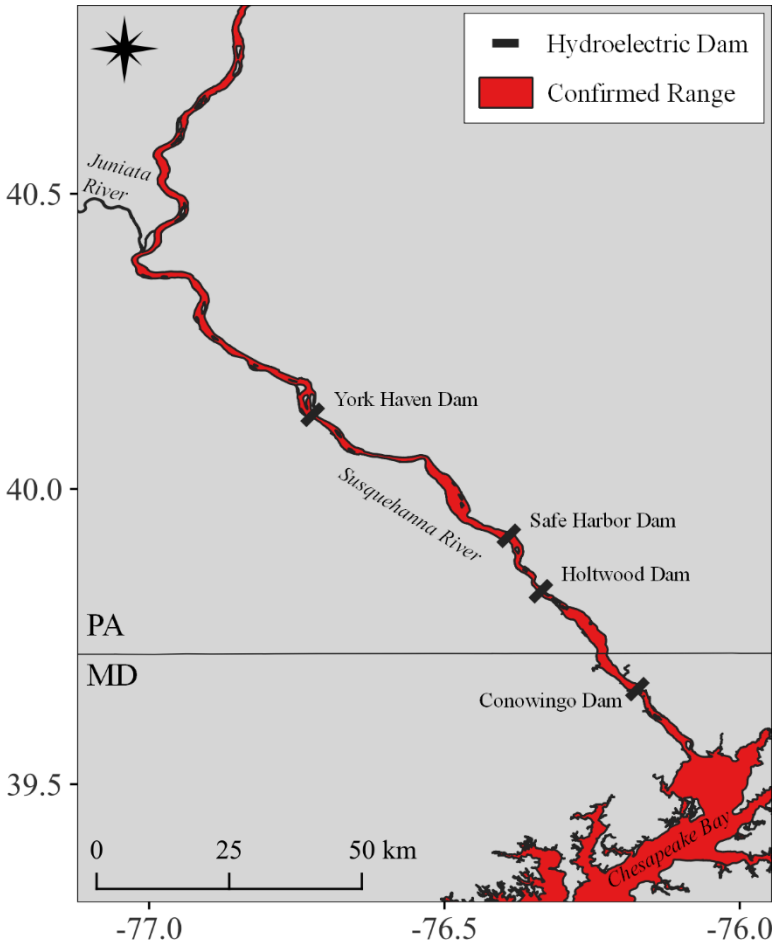
March 28, 2025 and may not reflect the current distribution of the species as its range changes through time.

This species is considered an omnivorous generalist, but the majority of prey items consumed are fishes and mollusks (Fuller and Neilson 2023). Non-native Blue Catfish in the Chesapeake Bay prey on migratory fishes including shad and herrings (Schmidt et al. 2017) and Blue Crabs (Schmidt et al. 2019). Thus, range expansion of Blue Catfish in the Susquehanna River Basin may be of concern for migratory fish restoration efforts, in addition to other fishery resources.

3.1.3. Flathead Catfish (*Pylodictis olivaris*)

Flathead Catfish are large, heavy bodied predators (up to 60 inches in length and over 50 pounds) native to parts of the Mississippi River Basin and several Gulf Slope drainages (Fuller et al. 2023a). Preferred habitat consists of pools in hard bottomed large rivers, streams, and lakes (Fuller et al. 2023a). Like Blue Catfish, Flathead Catfish were introduced into Virginia tributaries of the Chesapeake Bay in the 1960s and 1970s to establish a recreational fishery (Chesapeake Bay Program 2020). In the Susquehanna River basin, Flathead Catfish were first collected in the early 1990s in Speedwell Forge Lake, Lancaster County (Brown et al. 2005). The first capture in the Susquehanna River proper was at the Safe Harbor Dam in 2002 (Brown et al. 2005). It is thought that introductions were either by unauthorized angler introductions and/or by juvenile fish in contaminated game fish stockings (Brown et al. 2005). Presently, Flathead Catfish are found throughout most of the Susquehanna River Basin (Fuller et al. 2023a) and introductions upstream of impoundments in the lower Susquehanna have been attributed to unauthorized introductions by anglers, while downstream populations are likely due to volitional dispersal upstream through the fishways and downstream through the dams. Flathead Catfish has become well established in much of the Susquehanna River Basin but are currently absent from parts of the Juniata River and West Branch Susquehanna River sub-basins (Smith et al. 2021). As a species with popular recreational and trophy fisheries, current introduction and spread pathways are likely similar to that of Northern Snakehead and Blue Catfish (see above) and consist of deliberate introductions by anglers and natural spread through connected waterways.

Flathead Catfish (Credit: Pennsylvania Fish and Boat Commission).



Current distribution of Flathead Catfish in the Susquehanna River Basin based on verified specimen collections. The data used to generate this map were provided by PFBC, SRBC, and MDNR. This map was generated on March 28, 2025 and may

not reflect the current distribution of the species as its range changes through time.

Flathead Catfish is an active predator and typically prefers live prey, with dietary studies reporting a diverse diet of macroinvertebrates, centrarchids, and shads (Fuller et al. 2023a). Studies by Penn State University in collaboration with the PFBC evaluated the diet of non-native Flathead Catfish in the Susquehanna River (Stark et al. 2024) and had similar findings that Flathead Catfish consumed a wide array of fish species and macroinvertebrates found in the river. Brown et al. (2005) and Smith et al. (2021) speculate that the introduction of Flathead Catfish into the Susquehanna and Delaware River basins will have negative impacts on migratory fishes of conservation concern, such as American Shad. A study focused on the James River (Schmitt et al. 2017) found that non-native Flathead Catfish selectively preyed on American Shad and river herring, with shad and herring found in approximately 16% of Flathead Catfish stomachs. Pine et al. (2005) evaluated the diet of introduced Flathead Catfish in North Carolina and reported that juvenile American Shad and Hickory Shad (*Alosa mediocris*) were a component of their diet, suggesting possible impacts. Stark et al. (2024) noted blueback herring in the stomachs of Flathead Catfish collected from the lower Susquehanna River.

3.1.4. Alabama Bass (*Micropterus henshalli*)

Alabama Bass is a medium-sized (up to 24 inches in length) fish native to the Mobile Bay Basin in Mississippi, Alabama, and Georgia (reviewed by Benson 2023). Preferred habitat includes flowing pools of streams and rivers as well as impoundments (Benson 2023). Alabama Bass were once considered a subspecies of the Spotted Bass (*Micropterus punctulatus*) but were recently elevated to species status (Rider and Maceina 2015). Alabama Bass have been introduced outside of their native range primarily by unauthorized angler introductions (Rider and Maceina 2015; Sammons et al. 2023) and may readily disperse upstream if no barriers to dispersal are present (Sammons et al. 2023). Alabama Bass have been introduced into several impoundments and rivers in Virginia, Tennessee, North Carolina, and Georgia, with the closest population to the Susquehanna River Basin occurring in the James River, Virginia, a lower tributary of the Chesapeake Bay (Sammons et al. 2023).

Alabama Bass (Credit: Virginia Department of Wildlife Resources)

Studies focused on the diet of Alabama Bass reported that this species primarily feeds on shad (*Dorosoma* sp.) and crayfish (Rider and Maceina 2015). The most direct threats posed by potential invasion of the Susquehanna River Basin are displacement of naturalized black bass species and hybridization with existing Largemouth Bass and Smallmouth Bass. Alabama Bass have been demonstrated to compete with and displace Largemouth Bass from reservoirs, contributing to major reductions in Largemouth Bass abundance (Sammons et al. 2023). Additionally, Alabama Bass will readily hybridize with Smallmouth Bass and may extirpate Smallmouth Bass populations over time by genetic replacement (Rider and Maceina 2015; Sammons et al. 2023). These impacts are undesirable for other black bass fisheries as Alabama Bass populations, once established, reduce average fish weights for black bass fisheries, thus reduce angler satisfaction. It is difficult to predict how Alabama Bass may impact other species within the Susquehanna River Basin, such as migratory fish, as studies evaluating impacts of introduced Alabama Bass have focused on impacts towards other black bass species.

3.1.5. Freshwater Drum (*Aplodinotus grunniens*)

Freshwater Drum is medium-large, deep-bodied fish which can attain sizes of up to approximately 20 pounds. Average adult lengths of approximately 18 inches are common, but individuals may attain lengths of up to 36 inches (Fuller et al. 2023b). Freshwater Drum are widely distributed in portions of North America and Central America, and in Pennsylvania are native to the Lake Erie and the Ohio River basins. Typical habitat consists of pools and slower moving sections of larger streams and rivers, as well as lakes and impoundments (Stauffer et al. 2016). Freshwater Drum are not established in the Susquehanna River Basin or the Chesapeake Bay, but two adult specimens were caught downstream of Conowingo Dam in 2022 and 2023. Freshwater Drum have been introduced elsewhere by authorized and unauthorized stocking and may also be introduced by unintentional collections and

released as bait (juveniles). However, given recent Freshwater Drum collections in the lower Delaware River Basin, it has mainly been speculated that Freshwater Drum may have arrived downstream of the Conowingo Dam via migration through the Chesapeake and Delaware Canal. This pathway has been documented for other invasive fishes (e.g, Northern Snakehead).

Freshwater Drum (Credit: Pennsylvania Fish and Boat Commission)

The diet of Freshwater Drum consists primarily of hard-bodied aquatic invertebrates such as mollusks, crayfish, and aquatic insects (Stauffer et al. 2016). No studies have evaluated the trophic impacts of non-native Freshwater Drum, and so their potential impacts on migratory fishes or other natural resources in the Susquehanna River Basin are difficult to predict. Given that Freshwater Drum are molluscivorous, there is some concern by resource agency professionals regarding potential impacts to imperiled freshwater mussels and their restoration efforts in the Susquehanna River.

3.1.6. Invasive Carp

Invasive carp is a term used to collectively refer to Bighead Carp (*Hypophthalmichthys nobilis*), Grass Carp (*Ctenopharyngodon idella*), Silver Carp (*H. molitrix*), and Black Carp (*Mylopharyngodon piceus*) which are all native to Asia. More details on the habitat preferences, diet, maximum size, and invasion ecology of these species can be found in the National Carp Plan (ANSTF 2007), the Invasive Carp Action Plan (ICRCC 2023), and PFBC (2021). Native to Asia, these carp species became established in the U.S. through a combination of stocking by authorized agencies, unauthorized stocking by private individuals, and unintentional escape from aquaculture and other facilities (ANSTF 2007). Bighead, Grass, Silver, and Black Carp are all established in the Mississippi River watershed. Black Carp have the most restricted range in the Mississippi River watershed, Bighead and Silver Carp have rapidly spread northward in major river systems of the central U.S., and Grass Carp are found in 45 of 50 states due to historic stocking for aquatic

vegetation control. It should also be noted that triploid (sterile) Grass Carp are allowed to be stocked by permit in some states, including New York and Pennsylvania. Bighead, Silver, and Black Carp are not known from the Chesapeake Bay or the Susquehanna River Basin; however, occasional collections of feral Grass Carp have been reported in the Susquehanna River Basin (Stauffer et al. 2016). Following stocking or escape, dispersal and spread has occurred naturally through connected river systems, and transport and release by humans is thought to be a significant secondary dispersal pathway (ANSTF 2007, PFBC 2021). The National Carp Plan identified 22 potential pathways of introduction, some of which include transport and release of baitfish caught in the wild, stocking invasive carp in private or public waters for biological control, the production, transport, and sale of live invasive carp in seafood markets, live transport and intentional spread of invasive carp by commercial fishers, movement of invasive carp in ballast waters and live wells, and intentional releases of invasive carp by consumers, hobbyists, and animal rights activists.

Bighead Carp (top); Silver Carp (2nd from top); Black Carp (2nd from bottom); Grass Carp (bottom).
(Credits: U.S. Geological Survey; United States Geological Survey; Kentucky Department of Fish and Wildlife)

The nearest records of Bighead Carp and Silver Carp to the Susquehanna River Basin are populations in Mississippi River Basin tributaries in Ohio and West Virginia. The nearest records of Black Carp to the Susquehanna River Basin are from a pond in the West Virginia panhandle (Potomac River Basin). Of the four species of invasive carp, Bighead Carp and Silver Carp are likely of greatest concern to the Susquehanna River Basin. These species are primarily planktivorous and can attain exceptionally high biomass in large rivers, displacing many other fishes via trophic disruption and causing major impacts to fisheries (reviewed in the PFBC 2021). Thus, these species could have major impacts on fisheries in the Susquehanna River Basin; however, focused studies on potential impacts to migratory fishes of concern, such as American Shad and American Eel appear to be lacking. Black Carp primarily feed upon hard bodied invertebrates such as mollusks (Nico and Neilson 2023) and thus may be of concern to imperiled freshwater mussels in the Susquehanna River Basin. Grass Carp primarily feed on aquatic vegetation and may cause trophic disruptions and reduce sportfish breeding and rearing habitat by significantly reducing aquatic vegetation (Nico et al. 2023).

3.2. Pathways for Introduction

Introduction pathways are means by which species could enter the Susquehanna River Basin. Natural pathways for invasive fish introduction include dispersal (i.e., swimming) from areas in which they are established through interconnected waterways, or transport of eggs by waterfowl or other animals. Human pathways are those enhanced or created by human activity. These fall into intentional and unintentional pathways. Examples of intentional pathways of introduction include authorized stocking by resource agencies, angler transport and release (i.e., unauthorized stocking), aquarium release, ceremonial or compassionate release of captive animals, release of fish from live food markets or the seafood trade, and release of fish obtained from biological supply companies. Examples of unintentional fish introduction pathways include escape from aquaculture, live bait pathway (i.e., discarded live bait), release of ballast water from commercial vessels, and eggs being unintentionally transported on recreational watercraft, plants, or gear. The specific focus of this plan is to manage passage of invasive species through fish passage facilities at hydroelectric dams on the lower Susquehanna River and manage unauthorized transport and stocking by the public, though other possible pathways for introduction are discussed.

3.2.1. Fish Passage Facilities

All fish species considered in this plan could utilize existing fish passage facilities (i.e., fish lifts) at hydroelectric dams in the lower Susquehanna River to expand their range into the basin. This is an imminent concern for Northern Snakehead and Blue Catfish, given their abundance downstream of Conowingo Dam, ability to use the existing fishways, absence or low density upstream and the ability of fish to pass downstream through turbines. This is also a concern for Freshwater Drum that have been captured infrequently downstream of Conowingo Dam. Although Flathead Catfish are already established throughout much of the Susquehanna

River, they will also use fish passage facilities for upstream movement at the dams. At this time invasive carp and Alabama Bass are not known to occur in the Lower Susquehanna River or Upper Chesapeake Bay but could potentially use the fish passage facilities for upstream dispersal if they were to become established in the upper Chesapeake Bay. The design and operation of existing fish passage facilities on the river may need to be modified to effectively manage upstream dispersal of invasive species while continuing to support migratory fish restoration.

Fish lifts are a specific type of fish passage facility that are found on the three lower hydroelectric dams on the Susquehanna River (Conowingo, Holtwood, and Safe Harbor Dams). Although exact configuration of the fish lifts varies between locations, the general design is similar at all three dams. The entrance to a fish lift is in the dam tailrace and consists of one or more box-shaped concrete entrance channel(s). The dimensions of the entrance channels are different within a fish lift and between fish lifts. Generally, the fish lifts have multiple entrance channels that will terminate in a collection area that is crowded by a screen to force fish over a hopper (bucket) that is in the floor of the entrance channel. Once fish are crowded over the hopper, the hopper is raised vertically to the level where the fish will be released. Fish can be released into a sorting tank (currently only available at Conowingo Dam), or they can be released into an exit trough where they are then able to swim into the upstream impoundment (available at all dams). Exit troughs also have varying dimensions but are generally box-shaped metal and/or concrete channels that run through the dam into the upstream impoundment. All exit troughs have a viewing window to observe and count fish passing into the impoundment. Once the fish are released into the exit trough, there is currently very limited ability to re-capture fish before they can escape into the impoundment. Specific information on the design and operation of existing fish passage facilities is described below.

3.2.1.1. Conowingo Dam

Conowingo Dam is the first dam on the Susquehanna River, located at RM 10, and is 94 feet high and 4,648 feet long. Conowingo Dam has two fish lifts, one located on each side of the powerhouse. The West Fish Lift (WFL) began operation in 1972. This lift collects fish from the Conowingo Tailrace and deposits them into a tank where they can be sorted. The WFL is solely a trapping facility and does not have the ability to release fish directly into Conowingo Pond. Since the beginning of operation, the WFL has been used to support a trap and transport program for migratory fish, a collection location for American Shad to support tank spawning, and a location to collect biological samples for species of interest. Starting in 2019, all invasive fish species, including Northern Snakehead, Flathead Catfish, and Blue Catfish, have been removed from the WFL sorting tank and disposed of for beneficial use. In 2021, the WFL reinitiated operations to support a trap and transport program for American Shad and river herring where those fish are removed from the sorting tank and transported to

upstream locations. Although the WFL has some planned improvements in the future with respect to improving the sorting and handling conditions for the trap and transport program, the facility will remain a trapping facility where selected species will be removed for transport or disposal and all other collected species will be returned to the Conowingo tailrace.

The East Fish Lift (EFL) began operation in 1991. This lift can support both trap and transport operations by emptying fish from the hopper into a sorting tank or releasing fish into an exit trough near the top of the dam to allow for volitional passage into the impoundment upstream of the dam. From 1997 to 2020, the EFL was operated solely as a volitional fish passage facility, allowing all fish captured to be released upstream[1]. In 2021, the EFL was not operated, due to concerns over passing invasive fish upstream. Starting in 2022, the sorting facility at the EFL was made operational and currently all fish are sorted at the EFL. American shad and river herring are transported upstream, invasive species are removed for beneficial use, and all remaining species are returned to the Conowingo tailrace. Improvements are planned for the EFL in future to include mediation of velocity barriers approaching the fish lift entrance, improved entrance channel conditions, addition of a hopper and increased hopper capacity, and improved sorting and transport facilities.

The Conowingo fish lifts are operated in the spring season only, beginning when water temperatures reach 48^{o}F for three consecutive days and ending when water temperatures reach 72^{o}F for four consecutive days. Generally, Conowingo Dam fish lifts operate from early April to early June.

3.2.1.2. Holtwood Dam

Holtwood Dam is the second dam on the Susquehanna River, located at RM 25, and is 55 feet high and 2,392 feet long. Holtwood has two fish lifts, one located on either side of the spillway dividing wall of the tailrace on the western end of the powerhouse. The lifts began operation in 1997 and collect fish from both the powerhouse tailrace and spillway and release them into a single combined exit trough where fish can then swim volitionally into the impoundment upstream of the dam. There are no sorting facilities at this dam and no way to isolate or recapture fish once they have been released from the hopper into the exit trough.

The Holtwood fish lifts are operated during the migratory fish passage season to begin when American Shad are passed upstream from the Conowingo Dam and the season ends, by agreement with the resource agencies, several days after

[1] From 2018 to 2020, Best Management Practices (BMPs) were implemented for fish passage at the EFL to help prevent the upstream passage of invasive species, particularly Northern Snakehead. Those BMPs included removing fish by net from the hopper or the exit trough to the extent possible by fishway operators.

the last American Shad passes Conowingo Dam. In the past, Holtwood has operated the fish lifts for resident fish passage as well in the spring and fall. The Holtwood fish passage facilities operated annually from 1997-2020. In 2020, fish lift operations were suspended, per request of the resource agencies, to ensure that the 21 Northern Snakehead passed at Conowingo Dam that season were not passed further upstream through the Holtwood fish lifts. To preclude further spread of invasive fish species in the Susquehanna River, the Holtwood fish lifts have not operated since 2020.

3.2.1.3. Safe Harbor Dam

Safe Harbor Dam is the third dam on the Susquehanna River, located at RM 33, and is 75 feet high and 4,869 feet long. Safe Harbor has one fish lift located on the western end of the powerhouse. The lift began operation in 1997 and collects fish from the tailrace and releases them into an exit trough where fish can then swim volitionally into the impoundment upstream of the dam. There are no sorting facilities at this dam and no way to isolate or recapture fish once they have been released from the hopper into the exit trough.

The Safe Harbor fish lift is operated during migratory fish passage season and initiates operation when 500 American Shad are passed upstream from the Holtwood Dam and the season ends one to two days after the last American Shad passes Holtwood Dam. The Safe Harbor fish passage facilities have operated annually from 1997-2020. In 2020, fish lift operations were suspended, per request of the resource agencies, since no American Shad were being passed at Holtwood Dam. Per resource agency request, the Safe Harbor fish lift has not operated since 2020. The Safe Harbor Dam is the most upstream dam that provides a complete physical barrier to upstream dispersal.

3.2.1.4. Other Dams

There are several other dams on the Susquehanna River that are likely not complete barriers to fish movement. Some notable dams in the mainstem Susquehanna River include Muddy Run, York Haven, Dock Street, and Adam T. Bower Dams.

The Muddy Run Pumped Storage Facility is located at RM 22 on the east side of Conowingo Pond upstream of Conowingo Dam and downstream of Holtwood Dam. This is a large dam (260 feet high, 4,800 feet long) and the project withdraws water from the Conowingo Pond and releases it into an upper reservoir. Water is later discharged from the upper reservoir back into Conowingo Pond for electric generation. This water exchange cycle occurs daily, and fish can be moved into and out of the upper reservoir during the pumping and generating cycles, respectively. There are no dedicated fish passage facilities at this dam, but fish are likely freely transported into and out of the Muddy Run impoundment from the Conowingo Pond.

York Haven Dam is the fourth hydroelectric dam on the Susquehanna River located at RM 55, and is 9,080 feet long, has a maximum height of 18 feet and an average height of 10 feet. The East Channel portion of the dam has a vertical slot fish ladder that began operation in 2000 and is in operation from April 1 to mid-December annually. The dam is fully inundated periodically under high flow conditions, which likely allows passage of fish over the dam crest. A new nature-like fish passage facility is planned to be constructed at this dam in 2025. This fish passage facility will operate year-round and will facilitate passage of all species in the river.

The Dock Street Dam is in Harrisburg, PA is six feet high and 3,460 feet long. This dam is frequently inundated by moderate to high flows and is not a full barrier to fish passage under all river flow conditions.

The Adam T. Bower (Sunbury Fabridam) is an inflatable dam located in Sunbury, PA. This dam is created by inflating panels, which is done for the summer recreational period. This dam is a barrier to upstream migration when inflated under low and moderate flow conditions, but not high flow conditions. The dam is not a significant barrier to fish migration when the panels are deflated. A nature-like fishway was installed at the dam in 2023 to allow for fish passage around the dam when the panels are inflated.

Additional dams occur on the West and North Branches of the Susquehanna River as well as some significant tributaries.

- The Anthony J. Cimini (Hepburn St.) Dam; West Branch; Williamsport, PA
- Grant Street Dam; West Branch; Lockhaven, PA
- Goudey Station Dam; North Branch; Binghamton, NY
- Rock Bottom Dam; North Branch; Binghamton, NY
- Chase Hibbard Dam; Chemung River; Elmira NY

Two notable tributaries occur in the Susquehanna River downstream of Conowingo Dam. Both the Octoraro Creek and Deer Creek are known to have Northern Snakehead in their lower reaches. Octoraro Creek crosses into Maryland from Pennsylvania and fish have open access from the mainstem of the Susquehanna River to the Pine Grove Dam. No fish passage facilities exist on the Pine Grove Dam or the Octoraro Dam, though Northern Snakehead have been reported upstream of both dams in Octoraro Lake. Deer Creek has a Denil fish ladder at its first barrier at Wilson's Mill Dam. Although no Northern Snakehead have been documented upstream of Wilson's Mill Dam, it is assumed that they use the fishway and are present in Deer Creek upstream of Wilson's Mill Dam.

3.2.2. Unauthorized/Unintentional Transport

Human facilitated introduction is a likely pathway for these invasive fish species to colonize the Susquehanna River Basin. For Northern Snakehead, Blue Catfish, Flathead Catfish, and Alabama Bass the human pathway of greatest concern is deliberate introduction to create a fishery for either sport or consumption. For Northern Snakehead and Blue Catfish, the primary challenge will be convincing anglers who enjoy fishing for these species that it is in their best interests and that of society to keep these species from being illegally introduced into the Susquehanna River Basin. Alabama Bass could be mistaken for Largemouth Bass, as the species look similar, and introduced by individuals who think they are introducing Largemouth Bass. Although there are regulations prohibiting transport or release of many of these species (see Section 4), this activity still occurs. Current establishment of Northern Snakehead in Lake Redman and the quarry near Ephrata, PA are examples of unauthorized transport and release into these waterbodies.

3.2.3. Other Possible Dispersal Methods

Although establishment of invasive populations is less likely through other pathways of introduction, it still could occur. For example, transport of fish eggs by waterfowl was demonstrated in a recent experimental study showing a small percentage of Common Carp (*Cyprinus carpio*) eggs survived and hatched after being ingested and passing through the gut of mallard ducks (*Anas platyrhynchos*, Lovas-Kiss et al. 2020). Another possible pathway of introduction for invasive carp would be escape from waters where they are introduced for vegetation control.

4. EXISTING REGULATIONS AND AUTHORITIES

The Susquehanna River Basin encompasses three states (Maryland, Pennsylvania, and New York). Therefore, many partners are involved in efforts to prevent and manage invasive fish species across the basin. For further details on specific authorities, please see Appendix 1.

4.1. Maryland

It is illegal to transport any invasive aquatic organism in Maryland and there are fines/penalties for violating these regulations. There are no season or creel limits for snakehead or invasive catfish and there are limited gear restrictions. There are also specific commercial fishing licenses in Maryland that allow anglers to target snakehead and invasive catfish. Finally, Maryland also allows the targeting of catfish in non-tidal waters with cut bait.

4.2. Pennsylvania

The PFBC maintains a list of fish species approved, by watershed for introduction into the waters of the Commonwealth (https://www.fishandboat.com/Fishing/All-About-Fish/Documents/speciesapp.pdf). Fish species not included on this list, or not listed as approved for a watershed on this list, are not legal to introduce. Note that the legal definition of fish in Pennsylvania includes fin fishes, aquatic invertebrates, reptiles, amphibians, and aquatic organisms. All live snakehead species, including the Northern

Snakehead, and invasive carp including Bighead Carp, Silver Carp, Black Carp, and Diploid Grass Carp are banned for possession, sale, barter, transport, and introduction into Pennsylvania waters. Triploid Grass Carp may only be stocked with a special permit from the PFBC. For additional details regarding regulations pertaining to transportation stocking of live fish in Pennsylvania waters see 58 Pa. Code Chapter 71a. Transportation Of Live Fish Into This Commonwealth (pacodeandbulletin.gov).

There is no closed season, creel limit, or size limit for all snakehead species, and all snakehead species may be taken by rod and reel or by bow, spear, or gig. There is no closed season and up to 50 Freshwater Drum of any size may be taken by rod and reel statewide. There is no closed season and up to 50 combined catfish species of any size, including Flathead Catfish and Blue Catfish, may be taken per day by rod and reel or by bow, spear, or gig, except for listed species or waters with special regulations. The current Pennsylvania Fishing Summary Book should be consulted for further details on creel limits, special regulations, regulatory changes, and consumption advisories (https://www.fishandboat.com/Fishing/Regulations/Documents/2023SummaryBook.pdf).

The PFBC strongly encourages angler harvest of invasive fishes, such as Northern Snakehead, and harvest of introduced Flathead Catfish, Blue Catfish, and Freshwater Drum outside of their native range. The PFBC strongly requests that anglers report captures or observations of aquatic invasive species to the agency via an online reporting form: (https://www.fishandboat.com/Conservation/AIS/Pages/default.aspx).

4.3. New York

New York State Department of Environmental Conservation (NYSDEC) adopted regulations which include lists of prohibited and regulated species to slow the spread of invasive species through commerce. NYSDEC also requires permits for fish to be stocked, and that those fish be certified disease free. A separate permit is required to stock triploid Grass Carp only in approved waters. In addition, there are regulations regarding baitfish including a green list of species which may be used for bait where it is legal to use bait, limitations on transport of wild-caught bait within the state, and requirements that bait fish offered for sale be certified disease free. NYSDEC general fish regulations include the stipulation that any Northern Snakehead caught while angling may not be released back into the water but must be harvested and reported to the NYSDEC. Any species without a sportfish or endangered species regulation or designation such as Flathead Catfish, Blue Catfish, or invasive carp species have no closed season, no minimum length, and no daily limit.

4.4. Susquehanna River Basin Commission

The Susquehanna River Basin Commission (SRBC), being comprised of the three basin states as members, offers technical and implementation support of the states' coordinated projects and undertakes actions and projects that are consistent with the existing authorities of the states. AIS proliferation is of sufficiently significant interest

and concern to SRBC that addressing the issue has been elevated to a priority in the Comprehensive Plan for the Water Resources of the Susquehanna River Basin. To that end, SRBC will support and continue to promote the states' sound watershed management efforts through the use of the best available science to prevent the proliferation of AIS.

4.5. Federal Agencies

The U.S. Fish and Wildlife Service (USFWS) prohibits the import, export, or interstate transport of injurious species, including Bighead Carp, Black Carp, Silver Carp, and all snakehead species (family Channidae) through the Lacey Act. The USFWS and NOAA Fisheries support efforts to prevent and control the spread of aquatic invasive species within their respective purviews.

5. PLAN OBJECTIVES

The objectives of this plan are to facilitate the prevention, early detection and rapid response, monitoring, and control of specific aquatic invasive fish species in the Susquehanna River Basin whose distribution may be expanded through fish passage operations at the Conowingo, Holtwood, and Safe Harbor Dams, along with potential introductions by unauthorized stocking. The strategies and actions described in the next section support these objectives.

6. STRATEGIES AND ACTIONS

Strategies have been identified to manage invasive species spread into the Susquehanna River Basin to include prevention, early detection, rapid response, monitoring, control, and outreach. Each of these strategies has a suite of actions that can be implemented that will help in the prevention and control of aquatic invasive fish species in the Susquehanna River. While some actions have already been implemented, or are currently being implemented in the Susquehanna River, other actions can be considered for future implementation or are research needs. Although this section is a list of all strategies and actions currently under consideration with implementation of this plan, there is a prioritized implementation table listed in Section 7 that assigns a level of priority to all the actions described herein.

6.1. Prevention

Preventing the introduction of invasive species is a more cost-effective strategy used to manage invasive species compared to strategies around rapid response and control of populations once introduced and established. Effective prevention will be multi-faceted and will also be supported by actions in other strategies of this plan, including the education, outreach, and regulatory strategies.

6.1.1. STRATEGY: Minimize or eliminate risk of introduction through fish lifts at Conowingo, Holtwood, and Safe Harbor (selective fish passage, FERC license requirements).

6.1.1.1. ACTION: Work collaboratively with the hydropower companies to identify, research, and implement selective fish passage technologies and strategies to prevent invasive fish species passage at the fish lifts.

6.1.1.2. ACTION: Continue 100% sorting of fish at Conowingo Dam with removal of invasive species for interim period until additional technologies and/or strategies can be identified to allow for volitional passage of migratory fish while precluding passage of invasive fish species into Conowingo Pond.

6.1.1.3. ACTION: Research upstream dispersal triggers to inform seasonal implementation of removals or selective fish passage mechanisms.

6.1.1.4. ACTION: Research mechanisms to minimize passage probability for invasive fish using fish passage facilities (e.g., velocity, sound, bubble curtains) while maintaining or improving target species passage.

6.1.1.5. ACTION: Research mechanisms to attract invasive fish away from fish passage facilities (e.g., traps using pheromones, deterrents or attractants implemented outside of the fish passage facility).

6.1.1.6. ACTION: Require passage control technologies and/or strategies for invasive fish species to be added to the fish lifts at Holtwood and Safe Harbor Dams during their FERC relicensing process.

6.1.2. STRATEGY: Ensure that legal and regulatory frameworks are in place in respective jurisdictions regarding possession and transport of live invasive fish species.

6.1.2.1. ACTION: Encourage the three basin states to ban live possession and transport of invasive fish species.

6.1.2.2. ACTION: Encourage states to enforce and/or increase penalties for violation of invasive species laws and regulations.

6.1.3. STRATEGY: Minimize risk of introduction from non-fish passage pathways.

6.1.3.1. ACTION: Identify potential hotspots for introduction that include an intersection of physical pathways for introduction and suitable habitat for establishment.

6.1.3.2. ACTION: Implement bait-bucket checks by enforcement officers to discourage an introduction pathway for invasive species.

6.2. Early Detection

Early detection of a new aquatic species invasion provides an opportunity for resource agencies to consider implementation of rapid response protocols to potentially eliminate or contain the spread of the newly introduced species before it becomes established in the new habitat. Routine monitoring, close agency coordination, and clear actions to implement a rapid response will influence the ability of the resource agencies to eliminate or manage the spread of newly documented introductions.

6.2.1. STRATEGY: Coordinate annual invasive fish monitoring.

6.2.1.1. ACTION: Establish available partners, roles, and capabilities in annual pre-season coordination meeting including determining lead partner/agency and individual(s) responsible.

6.2.1.2. ACTION: Coordinate planned monitoring activities to minimize duplication of effort and utilize partner strengths and assets. Assign monitoring roles based on results of 6.2.1.1.

6.2.1.3. ACTION: Use existing SRAFRC annual meeting to establish pre-season strategies and identify passive and active actions to be taken by partners in the upcoming year.

6.2.2. STRATEGY: Establish monitoring protocols for invasive fish species of concern.

6.2.2.1. ACTION: Develop eDNA monitoring protocol, procedure and strategy in conjunction with partners.

6.2.2.2. ACTION: Query partners regarding existing electrofishing protocols to determine best methodology for monitoring lentic and wadeable and non-wadeable lotic environments employable by all partners.

6.2.2.3. ACTION: Query partners and assess use and access to alternative methods to monitoring invasive fish (e.g., trawl, angling, fyke, trap net, creel survey). Document and standardize to greatest extent possible the uses of alternative gears.

6.2.3. STRATEGY: Communicate monitoring findings in an efficient and timely manner to Agency Leads.

6.2.3.1. ACTION: Establish regular reporting intervals from partners.

6.2.4. STRATEGY: Establish new or improve existing ways to communicate reports to Agency Leads.

6.2.4.1. ACTION: Identify Susquehanna River AIS coordination leads and alternate leads.

6.2.4.2. ACTION: Coordinate mutual reporting strategy amongst AIS leads. Develop mechanism for consistent, rapid dissemination of information amongst AIS leads. Ensure all invasive fish reports are uploaded to United States Geological Survey (USGS) AIS database at least annually.

6.2.4.3. ACTION: Identify existing channels for public reports to authorities.

6.2.4.4. ACTION: Link current public reporting to AIS leads to validate/authenticate and assign authentication roles to partners by jurisdiction.

6.2.4.5. ACTION: Establish monitoring schedule and protocol for authenticated public reports consistent with section 6.2.3.

6.3. Rapid Response

Rapid response methods are often similar to the control methods described below in section 6.5 but deployed quickly as part of a rapid response plan. For instance, upon detection of Northern Snakehead, the fish lifts at Conowingo were initially closed to prevent further movement of individual fish upstream.

6.3.1. STRATEGY: Limit further expansion of new populations.

6.3.1.1. ACTION: Create or maintain high priority physical barriers to limit aquatic invasive fish dispersal into high priority protection areas or watersheds outside of, but connected to, the Susquehanna River Basin.

6.3.2. STRATEGY: Remove founder, or newly established, populations.

6.3.2.1. ACTION: Conduct electrofishing, gill netting, hoop netting, trap netting, and/or seining to capture and remove invasive species. These methods have the advantages of being portable, readily available to research and management organizations, and selective harvest can be achieved to target the invasive species. Acknowledging that in a large river system, these methods may only work to reduce biomass and not remove populations.

6.3.2.2. ACTION: Use rotenone, antimycin, and dewatering in smaller enclosed systems. These methods are not selective to the invasive species, can be very expensive, and permitting and policies would need to be in place as part of the rapid response plan in order to use these methods quickly in an emergency situation.

6.3.3. STRATEGY: Use public reports to identify potential range expansion.

6.3.3.1. ACTION: Inform and involve the public including landowners and anglers to prevent further spread of the invasive species and to enlist their help in identifying the new range of the species and to remove founder population individuals if they encounter them, see section 6.6.

6.4. Monitoring and Inventory

There are a number of surveys currently being conducted by resource agencies in the Susquehanna River Basin. Most are not designed to target invasive fish specifically but may encounter them during their execution. Surveys are critical to document the geographic range of AIS, as well as track other fish populations through time to identify possible shifts in species composition following the unwanted introduction of AIS. Additional targeted sampling for invasive fish may be necessary, in addition to current fishery surveys being implemented, to adequately track range expansion through time.

6.4.1. STRATEGY: Identify existing fishery survey efforts in the Susquehanna River Basin.

6.4.1.1. ACTION: Compile a list of all existing surveys completed in the respective jurisdictions of the Susquehanna River Basin.

6.4.1.2. ACTION: Determine detection probabilities for existing and new surveys.

6.4.1.3. ACTION: Evaluate effectiveness of existing capture techniques and control mechanisms.

6.4.2. STRATEGY: Identify where expanded or new survey efforts are needed.

6.4.2.1. ACTION: Develop a list of future survey efforts needed and lead agencies responsible for implementing surveys based on gaps in existing surveys being conducted.

6.5. Control and Slow Spread of Established Populations

When an invasive fish species becomes established in a large open system like the Susquehanna River, extirpation is rarely an option. At this stage, management actions that either limit the spread of the invasive species or limit its population growth become a top priority. For limiting the spread, maintaining natural and artificial barriers can prevent upstream movements of invasive fishes. For limiting population growth, recreational and commercial harvest can be effective for certain invasive fish species when exploitation is high. For other invasive fishes, targeted removals are often the only option.

6.5.1. STRATEGY: Maintain physical barriers to upstream fish movement where appropriate.

6.5.1.1. ACTION: Implement fish passage strategies at Conowingo Dam that include management of invasive species while supporting restoration of migratory fish to the Susquehanna River Basin.

6.5.1.2. ACTION: Implement fish passage strategies at Holtwood Dam that include management of invasive species while supporting full restoration of migratory fish to the Susquehanna River Basin.

6.5.1.3. ACTION: Implement fish passage strategies at Safe Harbor Dam that include management of invasive species while supporting full restoration of migratory fish to the Susquehanna River Basin.

6.5.1.4. ACTION: Consider impacts to migratory fish restoration and spread of invasive fish when evaluating dam removal and fish passage projects in the Susquehanna River Basin.

6.5.2. STRATEGY: Maintain high priority physical barriers to downstream fish movement.

6.5.2.1. ACTION: Evaluate opportunities to eliminate the potential for downstream spread of invasive species at impoundment outfalls where invasive fish may be established (e.g., Lake Redman).

6.5.3. STRATEGY: Remove invasive fish from fish passage facilities.

6.5.3.1. ACTION: Remove invasive fish when possible in the fish lifts at Conowingo Dam.

6.5.3.2. ACTION: Remove invasive fish if and when possible in the fish lifts at Holtwood Dam.

6.5.3.3. ACTION: Remove invasive fish if and when possible in the fish lift at Safe Harbor Dam.

6.5.3.4. ACTION: Consider opportunities for removal of invasive fish passing other fishways in the Susquehanna River Basin.

6.5.3.5. ACTION: Consider impacts of invasive fish populations in regard to the passage performance and restoration potential for migratory fish. Continually weigh the relative benefits of control impacts against the relative impacts to fish passage for native species.

6.5.4. STRATEGY: Target invasive fish populations through recreational fisheries.

6.5.4.1. ACTION: Reduce or eliminate recreational harvest limits for invasive fish in each management jurisdiction.

6.5.4.2. ACTION: Expand fisheries tools (e.g., bow fishing) used by the public to harvest AIS.

6.5.4.3. ACTION: Encourage recreational anglers to harvest all captured invasive fish.

6.5.4.4. ACTION: Evaluate advisories and risks for consuming invasive fishes.

6.5.5. STRATEGY: Target invasive fish populations through commercial fisheries.

6.5.5.1. ACTION: Remove all quantity, season, and gear restrictions for invasive fish for commercial fishers, when or where practical after considering possible risks to non-target species and societal benefits.

6.5.5.2. ACTION: Work with federal regulators to reduce burdens required for commercial processing of catfish species.

6.5.5.3. ACTION: Develop new beneficial uses for invasive fish products, including consumption in schools, prisons, other institutions, distribution through food banks, and use in pet food and fertilizer.

6.5.6. STRATEGY: Control invasive fish populations through incentivized harvest.

6.5.6.1. ACTION: Evaluate effectiveness of implementing a long-term contractual harvesting program to reduce invasive fish populations.

6.5.6.2. ACTION: Promote the harvest of established fish populations through social media campaigns, fishing awards, tournaments, email blasts, press releases, and websites.

6.5.7. STRATEGY: Support effective Law Enforcement of AIS issues.

6.5.7.1. ACTION: Improve communication with and provide AIS training and educational materials to Law Enforcement staff on current laws, regulations, and the purpose of those laws and regulations in controlling the spread.

6.5.7.2. ACTION: Consult with Law Enforcement staff prior to proposing new regulations to ensure enforceability.

6.5.8. STRATEGY: Other control methods.

6.5.8.1. ACTION: Evaluate effectiveness of novel barrier types (e.g., electrical barriers) to preclude spread of AIS.

6.5.8.2. ACTION: Evaluate feasibility and effectiveness of using electrofishing as a tool for invasive fish removal.

6.5.8.3. ACTION: Consider use of piscicides or draining of small, confined waterbodies with novel introductions of invasive fish.

6.5.8.4. ACTION: Evaluate behavior of invasive fish to inform more effective control and management methods.

6.5.8.5. ACTION: Consider use of chromosomal bioengineering to control invasive fish populations.

6.5.9. STRATEGY: Prioritizing control in ecologically sensitive areas.

6.5.9.1. ACTION: Evaluate potential impacts by invasive fish on the Susquehanna River ecosystem, including impacts to existing fisheries, at-risk species, migratory fish, and associated economic impacts of introductions.

6.5.9.2. ACTION: Evaluate habitat preferences of invasive fish species to better understand geographic areas where invasion may be most likely in the Susquehanna River.

6.5.9.3. ACTION: Evaluate trends in populations of invasive fish where they have become established.

6.5.9.4. ACTION: Evaluate the susceptibility of invasive fish to existing fish diseases and ability to transmit diseases.

6.6. Outreach and Education

Outreach and education are key elements to reduce the spread of AIS by the public through intentional or unintentional pathways. In addition, as members of the public are often first to detect an AIS, outreach and education are key to acquaint the public with AIS so that new introductions can be recognized and reported to the appropriate agency. Furthermore, the public can play a role in assisting resource agencies in management of AIS, such as the harvest of invasive fishes like Northern Snakehead. Last, outreach and education are key to informing the public regarding actions and decisions made by resource agencies to manage or contain AIS in the interest of

resource conservation in the Susquehanna River Basin, especially in the context of native migratory fish restoration efforts.

6.6.1. STRATEGY: Increase public understanding about the threats of AIS in the Susquehanna River Basin.

6.6.1.1. ACTION: Develop outreach and educational materials to convey the importance of migratory fish restoration in the Susquehanna River Basin and the threats invasive fishes pose to migratory fish restoration.

6.6.1.2. ACTION: Develop outreach and educational messaging to emphasize the environmental and economic impacts of invasive fish on important fisheries in the Susquehanna River Basin, in addition to migratory fish restoration efforts.

6.6.1.3. ACTION: Develop outreach and educational messaging to emphasize the environmental consequences of transport and release of invasive fishes with the goal of preventing further introductions.

6.6.1.4. ACTION: Develop outreach materials to help the public distinguish among similar looking species, (e.g., Blue Catfish vs. Channel Catfish) and encourage harvest of invasives.

6.6.1.5. ACTION: Develop outreach and materials to explain the difference between invasive, desirable non-native, and native species in the Susquehanna River Basin, as confusion often occurs in distinguishing desirable non-native species from invasive species.

6.6.1.6. ACTION: Develop a centralized website for the Susquehanna River dedicated to conveying information on the impacts and management of invasive fish with links to respective jurisdictions websites and information on how to report AIS sightings.

6.6.2. STRATEGY: Improve public reporting for more consistent and advertised mechanisms to report AIS.

6.6.2.1. ACTION: Identify a preferred reporting mechanism for each jurisdiction with an identified staff point of contact.

6.6.2.2. ACTION: Ensure all outreach and educational messaging emphasizes public reporting through the preferred reporting mechanism to the appropriate jurisdictional agency by geography.

6.6.3. STRATEGY: Encourage harvest of invasive fishes in established areas.

6.6.3.1. ACTION: Develop messaging on ethical, but effective, ways to dispatch invasive fishes.

6.6.3.2. ACTION: Develop messaging for carcass disposal or donation for those who wish to remove invasive fishes and choose not to eat their catch. Consumption advisories should also be considered.

6.6.3.3. ACTION: Support organized tournaments in areas where invasive species are established that are focused on harvest of invasive fish that are sponsored or approved by the appropriate jurisdictional resource agency.

6.6.4. STRATEGY: Convey penalties for moving invasive fishes to new locations.

6.6.4.1. ACTION: Develop messaging to convey the applicable legal penalties by jurisdiction for invasive fishes of concern. Potentially, publicize legal cases or citations to emphasize penalties and a conservation law enforcement presence and awareness of this issue.

6.6.4.2. ACTION: Provide information to the public on where they may be able to direct tips to law enforcement regarding suspected possession or transport of banned AIS in the Susquehanna River Basin (e.g., contact information for appropriate regional offices).

6.6.4.3. ACTION: Provide interjurisdictional trainings or briefings for conservation law enforcement officials on AIS of concern in the Susquehanna River Basin.

6.6.5. STRATEGY: Optimize communication tools to reach the public.

6.6.5.1. ACTION: Press Releases – Determine what kinds of events and/or information could require the need for a press releases (i.e., range expansion, new species, eDNA survey results, monitoring results, progress on fish passage improvements), and determine a way to identify which jurisdiction would lead in the development of the release and ensure coordination with remaining jurisdictions.

6.6.5.2. ACTION: Websites – Develop or enhance an existing website as a central location for invasive fishes of concern and migratory fish passage in the Susquehanna River Basin.

6.6.5.3. ACTION: Social media – Develop a new Susquehanna-specific platform or supplement existing resource agency platforms to share messaging related to invasive fishes and migratory fish passage in the Susquehanna River Basin.

6.6.5.4. ACTION: Video outreach – Create video clips that could be hosted on YouTube or another network and shared with the public via social media or linked on websites to educate the public on various topics.

6.6.5.5. ACTION: Signs at fishing or boating access areas – Create or update signage on invasive fish for posting at fishing and boating accesses in the Susquehanna River Basin to incorporate key messages as applicable.

6.6.5.6. ACTION: Print media – Brochures and other handout print materials developed collaboratively by SRAFRC resource agencies to communicate important messages on invasive fishes and migratory fish restoration in the Susquehanna River Basin.

6.6.5.7. ACTION: Direct communication with angler groups, school groups, youth organizations, and other stakeholders – Have staff meet directly with angler groups such as outdoor recreation clubs and youth clubs on invasive fishes of concern by offering presentations at meetings, or by educational booths/presentations during fishing expos or tournaments.

6.6.5.8. ACTION: Signs at fishways – Develop and install educational kiosks adjacent to fishways, in partnership with the hydropower companies, which illustrate concerns about invasive fishes and the need for migratory fish restoration in the Susquehanna River Basin.

7. IMPLEMENTATION TABLE

This implementation table prioritizes strategies and actions identified in this plan. For each of those strategies and actions, the table also identifies expected funding needed to complete the action, the lead organization to implement the action and other agencies that would be assisting in that effort. This list will be reviewed and may be updated annually as actions are completed and items are reprioritized.

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
Prevention: 6.1.1 Minimize or eliminate risk of introduction through fish lifts at Conowingo, Holtwood, and Safe Harbor	6.1.1.1 Work collaboratively with the hydropower companies to identify, research, and implement selective fish passage technologies and strategies to prevent invasive fish species passage at the fish lifts.	*H*	*In Progress*	*$$$*	*USFWS*	*MDNR* *PFBC* *NYSDEC* *NOAA* *SRBC*
	6.1.1.2 Continue 100% sorting of fish at Conowingo Dam with removal of invasive species for interim period until additional technologies and/or strategies can be identified to allow for volitional passage of migratory fish while precluding passage of invasive fish species into Conowingo Pond.	*H*	*In Progress*	*$ to agencies* *$$-$$$ construction and annual costs to Constellation*	*USFWS*	*MDNR* *MDE* *SRBC*
	6.1.1.3 Research upstream dispersal triggers to inform seasonal implementation of removals or selective fish passage mechanisms.	*H*	*To Be Completed*	*$$-$$$*	*USFWS* *MDNR*	*PADEP* *NYSDEC* *SRBC* *NOAA*
	6.1.1.4 Research mechanisms to minimize passage probability for invasive fish using fish passage facilities while maintaining or improving target species passage.	*H*	*In Progress*	*$$-$$$*	*USFWS* *MDNR*	*PADEP* *NYSDEC* *SRBC* *NOAA*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.1.1.5 Research mechanisms to attract invasive fish away from fish passage facilities.	*H*	*To Be Completed*	*$$-$$$*	*USFWS* *MDNR*	*PADEP* *NYSDEC* *SRBC* *NOAA*
	6.1.1.6 Require passage control technologies and/or strategies for invasive fish species to be added to the fish lifts at Holtwood and Safe Harbor Dams during their FERC relicensing process.	*H*	*To Be Completed*	*$ to Agencies* *$$-$$$ construction and annual costs to Brookfield*	*USFWS*	*PADEP* *PFBC* *SRBC*
Prevention: 6.1.2 Ensure that legal and regulatory frameworks are in place in respective jurisdictions regarding possession and transport of live invasive fish species.	6.1.2.1 Encourage the three basin states to ban live possession and transport of invasive fish species.	*H*	*Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	*USFWS*
	6.1.2.2 Encourage states to enforce and/or increase penalties for violation of invasive species laws and regulations.	*M*	*In Progress*	*$*	*PFBC* *MDNR* *NYSDEC*	*USFWS*
Prevention: 6.1.3 Minimize risk of introduction from non-fish passage pathways.	6.1.3.1 Identify potential hotspots for introduction that include an intersection of physical pathways for introduction and suitable habitat for establishment.	*M*	*To Be Completed*	*$-$$*	*SRBC*	*USFWS* *PFBC* *NYSDEC*
	6.3.1.2 Implement bait-bucket checks by enforcement officers to discourage an introduction pathway for invasive species.	*L*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	
Early Detection: 6.2.1 Coordinate annual invasive fish monitoring.	6.2.1.1 Establish available partners, roles, and capabilities in annual pre-season coordination meeting including determining lead partner/agency and individual(s) responsible.	*H*	*In Progress*	*$*	*SRBC*	*PFBC* *NYSDEC* *MDNR* *USFWS*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.2.1.2 Coordinate planned monitoring activities to minimize duplication of effort and utilize partner strengths and assets. Assign monitoring roles based on results of 6.2.1.1.	*M*	*In Progress*	*$*	*SRBC*	*PFBC* *NYSDEC* *MDNR* *USFWS*
	6.2.1.3 Use existing SRAFRC annual meeting to establish pre-season strategies and identify passive and active actions to be taken by partners in the upcoming year.	*M*	*In Progress*	*$*	*SRBC*	*PFBC* *NYSDEC* *MDNR* *USFWS*
Early Detection: 6.2.2 Establish monitoring protocols for invasive fish species of concern.	6.2.2.1 Develop eDNA monitoring protocol, procedure and strategy in conjunction with partners.	*H*	*In Progress*	*$$*	*SRBC*	*USFWS*
	6.2.2.2 Query partners regarding existing electrofishing protocols to determine best methodology for monitoring lentic and wadeable and non-wadeable lotic environments employable by all partners.	*H*	*In Progress*	*$*	*PFBC*	*SRBC* *USFWS* *NYSDEC* *MDNR*
	6.2.2.3 Query partners and assess use and access to alternative methods to monitoring invasive fish. Document and standardize to greatest extent possible the uses of alternative gears.	*M-L*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC* *SRBC* *USFWS*	
Early Detection: 6.2.3 Communicate monitoring findings to an efficient and timely manner to Agency Leads.	6.2.3.1 Establish regular reporting intervals from partners.	*H*	*Completed (Included in this Plan)*	*$*	*USFWS*	*SRBC* *PFBC* *NYSDEC* *MDNR*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
Early Detection: 6.2.4 Establish new or improve existing ways to communicate reports to Agency Leads.	6.2.4.1 Identify Susquehanna River AIS coordination leads and alternate leads.	*H*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC* *SRBC* *USFWS*	*NOAA*
	6.2.4.2 Coordinate mutual reporting strategy amongst AIS leads. Develop mechanism for consistent, rapid dissemination of information amongst AIS leads. Ensure all invasive fish reports are uploaded to United States Geological Survey (USGS) AIS database at least annually.	*H*	*To Be Completed*	*$*	*SRBC* *USFWS* *MDNR* *PFBC* *NYSDEC*	
	6.2.4.3 Identify existing channels for public reports to authorities.	*M*	*Completed (Included in this Plan)*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC*
	6.2.4.4 Link current public reporting to AIS leads to validate/authenticate and assign authentication roles to partners by jurisdiction.	*H*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	
	6.2.4.5 Establish monitoring schedule and protocol for authenticated public reports consistent with section 6.2.3.	*H*	*Completed (Included in this Plan)*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS*
Rapid Response: 6.3.1 Limit further expansion of new populations.	6.3.1.1 Create or maintain high priority physical barriers to limit aquatic invasive fish dispersal into high priority protection areas or watersheds outside of, but connected to, the Susquehanna River Basin.	*H*	*To Be Completed (As Needed)*	*$$-$$$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS* *NOAA*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
Rapid Response: 6.3.2 Remove founder, or newly established, populations.	6.3.2.1 Conduct electrofishing, gill netting, hoop netting, trap netting, and/or seining to capture and remove invasive species. These methods have the advantages of being portable, readily available to research and management organizations, and selective harvest can be achieved to target the invasive species. Acknowledging that in a large river system, these methods may only work to reduce biomass and not remove populations.	*H*	*To Be Completed (As Needed)*	*$*	*MDNR* *PFBC* *NYSDEC* *SRBC* *USFWS*	
	6.3.2.2 Use rotenone, antimycin, and dewatering in smaller enclosed systems. These methods are not selective to the invasive species, can be very expensive, and permitting and policies would need to be in place as part of the rapid response plan in order to use these methods quickly in an emergency situation.	*M*	*To Be Completed (As Needed)*	*$$-$$$*	*NYSDEC*	*PFBC* *MDNR* *SRBC* *USFWS*
Rapid Response: 6.3.3 Use public reports to identify potential range expansion.	6.3.3.1 Inform and involve the public including landowners and anglers to prevent further spread of the invasive species and to enlist their help in identifying the new range of the species and to remove founder population individuals if they encounter them, see section 6.6.	*H*	*To Be Completed*	*$$$*	*PFBC*	*MDNR* *NYSDEC* *SRBC* *USFWS*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
Monitoring and Inventory: 6.4.1 Identify existing fishery survey efforts in the Susquehanna River Basin.	6.4.1.1 Compile a list of all existing surveys completed in the respective jurisdictions of the Susquehanna River Basin.	*M*	*Completed (Included in this plan)*	*$*	*MDNR* *PFBC* *NYSDEC* *SRBC* *USFWS*	
	6.4.1.2 Determine detection probabilities for existing and new surveys.	*M*	*To Be Completed*	*$$*	*MDNR* *PFBC* *NYSDEC* *SRBC*	*USFWS*
	6.4.1.3 Evaluate effectiveness of existing capture techniques and control mechanisms.	*M*	*To Be Completed*	*$$*	*MDNR* *PFBC* *NYSDEC* *SRBC*	*USFWS*
Monitoring and Inventory: 6.4.2 Evaluate effectiveness of existing capture techniques and control mechanisms.	6.4.2.1 Develop a list of future survey efforts needed and lead agencies responsible for implementing surveys based on gaps in existing surveys being conducted.	*H*	*In Progress*	*$*	*USFWS*	*MDNR* *PFBC* *NYSDEC* *SRBC*
Control: 6.5.1 Maintain physical barriers to upstream fish movement where appropriate.	6.5.1.1 Implement fish passage strategies at Conowingo Dam that include management of invasive species while supporting restoration of migratory fish to the Susquehanna River Basin.	*H*	*In Progress*	*$ to agencies* *$$$ to Constellation*	*USFWS* *MDNR* *MDE*	*SRBC* *PFBC* *NYSDEC*
	6.5.1.2 Implement fish passage strategies at Holtwood Dam that include management of invasive species while supporting full restoration of migratory fish to the Susquehanna River Basin.	*H*	*To Be Completed*	*$ to agencies* *$$$ to Brookfield*	*USFWS* *PFBC* *PADEP*	*SRBC* *MDNR* *NYSDEC* *NOAA*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.5.1.3 Implement fish passage strategies at Safe Harbor Dam that include management of invasive species while supporting full restoration of migratory fish to the Susquehanna River Basin.	*H*	*To Be Completed*	*$ to agencies* *$$$ to Brookfield*	*USFWS* *PFBC* *PADEP*	*SRBC* *MDNR* *NYSDEC* *NOAA*
	6.5.1.4 Consider impacts to migratory fish restoration and spread of invasive fish when evaluating dam removal and fish passage projects in the Susquehanna River Basin.	*M*	*To Be Completed*	*$*	*PFBC* *MDNR* *NYSDEC*	*SRBC* *USFWS* *NOAA*
Control: 6.5.2 Maintain high priority physical barriers to downstream fish movement.	6.5.2.1 Evaluate opportunities to eliminate the potential for downstream spread of invasive species at impoundment outfalls where invasive fish may be established.	*L*	*To Be Completed*	*$$-$$$*	*PFBC*	*MDNR* *NYSDEC* *USFWS* *SRBC*
Control: 6.5.3 Remove invasive fish from fish passage facilities.	6.5.3.1 Remove invasive fish when possible in the fish lifts at Conowingo Dam.	*H*	*In Progress*	*$$ to Agencies* *$$$ to Constellation*	*MDNR*	*USFWS*
	6.5.3.2 Remove invasive fish if and when possible in the fish lifts at Holtwood Dam.	*M*	*To Be Completed*	*$$ to Agencies* *$$$ to Brookfield*	*PFBC*	*USFWS*
	6.5.3.3 Remove invasive fish if and when possible in the fish lifts at Safe Harbor Dam.	*M*	*To Be Completed*	*$$ to Agencies* *$$$ to Brookfield*	*PFBC*	*USFWS*
	6.5.3.4 Consider opportunities for removal of invasive fish passing other fishways in the Susquehanna River Basin.	*L*	*To Be Completed*	*$-$$$*	*PFBC* *NYSDEC*	*USFWS* *SRBC*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.5.3.5 Consider impacts of invasive fish populations in regard to the passage performance and restoration potential for migratory fish. Continually weigh the relative benefits of control impacts against the relative impacts to fish passage for native species.	*H*	*In Progress*	*$*	*USFWS* *MDNR* *PFBC* *NYSDEC* *SRBC*	*NOAA*
Control: 6.5.4 Target invasive fish populations through recreational fisheries.	6.5.4.1 Reduce or eliminate recreational harvest limits for invasive fish in each management jurisdiction.	*M*	*Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	
	6.5.4.2 Expand fisheries tools used by the public to harvest AIS.	*M*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	
	6.5.4.3 Encourage recreational anglers to harvest all captured invasive fish.	*H*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS* *NOAA*
	6.5.4.4 Evaluate advisories and risks for consuming invasive fishes.	*M*	*In Progress*	*$*	*MDNR* *MDE*	*SRBC* *PFBC*
Control: 6.5.5 Target invasive fish populations through commercial fisheries.	6.5.5.1 Remove all quantity, season, and gear restrictions for invasive fish for commercial fishers, when or where practical after considering possible risks to non-target species and societal benefits.	*M*	*In Progress*	*$*	*MDNR*	
	6.5.5.2 Work with federal regulators to reduce burdens required for commercial processing of catfish species.	*M*	*In Progress*	*$*	*MDNR*	

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.5.5.3 Develop new beneficial uses for invasive fish products, including consumption in schools, prisons, other institutions, distribution through food banks, and use in pet food and fertilizer.	*M*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS* *NOAA*
Control: 6.5.6 Control invasive fish populations through incentivized harvest.	6.5.6.1 Evaluate effectiveness of implementing a long-term contractual harvesting program to reduce invasive fish populations.	*M*	*In Progress*	*$$*	*MDNR*	
	6.5.6.2 Promote the harvest of established fish populations through social media campaigns, fishing awards, tournaments, email blasts, press releases, and websites.	*H*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS* *NOAA*
Control: 6.5.7 Support effective Law Enforcement of AIS issues.	6.5.7.1 Improve communication with and provide AIS training and educational materials to Law Enforcement staff on current laws, regulations, and the purpose of those laws and regulations in controlling the spread.	*M*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	
	6.5.7.2 Consult with Law Enforcement staff prior to proposing new regulations to ensure enforceability.	*M*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	
Control: 6.5.8 Other control methods.	6.5.8.1 Evaluate effectiveness of novel barrier types to preclude spread of AIS.	*M*	*To Be Completed*	*$$*	*USFWS*	*MDNR* *PFBC* *NYSDEC* *SRBC*
	6.5.8.2 Evaluate feasibility and effectiveness of using electrofishing as a tool for invasive fish removal.	*M*	*In Progress*	*$$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.5.8.3 Consider use of piscicides or draining of small, confined waterbodies with novel introductions of invasive fish.	*L*	*Completed (Included in this Plan)*	*$$*	*NYSDEC PFBC*	*MDNR*
	6.5.8.4 Evaluate behavior of invasive fish to inform more effective control and management methods.	*M*	*To Be Completed*	*$$*	*USFWS*	*MDNR PFBC NYSDEC SRBC*
	6.5.8.5 Consider use of chromosomal bioengineering to control invasive fish populations.	*L*	*To Be Completed*	*$$*	*USFWS*	*MDNR PFBC NYSDEC SRBC*
Control: 6.5.9 Prioritizing control in ecologically sensitive areas.	6.5.9.1 Evaluate potential impacts by invasive fish on the Susquehanna River ecosystem, including impacts to existing fisheries, at-risk species, migratory fish, and associated economic impacts of introductions.	*H*	*To Be Completed*	*$*	*USFWS PFBC SRBC*	*MDNR NYSDEC*
	6.5.9.2 Evaluate habitat preferences of invasive fish species to better understand geographic areas where invasion may be most likely in the Susquehanna River.	*M*	*To Be Completed*	*$*	*USFWS PFBC SRBC*	*MDNR NYSDEC*
	6.5.9.3 Evaluate trends in populations of invasive fish where they have become established.	*M*	*In Progress*	*$*	*USFWS MDNR*	*PFBC NYSDEC SRBC*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.5.9.4 Evaluate the susceptibility of invasive fish to existing fish diseases and ability to transmit diseases.	*L*	*To Be Completed*	*$*	*USFWS*	*MDNR* *PFBC* *NYSDEC* *SRBC*
Outreach and Education: 6.6.1 Increase public understanding about the threats of AIS in the Susquehanna River Basin.	6.6.1.1 Develop outreach and educational materials to convey the importance of migratory fish restoration in the Susquehanna River Basin and the threats invasive fishes pose to migratory fish restoration.	*H*	*To Be Completed*	*$$*	*MDNR* *NYSDEC* *PFBC* *USFWS* *SRBC*	*NOAA*
	6.6.1.2 Develop outreach and educational messaging to emphasize the environmental and economic impacts of invasive fish on important fisheries in the Susquehanna River Basin, in addition to migratory fish restoration efforts.	*H*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS*
	6.6.1.3 Develop outreach and educational messaging to emphasize the environmental consequences of transport and release of invasive fishes with the goal of preventing further introductions.	*H*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS* *NOAA*
	6.6.1.4 Develop outreach materials to help the public distinguish among similar looking species and encourage harvest of invasives.	*M*	*In Progress*	*$*	*PFBC*	*MDNR* *SRBC* *NYSDEC*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.6.1.5 Develop outreach and materials to explain the difference between invasive, desirable non-native, and native species in the Susquehanna River Basin, as confusion often occurs in distinguishing desirable non-native species from invasive species.	*M*	*In Progress*	*$*	*PFBC* *NYSDEC* *MDNR*	*SRBC*
	6.6.1.6 Develop a centralized website for the Susquehanna River dedicated to conveying information on the impacts and management of invasive fish with links to respective jurisdictions websites and information on how to report AIS sightings.	*H*	*To Be Completed*	*$*	*SRBC*	*MDNR* *PFBC* *NYSDEC* *USFWS*
Outreach and Education: 6.6.2 Improve public reporting for more consistent and advertised mechanisms to report AIS.	6.6.2.1 Identify a preferred reporting mechanism for each jurisdiction with an identified staff point of contact.	*H*	*Completed (Included in this Plan)*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS*
	6.6.2.2 Ensure all outreach and educational messaging emphasizes public reporting through the preferred reporting mechanism to the appropriate jurisdictional agency by geography.	*M*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS*
Outreach and Education: 6.6.3 Encourage harvest of invasive fishes in established areas.	6.6.3.1 Develop messaging on ethical, but effective, ways to dispatch invasive fishes.	*M*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS*
	6.6.3.2 Develop messaging for carcass disposal or donation for those who wish to remove invasive fishes and choose not to eat their catch. Consumption advisories should also be considered.	*M*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS*

Objective/Strategy	**Action**	**Priority** H=High M=Medium L=Low	**Status**	**Additional Funding ($)** $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	**Lead Agency**	**Co-op Agency**
	6.6.3.3 Support organized tournaments in areas where invasive species are established that are focused on harvest of invasive fish that are sponsored or approved by the appropriate jurisdictional resource agency.	*L*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	*SRBC* *USFWS*
Outreach and Education: 6.6.4 Convey penalties for moving invasive fishes to new locations.	6.6.4.1 Develop messaging to convey the applicable legal penalties by jurisdiction for invasive fishes of concern. Potentially, publicize legal cases or citations to emphasize penalties and a conservation law enforcement presence and awareness of this issue.	*L*	*In Progress*	*$*	*MDNR* *PFBC* *NYSDEC*	*USFWS*
	6.6.4.2 Provide information to the public on where they may be able to direct tips to law enforcement regarding suspected possession or transport of banned AIS in the Susquehanna River Basin.	*L*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	
	6.6.4.3 Provide interjurisdictional trainings or briefings for conservation law enforcement officials on AIS of concern in the Susquehanna River Basin.	*M*	*To Be Completed*	*$*	*MDNR* *PFBC* *NYSDEC*	
Outreach and Education: 6.6.5 Optimize communication tools to reach the public.	6.6.5.1 Press Releases – Determine what kinds of events and/or information could require the need for a press releases (i.e., range expansion, new species, eDNA survey results, monitoring results, progress on fish passage improvements), and determine a way to identify which jurisdiction would lead in the development of the release and ensure coordination with remaining jurisdictions.	*M*	*Completed (Included in this Plan)*	*$*	*USFWS* *MDNR* *PFBC* *NYSDEC* *SRBC*	

Objective/Strategy	Action	Priority H=High M=Medium L=Low	Status	Additional Funding ($) $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	Lead Agency	Co-op Agency
	6.6.5.2 Websites – Develop or enhance an existing website as a central location for invasive fishes of concern and migratory fish passage in the Susquehanna River Basin.	*H*	*To Be Completed*	*$*	*SRBC*	*MDNR PFBC NYSDEC USFWS*
	6.6.5.3 Social media – Develop a new Susquehanna-specific platform or supplement existing resource agency platforms to share messaging related to invasive fishes and migratory fish passage in the Susquehanna River Basin.	*M*	*To Be Completed*	*$*	*SRBC MDNR PFBC NYSDEC USFWS*	
	6.6.5.4 Video outreach – Create video clips that could be hosted on YouTube or another network and shared with the public via social media or linked on websites to educate the public on various topics.	*M*	*To Be Completed*	*$*	*SRBC MDNR PFBC NYSDEC USFWS*	
	6.6.5.5 Signs at fishing or boating access areas – Create or update signage on invasive fish for posting at fishing and boating accesses in the Susquehanna River Basin to incorporate key messages as applicable.	*H*	*In Progress*	*$$*	*MDNR PFBC NYSDEC*	*SRBC USFWS NOAA*
	6.6.5.6 Print media – Brochures and other handout print materials developed collaboratively by SRAFRC resource agencies to communicate important messages on invasive fishes and migratory fish restoration in the Susquehanna River Basin.	*M*	*To Be Completed*	*$$*	*SRBC*	*MDNR PFBC NYSDEC USFWS*

Objective/Strategy	Action	Priority H=High M=Medium L=Low	Status	Additional Funding ($) $=<$10,000 $$=$10,000-$100,000 $$$=>$100,000	Lead Agency	Co-op Agency
	6.6.5.7 Direct communication with angler groups, school groups, youth organizations, and other stakeholders – Have staff meet directly with angler groups such as outdoor recreation clubs and youth clubs on invasive fishes of concern by offering presentations at meetings, or by educational booths/presentations during fishing expos or tournaments.	*H*	*In Progress*	*$*	*MDNR PFBC NYSDEC*	*SRBC USFWS*
	6.6.5.8 Signs at fishways – Develop and install educational kiosks adjacent to fishways, in partnership with the hydropower companies, which illustrate concerns about invasive fishes and the need for migratory fish restoration in the Susquehanna River Basin.	*H*	*To Be Completed*	*$$*	*MDNR PFBC*	*SRBC USFWS NYSDEC*

8. SUPPORTING DOCUMENTS

8.1. Aquatic invasive species websites for SRAFRC agencies.

Agency	Website
Maryland Department of Natural Resources	https://dnr.maryland.gov/Invasives/pages/default.aspx
New York Department of Environmental Protection	https://www.dec.ny.gov/animals/265.html
Pennsylvania Fish and Boat Commission	https://www.fishandboat.com/Conservation/AIS/Pages/default.aspx
Susquehanna River Basin Commission	https://storymaps.arcgis.com/stories/85e2fade8b9047acbf6e5b69ece542f5
U.S. Fish and Wildlife Service	https://www.fws.gov/initiative/aquatic-invasive-species
NOAA Fisheries	https://www.fisheries.noaa.gov/insight/invasive-and-exotic-marine-species

8.2. Existing AIS plans (with hyperlinks, where available) applicable to the Susquehanna River watershed.

Plan Title	Year	Level	State	Focal Species
Maryland Aquatic Nuisance Species Management Plan	2016	State	MD	All (including Northern Snakehead, Blue Catfish, Flathead Catfish, and invasive carp)
Commonwealth of Pennsylvania Invasive Species Council Aquatic Invasive Species Management Plan	2006	State	PA	All (including Northern Snakehead, Flathead Catfish, and invasive carp)
New York State Aquatic Invasive Species Management Plan	2015	State	NY	All (including Northern Snakehead and invasive carp)
Rapid Response Planning for Aquatic Invasive Species: A Maryland Example	2009	State / Regional	MD	All (including Northern Snakehead)
Rapid Response Plan & Procedures for Responding to Aquatic Invasive Species in Pennsylvania	2022	State	PA	All (including Northern Snakehead and invasive carp)
Rapid Response for Invasive Species: Framework for Response	2016	State	NY	All (including Northern Snakehead and invasive carp)
National control and management plan for members	2015	National	All	Snakehead species

Plan Title	Year	Level	State	Focal Species
of the snakehead family (Channidae)				
Northern Snakehead Control and Management Plan for the Chesapeake Bay	2023	Regional	DC, DE, MD, NY, PA, VA, WV	Northern Snakehead
Aquatic Invasive Species (AIS) Control Plan: Northern Snakehead	2023	State	PA	Northern Snakehead
Invasive Catfish Management Strategy	2020	Regional	DC, MD, PA, VA	Blue Catfish, Flathead Catfish
Strategic Plan for Management of Channel Catfish and Flathead Catfish in Pennsylvania	2013	State	PA	Flathead Catfish
Fishery Management Plan for Tidewater Catfish	2021	State	MD	Blue Catfish, Flathead Catfish
Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States	2007	National	All	Bighead, Black, Grass, and Silver Carps
Invasive Carp Action Plan	2023	Regional	Great Lakes states	Bighead, Black, Grass, and Silver Carps
Aquatic Invasive Species (AIS) Control Plan: Invasive Carp	2021	State	PA	Bighead, Black, Grass, and Silver Carps
Maryland Emergency Response Plan for Invasive Pests	2018	State	MD	All Species
Standard Operating Procedures, Notification of Findings of the U.S. Fish and Wildlife Service, Great Lakes Early Detection Monitoring Program	2019	Regional	Great Lakes states	All Species
Invasive Fishes Communications Protocol for the Council of Great Lakes Fishery Agencies	2023	Regional	Great Lakes states	All Species

9. GLOSSARY

Anadromous – Fish living in the ocean which move to fresh water to spawn.

Invasive Fish – Non-native species introduced or expanding their range and negatively impacting the environment, economy or human health.

Migratory Fish – Fish that periodically move from one place to another (upstream or downstream).

Naturalized Fish – Non-native fish acclimated to the new environment. In the Susquehanna River, this generally means sportfish that were historically intentionally introduced and currently support recreational fisheries.

Non-Native Fish – Not native, nonindigenous, belonging or having originally evolved in a different place.

Resident Fish – Fish complete their life cycle in the given defined environment that includes the Susquehanna River.

Restoration – Returning to an unimpaired state or condition.

Unwanted Fish – Not desirable from a fisheries management, ecological or angling perspective.

10. ABBREVIATIONS

AIS – aquatic invasive species
ANSTF – Aquatic Nuisance Species Task Force
CBP – Chesapeake Bay Program
CIM – continuous instream monitoring
eDNA – environmental deoxyribonucleic acid
EFL – East Fish Lift
FEMA – Federal Emergency Management Agency
IAP – incident action plan
ICS – Incident Command System
MAPAIS – Mid Atlantic Panel on Aquatic Invasive Species
MBSS – Maryland Biological Stream Survey
MDE – Maryland Department of the Environment
MDNR – Maryland Department of Natural Resources
NGO – non-governmental organization
NOAA – National Oceanic and Atmospheric Administration
NYSDEC – New York State Department of Environmental Conservation
PADEP – Pennsylvania Department of Environmental Protection
PFBC – Pennsylvania Fish and Boat Commission
RM – river mile
SRAFRC – Susquehanna River Anadromous Fish Restoration Cooperative
SRB – Susquehanna River Basin
SRBC – Susquehanna River Basin Commission
UC – unified command
USFWS – U.S. Fish and Wildlife Service
WFL – West Fish Lift
YOY – young-of-year

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12. APPENDIX A – COMPILATION OF REGULATIONS AND AUTHORITIES TO MANAGE AIS BY JURISDICTION

Below is a list of the primary federal, regional, and state laws and authorities that support this plan and its associated actions.

12.1. Federal:

Federal Laws:

- Nonindigenous Aquatic Nuisance Prevention and Control Act (1990)
  - Act to prevent and control infestations of the coastal inland waters of the United States by the Zebra Mussel and other nonindigenous aquatic nuisance species, to reauthorize the National Sea Grant College Program, and for other purposes.
- National Invasive Species Act (1996)
  - Amends the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 to mandate regulations to prevent the introduction and spread of aquatic nuisance species into the Great Lakes through ballast water.
- Lacey Act
  - Wildlife law that prohibits importation of listed species. Bighead Carp, Black Carp, Silver Carp, and all snakehead species (family Channidae) listed as injurious under the Lacey Act thereby prohibiting their importation.
- Executive Order 13112
  - Executive Order 13112 of February 3, 1999 (Invasive Species), called upon executive departments and agencies to take steps to prevent the introduction and spread of invasive species, and to support efforts to eradicate and control invasive species that are established.

Federal Authorities:

- United States Fish and Wildlife Service (USFWS)
  - Mission is to work with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. USFWS addresses invasive species issues through a variety of programs and partnerships, develops regulations to prohibit the importation and some transport of harmful species known as injurious wildlife, and serves as a co-chair to the Aquatic Nuisance Species Task Force.
- National Oceanographic and Atmospheric Administration (NOAA)
  - Mission is to understand and predict our changing environment, from the deep sea to outer space, and to manage and conserve America's coastal and marine resources. NOAA has responsibility for prevention, monitoring, control, education, and research to prevent future introductions and the spread of aquatic invasive species, and co-chairs the Aquatic Nuisance Species Task Force.
- United States Army Corps of Engineers (USACE)

- USACE is the steward of 12 million acres of public lands and waters at hundreds of water resources projects nationwide. To manage the threat of invasive species, USACE employs the latest economically efficient technologies and research; and biological, mechanical, and chemical control methods. USACE also stays on the leading edge of invasive species management by developing new pest control techniques through its Aquatic Nuisance Species Research Program and Aquatic Plant Control Research Program.

- United States Geological Survey (USGS)
  - USGS maintains the Nonindigenous Aquatic Species (NAS) information resource, which is a central repository for spatially referenced biogeographical accounts of introduced species in the United States. USGS also conducts research on invasive species.
- Environmental Protection Agency (EPA)
  - Mission of EPA is to protect human health and the environment. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) is the principal law that authorizes EPA to regulate the manufacture, distribution, sale, and use of pesticides in the United States including rotenone, a piscicide used in several invasive fish eradication attempts.
- Aquatic Nuisance Species Task Force (ANSTF)
  - Intergovernmental organization dedicated to preventing and controlling aquatic nuisance species as authorized by the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990.

12.2. Regional:

- Mid-Atlantic Panel on Aquatic Invasive Species (MAPAIS)
  - One of six regional panels administered by the Aquatic Nuisance Species Task Force. Formed in 2003 through the efforts of the Chesapeake Bay Program's Invasive Species Workgroup, the MAPAIS mission is to assist state and federal agencies, and other stakeholders, in developing and implementing strategic, coordinated, action-oriented approaches to prevent and control aquatic invasive species in the Mid-Atlantic region.
- Chesapeake Bay Program (CBP)
  - Regional partnership that has led and directed the restoration of the Chesapeake Bay since 1983 and is involved in a variety of efforts to prevent, identify, and control aquatic invasive species.
- Susquehanna River Basin Commission (SRBC)
  - Interstate (Maryland, Pennsylvania, New York) agency with mission to enhance public welfare through comprehensive planning, water supply allocation, and management of the water resources of the Susquehanna River Basin.
- Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC)

- SRAFRC is an organization comprised of fishery agencies from the three basin states, the SRBC, and the federal government working together to restore self-sustaining anadromous fishery resources and their habitats to the Susquehanna River Basin.

12.3. Maryland:

Maryland Laws and Regulations:

The fines/penalties listed below were effective March 31, 2023. These amounts are updated yearly and subject to change.

- *08.02.19.03*
  - A person may not introduce into State waters any transgenic aquatic organism. Penalties for breaking these laws include fines ranging from $750 to $25,000 and up to 30 days imprisonment.
- *08.02.19.04A(1)*
  - A person may not import, transport, purchase, possess, propagate, sell, or release into State waters the following nonnative aquatic organisms (including but not limited to Alabama Bass, Spotted Bass, Bighead Carp, Silver Carp, Black Carp, Grass Carp, and round goby). Penalties for breaking these laws include fines ranging from $750 to $25,000 and up to 30 days imprisonment.
- *08.02.19.04B(1)*
  - A person may not transport the following nonnative aquatic organisms (Blue Catfish and Flathead Catfish are the most relevant species from this section). Penalties for breaking these laws include fines ranging from $750 to $25,000 and up to 30 days imprisonment.
- *08.02.19.06*
  - A person may not import, transport, or introduce into the State any live fish or viable eggs of snakehead fish of the Family Channidae. A person may not sell or breed live snakehead fish of the Family Channidae in the State. A person may not possess the viable eggs or live snakehead fish of the species blotched snakehead or Northern Snakehead. An individual may only possess a snakehead if, immediately upon capture, the snakehead is killed. Penalties for breaking these laws include fines ranging from $250 to $25,000, up to 1 year imprisonment, and up to 1-year recreational fishing suspension (08.02.13.05).
- Snakehead and invasive catfish harvest regulations
  - There is no minimum size or creel limit for snakeheads (08.02.11.04N(2)) or invasive catfish (08.02.11.04A(1)(c); 08.02.11.04A(2)(k)) in non-tidal waters or tidal waters. Snakeheads are the only fish species in non-tidal waters that can have their head and/or tail removed at a fishing location (08.02.11.04J(3)). They can be targeted in both non-tidal and tidal waters with hook and line, dip nets (in in areas of the Potomac River, Monocacy River and Conococheague Creek that lie within Allegany, Carroll, Frederick

and Washington counties), bow, gig, spear, spear gun, hand and noodling, and jugs (tidal only) (08.02.25.03; 08.02.25.03).
    - In Maryland, there are no commercial size or season limits for snakeheads or invasive catfish in the Chesapeake Bay and its tidal tributaries. There are also specific commercial fishing licenses for Northern Snakehead Bowfishing (08.02.25.05) and Invasive Catfish Finfish Trotline (08.02.25.06).

Maryland Authorities:

- Maryland Department of Natural Resources (MDNR)
    - Maryland's aquatic invasive species laws are implemented primarily through the MDNR. The MDNR has unified authority to address all invasion pathways and all types of organisms, except for the horticulture industry, which is regulated by the Maryland Department of Agriculture.
- Other state authorities listed in Maryland Aquatic Nuisance Species Management Plan
    - Maryland Department of Agriculture (MDA)
    - Maryland Department of the Environment (MDE)
    - Maryland Department of Transportation Port Administration (MPA)
    - Maryland Sea Grant

12.4. Pennsylvania:

Pennsylvania Laws and Regulations:

- Title 30 Pa. Code Chapter 3, section 321
    - Authority is given to the Pennsylvania Fish and Boat Commission (PFBC) over regulation of "fish" in the Commonwealth. Note that in Pennsylvania, the legal definition of fish (as per Title 30 Pa. Code, Section 102) is "When used as a noun, includes all game fish, fish bait, bait fish, amphibians, reptiles and aquatic organisms."
- Title 58 Pa. Code Chapter 71a
    - It is unlawful to propagate Grass Carp, diploid or triploid, in this Commonwealth.
    - The introduction or importation of Grass Carp into this Commonwealth or waters of this Commonwealth is prohibited, except that triploid Grass Carp may be introduced as provided in § 71a.10 (relating to triploid Grass Carp).
    - A genetically modified fish may not be propagated and introduced into waters of this Commonwealth, without prior written approval from the Commission.
    - No person may introduce any species of fish into waters of this Commonwealth (except baited on a hook for angling purposes) without prior submission of a Notice of Stocking to the Commission. For the purposes of this subsection, ''waters of this Commonwealth'' does not include waters contained within a property or premise of a propagation or dealer facility licensed under 3 Pa.C.S. §§ 4201—4223 (relating to Aquacultural Development Law). Persons who notify the Commission of an intent to stock fish through a Notice of Stocking should also ensure that fish intending to be stocked are limited to those listed on the Notice of Stocking and the Commission's Species by Watershed Approved for

Open System (Flow Through) Propagation and Introductions list. An electronic or hard copy of the Notice of Stocking shall be present at the location during the time fish are stocked. In the event the person(s) who filed a Notice of Stocking is not present during the time of stocking, an entity stocking fish on behalf of the authorized person shall possess a copy of the Notice of Stocking.

- In addition to the Notice of Stocking requirement, species of fish may not be transported into this Commonwealth from another state, province or country and liberated in a watershed of this Commonwealth without previous written permission from the Commission, nor may a species of fish be transferred from waters in this Commonwealth into another drainage of this Commonwealth where this particular species is not always present without prior written consent from the Commission. Inspection for species composition or presence of disease, or both, will be required at the discretion of the Commission on all lots of fish transported into this Commonwealth. Written permission from the Commission may be obtained by sending a request to the Executive Director, P.O. Box 67000, Harrisburg, Pennsylvania 17106
- It is unlawful to introduce, import, possess or transport in or through this Commonwealth, or the waters of this Commonwealth, the following species:
  (1) Snakeheads (all species).
  (2) Black Carp (*Mylopharyngodon piceus*).
  (3) Bighead Carp (*Hypophthalmichtys nobilis*).
  (4) Silver Carp (*Hypophthalmichtys molitrix*).
  (5) Zebra mussel (*Dreissena polymorpha*).
  (6) Quagga mussel (*Dreissena rostriformis bugensis).*
  (7) Round goby (Neogobius *melanostomus*).
  (8) Freshwater tubenose goby (*Proterorhinus semilunaris*).
  (9) European rudd (*Scardinius erythrophthalmus*).
  (10) Crayfish (all live species), except when any of the following apply:
    (i) Possessed and used as bait on, in or about the water from which taken.
    (ii) Possessed or imported for testing and scientific purposes or restaurant consumption, adequate measures have been taken to prevent their escape, and they are accompanied by documentation stating the point of origin and the destination to which they are to be delivered.
    (iii) Dead with the head removed or salted and dried for angling purposes.
  (11) Ruffe (*Gymnocephalus cernua*).

  (b) Exceptions. Species in subsection (a)(1)—(4) may be possessed in this Commonwealth for the purposes of consumption or slaughter only. Other exceptions for species in subsection (a) shall require prior written approval from the Commission's Executive Director.
- A person may not release or dispose live bait fish into any water of this Commonwealth, except live bait fish baited on a hook for angling purposes, without prior submission of a Notice of Stocking to the Commission. A person

may collect live bait fish for angling. A species of bait fish collected for use as bait may not be transferred from waters in this Commonwealth into another drainage of this Commonwealth where this particular species does not already exist. This subsection does not apply to the Commission, or a propagation facility licensed by the Department under 3 Pa.C.S. §§ 4201—4223 (relating to Aquaculture Development Law) for the purpose of releasing bait fish into waters of this Commonwealth as food for aquaculture or fisheries management purposes.

- Live bait fish imported and intended for introduction into waters of this Commonwealth shall be in compliance with § 71a.6 (relating to fish health certificate requirements).
- This subsection does not apply to dead bait fish (salted or frozen) sold for angling purposes outside the Lake Erie watershed. The provisions of § 71a.7 (relating to introduction or transportation of VHS-susceptible species of fish) shall be adhered to for purposes of this section.

- Title 58 Pa. Code § 63.8
  - Snakehead, carp, suckers and catfish may be taken with long bows and arrow, including compound bows, crossbows, spears or gigs any hour of the day or night aided by a light at night if so desired, in Commonwealth waters with additional restrictions.

<u>Pennsylvania Authorities:</u>

- Pennsylvania Fish and Boat Commission
  - The PFBC is charged with ensuring the protection, propagation, and distribution of game fish, fish bait, baitfish, amphibians, reptiles, and aquatic organisms and managing recreational boating and fishing in the Commonwealth of Pennsylvania. The agency's legislatively mandated jurisdiction over aquatic organisms includes most AIS, which are considered a major threat to the aquatic resources of Pennsylvania.
- Other state authorities listed in Pennsylvania Aquatic Invasive Species Management Plan
  - Pennsylvania Department of Agriculture (PDA)
    - PDA oversees registering aquaculture dealers and propagators (including live bait dealers) with some degree of guidance/joint regulation by the PFBC.
  - Pennsylvania Department of Conservation and Natural Resources (DCNR)
    - DCNR has jurisdiction over the management of AIS that occur in State Parks and State Forests
  - Pennsylvania Department of Environmental Protection (DEP)
  - Pennsylvania Department of Health (DOH)
  - Pennsylvania Department of Transportation (PennDOT)
  - Pennsylvania Game Commission (PGC)
  - Pennsylvania Sea Grant

12.5. New York:

New York Laws and Regulations:

- New York State Environmental Conservation Law – ECL § 3-0301
    - Required the New Yor State Department of Environmental Conservation (NYSDEC) to develop an AIS management plan. In 1994, the ANSTF approved New York State's AIS Management Plan, making it the first such state plan approved.
- Chapter 234, Laws of New York State, 2003
    - Required the formation of a task force to explore the invasive species issue in New York State and to provide recommendations to the Governor and the Legislature. The statute directed this Invasive Species Task Force (ISTF) to be co-led by the NYSDEC and the Department of Agriculture and Markets (NYSDAM).
- ECL § 9-1709
    - Established the New York Invasive Species Council (NYISC), a nine-member body co-led by NYSDEC and NYSDAM, and the New York Invasive Species Advisory Committee (ISAC). This law also called for NYSDEC to take specific actions, including establishing, operating, and maintaining statewide invasive species databases and clearinghouses; coordinating state agency and public authority actions to phase out use of invasive species; expand use of native species; promote use of native species; prohibit and actively eliminate invasive species at sites funded or regulated by the state; and, in collaboration with NYISC, aid in the review and reform of regulatory processes to remove unnecessary impediments to the restoration of invaded ecosystems.
- 6 NYCRR § 180.9
    - Lists non-native fish that may not be imported, possessed, bought or sold except under permit issued by the Department. Species included are invasive carp (Bighead, Silver and Black Carp) and 27 different species of snakehead fish.
- 6 CRR-NY 575.3
    - No person shall knowingly possess with the intent to sell, import, purchase, transport, or introduce any prohibited invasive species including but not limited to Northern Snakehead, Silver Carp, Bighead Carp, Black Carp.
- 6 NYCRR 10.1 (c)(6)
    - Any snakehead fish, as defined in section 180.9(b)(1)(iv) of this Title, caught while angling shall not be returned to the water, and shall be immediately euthanized and reported to DEC.

New York Authorities:

- New York State Department of Environmental Conservation

    - Developed Aquatic Invasive Species Management Plan, developed Rapid Response Framework for Invasive Species, and responsible for adopting regulations pertaining to aquatic invasive species.
- Other state authorities listed in New York State Aquatic Invasive Species Management Plan
    - New York Invasive Species Council (NYISC)
    - Invasive Species Advisory Committee (ISAC)
    - New York State Department of Agriculture and Markets (NYSDAM)
    - Department of State (DOS)
    - Adirondack Park Agency (APA)
    - New York State Department of Transportation (NYSDOT)
    - Office of Parks, Recreation, and Historic Preservation (OPRHP)
    - New York State Canal Corporation (NYSCC)
    - New York City Department of Environmental Protection (NYCDEP)

13. APPENDIX B – SUSQUEHANNA RIVER INVASIVE FISH SPECIES RAPID RESPONSE PLAN

13.1. Executive Summary

This rapid response plan for the invasive fish species is designed to assist resource agencies with inter-agency communication when a new invasive fish infestation is detected in the Susquehanna River Basin. The quick and accurate dissemination of information is critical for preventing and mitigating the spread of priority invasive fish species identified in this plan within the Susquehanna River. This plan incorporates each of the existing Susquehanna River Basin state aquatic invasive species rapid response plans into a framework that facilitates both the inclusion of additional intra-basin resource agencies and the cooperation between all the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) agencies. Included is a decision tree that provides guidance for what to do when a new invasive fish infestation is reported in the basin, as well as a section with detailed descriptions for each action.

13.2. Introduction

The SRAFRC has been working to restore migratory fish to the Susquehanna River Basin since the 1960s. The cooperative consists of three state agencies (the Maryland Department of Natural Resources (MDNR), the Pennsylvania Fish and Boat Commission (PFBC), and the New York State Department of Environmental Conservation (NYSDEC)), one federal-interstate compact commission (the Susquehanna River Basin Commission (SRBC)), and two federal agencies (the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) Fisheries)). A key component of the current migratory fish restoration plan (SRAFRC 2010) is to provide safe, timely, and effective fish passage at the hydroelectric dams in the lower Susquehanna River. Nearly all available spawning and nursery habitat for migratory fish in the Susquehanna River occurs upstream of these dams; therefore, it is critical to provide upstream fish passage to support migratory fish restoration.

Beginning in 2017, the threat of spreading invasive fish species through fish lifts at the hydroelectric dams became a concern to SRAFRC when a single Northern Snakehead (*Channa argus*) was passed upstream at Conowingo Dam. Growth and expansion of both Northern Snakehead and Blue Catfish (*Ictalurus furcatus*) populations in the Chesapeake Bay and downstream of Conowingo Dam have prompted SRAFRC, in cooperation with the hydroelectric companies, to modify operations of the fish passage facilities to continue to support migratory fish restoration while precluding the spread of invasive fish species through the fish lifts on the lower Susquehanna River. In 2023, SRAFRC developed the Priority Invasive Fish Species Action Plan for the Susquehanna River Basin to provide a suite of actions that can be taken to reduce the likelihood that the Susquehanna River will be further colonized by invasive fish species. To supplement that plan, this rapid response plan was created as an inter-agency decision support tool designed to aid the SRAFRC agencies in responding to new invasive fish infestations.

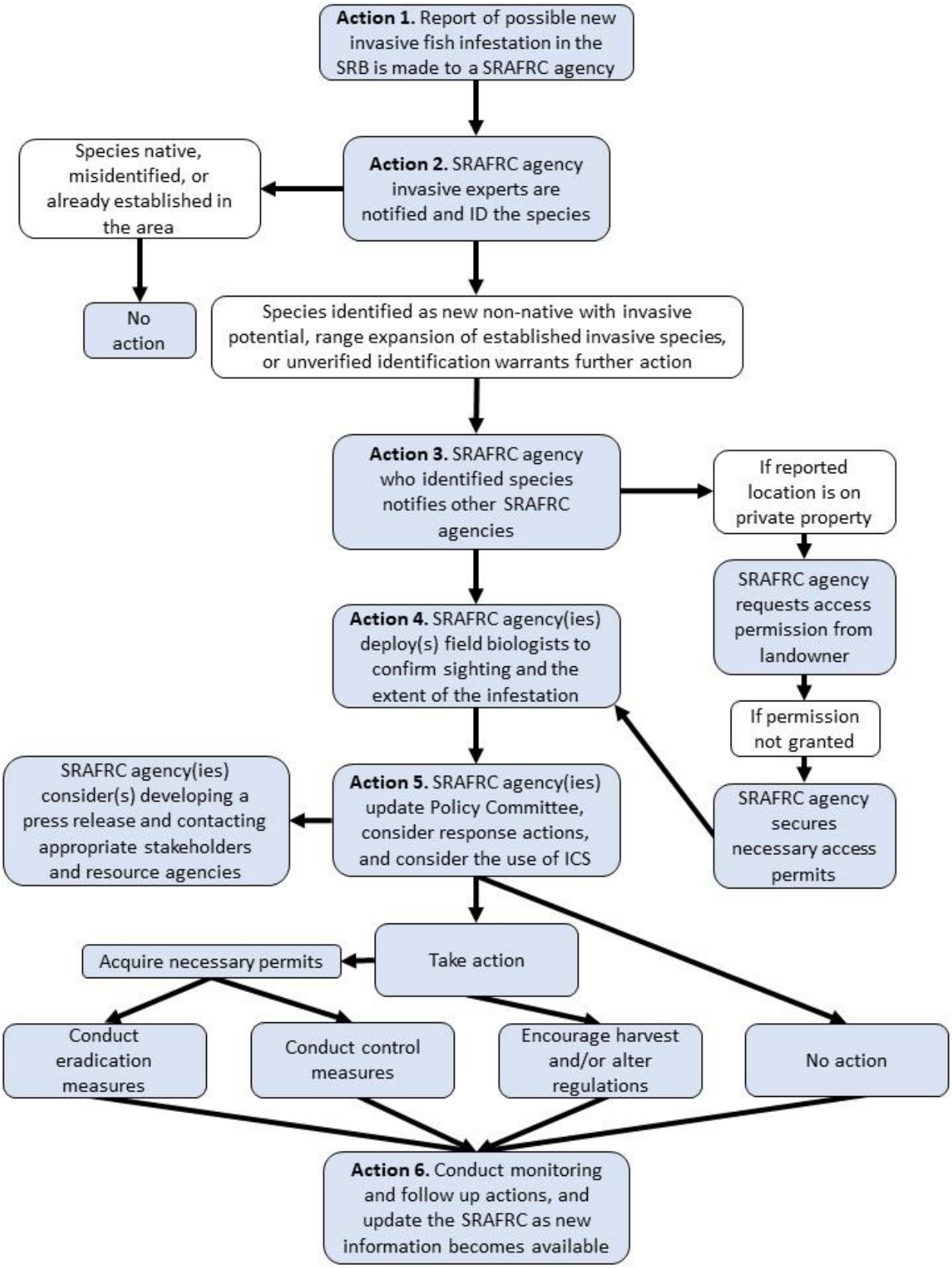
The National Invasive Species Council defines rapid response as “a systematic effort to eradicate, contain, or control a potentially invasive non-native species introduced into an ecosystem while the infestation of that ecosystem is still localized.” While each state in the basin already has their own rapid response plan for aquatic invasive species, a plan specific to

the Susquehanna River Basin is necessary due to both the interconnectivity of the system, and the several non-state resource agencies who help cooperatively manage the basin's resources. Although the framework of this rapid response plan is not identical to any of the state plans, this rapid response plan was constructed in a way that each state can still follow their own rapid response plan without straying from the one presented here. The exceptions are that this rapid response plan includes the action of specifically notifying the other SRAFRC agencies and hydroelectric companies at various points throughout the process to encourage inter-agency cooperation. This plan is also different from the state plans in that it is specific to priority invasive fish species identified in this plan, as opposed to all potential aquatic invasive species.

13.3 Procedure

The Susquehanna River Basin Rapid Response Plan is designed in a way that allows each state to follow their own rapid response plan prior to determining whether there is a verified threat of a new invasive fish infestation in the Susquehanna River Basin. While responding to new invasive fish infestations in the basin will often require input and resources from several agencies, not every report of a suspected infestation warrants multi-agency collaborations. Similarly, not all infestations warrant the same level of response. The decision tree below outlines the necessary steps and actions required for the successful management of new invasive fish infestations. Each action is arranged chronologically, with a following section describing each action in greater detail.

Should an infestation occur that threatens the entire basin, the Incident Command System (ICS) structure may be appropriate for the incident. The ICS was originally developed by the U.S. Forest Service and has been adopted by several state and federal agencies as a standardized approach for responding to natural disasters. All three state rapid response plans include ICS as a tool, with Maryland's plan using ICS as its primary framework and Pennsylvania and New York encouraging the use of ICS to respond to scenarios that may benefit from a highly coordinated and structured format. Ultimately, whether ICS is used may come down to the jurisdiction of the verified infestation and the potential severity of the infestation. For more information about ICS see the Supplemental Information at the end of this document.


Action 1. Report of possible new invasive fish infestation in the SRB is made to a SRAFRC agency
Action 2. SRAFRC agency invasive experts are notified and ID the species
Species native, misidentified, or already established in the area
No action
Species identified as new non-native with invasive potential, range expansion of established invasive species, or unverified identification warrants further action
Action 3. SRAFRC agency who identified species notifies other SRAFRC agencies
If reported location is on private property
SRAFRC agency requests access permission from landowner
If permission not granted
SRAFRC agency secures necessary access permits
Action 4. SRAFRC agency(ies) deploy(s) field biologists to confirm sighting and the extent of the infestation
Action 5. SRAFRC agency(ies) update Policy Committee, consider response actions, and consider the use of ICS
SRAFRC agency(ies) consider(s) developing a press release and contacting appropriate stakeholders and resource agencies
Take action
Acquire necessary permits
Conduct eradication measures
Conduct control measures
Encourage harvest and/or alter regulations
No action
Action 6. Conduct monitoring and follow up actions, and update the SRAFRC as new information becomes available

13.4 Actions

Action 1. Report of possible new invasive fish infestation in the Susquehanna River Basin made to a SRAFRC agency

There are several ways in which a new invasive fish infestation could be discovered in the Susquehanna River Basin. These infestations are most likely to be discovered either in-person, such as by an angler or field biologist, or through a social media post by someone who encountered an invasive fish species. Regardless of how the potential infestation is discovered, it is important that it is immediately reported through one of the state agency reporting websites (Maryland's Invasive Species Tracker, the Pennsylvania Fish and Boat Commission Aquatic Invasive Species Reporting Form, or New York's Invasive Species Report Form). As much detail as possible should be included in the report, such as the latitude and longitude (if possible), directions to the capture location, photos of the specimen from different angles with a reference item for scale, and photos of the immediate environment from which the specimen was collected. If a report is received by a resource agency that is not the authority responsible for that taxon, all relevant information should be immediately forwarded to the appropriate agency.

Action 2. SRAFRC agency invasive experts are notified and identify the species

After a report is received, it should be quickly forwarded to the respective invasive species experts within the agency. The agency experts will then determine if the report is credible and if further action is necessary. This step typically involves having multiple experts confirm the correct identification of the fish and interviewing the person who made the report to confirm the legitimacy of the report. When possible, the specimen should be retained for physical, and potentially genetic, identification, but care should be taken to ensure that state regulations regarding the live transport or possession of an invasive species are not violated. If the potential invasive fish species has not previously been found in the region, existing information about the species should be collected through literature searches and correspondence with experts so that its invasive potential can be evaluated. Further action by the resource agency would not be required if the species is determined to be native to the basin, already known to be in the area from which it was reported, or if it is determined that the species would not be able to survive in the location's climate.

Action 3. SRAFRC agency who identified species notifies other SRAFRC agencies

If the species is determined to be a new non-native with invasive potential or a noteworthy range expansion of an established invasive fish species, then the other SRAFRC agencies should be notified (as well as other relevant agency contacts such as law enforcement). The SRAFRC agency who received the report should plan to inform the rest of the SRAFRC of how they intend to assess the severity of the infestation. A general time frame of the investigation should also be provided so that other agencies can be prepared to act quickly depending on its results. This step can often be completed over email for the sake of brevity; however, if the infestation is deemed severe enough, an emergency SRAFRC meeting may need to be scheduled. This would be the ideal time for said SRAFRC agency to request assistance from other agencies to help with the assessment if needed. If the location of the report is on private property, then the agency will need to request access from the respective landowner, as well as secure the

necessary permits if permission is not granted. At this point, consideration should also be made as to whether a press release should be made once the extent of the infestation is determined.

Susquehanna River Anadromous Fish Restoration Cooperative Agency Contact Information

Agency	Level	Name	Email	Phone
Maryland Dept. of Natural Res.	Policy	Tony Prochaska	tony.prochaska@maryland.gov	410-375-5219
	Technical	Matt Jargowsky	matthew.jargowsky@maryland.gov	609-602-7922
New York State Dept. of Env. Cons.	Policy	Steve Hurst	steve.hurst@dec.ny.gov	518-402-8920
	Technical	Emily Zollweg-Horan	emily.zollweg-horan@dec.ny.gov	607-753-3095
NOAA Fisheries	Policy	Karen Greene	karen.greene@noaa.gov	978-559-9871
	Technical	Jonathan Watson	jonathan.watson@noaa.gov	978-675-2180
Pennsylvania Fish and Boat Comm.	Policy	Kris Kuhn	kkuhn@pa.gov	814-359-5115
	Technical	Sean Hartzell	sehartzell@pa.gov	814-359-5163
Susquehanna River Basin Comm.	Policy	Drew Dehoff	adehoff@srbc.gov	717-770-0954
	Technical	Aaron Henning	ahenning@srbc.net	717-884-5937
U.S. Fish and Wildlife Serv.	Policy	Rick Jacobson	rick_jacobson@fws.gov	413-468-0523
	Technical	Sheila Eyler	sheila_eyler@fws.gov	717-387-2117

Action 4. SRAFRC agency(ies) deploy(s) field biologists to confirm sighting and determine the extent of the infestation

Once the report has been verified, and the rest of the SRAFRC agencies have been briefed, a site assessment should be performed to determine the extent and possible source of the infestation. Depending on the severity of the infestation, this site assessment may include additional SRAFRC agencies working in collaboration to evaluate the site as quickly as possible. It is important to determine how abundant the invasive fish is at the site, if the infestation extends beyond the initial reported site, if multiple year-classes are present (which would indicate that spawning is likely occurring), and if there is a need for law enforcement action. The site itself must also be assessed to properly evaluate what types of rapid response measures are possible and most likely to be effective. It should be determined if containment at the site is possible and to assess the risk of the species spreading from the current site to other areas of the basin. Additional site considerations should include the potential environmental, economic, and human health risks if the invasive fish species were to proliferate in the area or if the site were to be quarantined or treated with piscicides.

Action 5. SRAFRC agency(ies) update Policy Committee, consider response actions, and consider the use of ICS

Following the site assessment, the SRAFRC agency(ies) that conducted the assessment should update the SRAFRC Policy Committee and response actions should be considered. Depending

on the severity and extent of the infestation, this can either be done over email with an update given at the next Policy Committee meeting or at an emergency meeting. The hydroelectric companies should also be informed of the status of the infestation at this step, particularly if the infestation is likely to impact fish passage operations in anyway. Similarly, the relevant law enforcement agencies should also be notified at this step if there is the potential that anglers could encounter the species. Potential immediate response actions include limiting the further expansion of the invasive fish through creating or maintaining barriers, removing fish through capture methods (electrofishing, nets, fish lifts, etc.), piscicides, or draining (see the Priority Invasive Fish Species Action Plan for the Susquehanna River Basin for a more detailed list of response actions).

If a press release is deemed to be appropriate, now would also be the time to release it. Outreach and education play critical roles in the control and monitoring of new invasive fish infestations, so resources dedicated to these efforts should be prioritized. Furthermore, if extirpation is deemed improbable given the status of the infestation, methods for controlling the spread, such as encouraging harvest and either creating new regulations or strengthening existing regulations to prevent the public from further spreading the invasive should be explored. Incidence of new invasive fish should be reported to the United States Geological Survey's online Sighting Report Form by the lead SRAFRC agency at this time.

The use of ICS should also be considered if it is not already in use. See the Supplemental Information to this plan for more information. Whether or not the basin states and federal agencies act as a Unified Commander (UC) or if one state acts as the Incident Commander (IC), and the other states act as advisors, will depend on the severity and location of the infestation (See Appendix C in Rapid Response Planning for Aquatic Invasive Species – a Maryland Example). The advantage of using ICS and having a SRAFRC UC is that the invasive fish infestation would be dealt with at a basin-wide level and resources dedicated to the eradication or containment of the infestation would likely be better allocated to areas where they could make the greatest impacts. The primary disadvantage of this method is that each state and agency is likely to have different levels of investment with regards to new invasive fish infestations and having a SRAFRC UC would likely slow the response process due to logistical issues. It may make most sense to have a state-level IC when the infestation is a range expansion into a new state (such as Northern Snakehead being reported past Holtwood Dam), whereas a SRAFRC UC may make sense if a new invasive fish species of concern is introduced to the basin in an area where it is likely to spread (such as invasive carp being found upriver of Safe Harbor Dam).

Action 6. Conduct monitoring and follow up actions, and update the SRAFRC PC as new information becomes available

Regardless of the chosen course of action, it is important that the potential infestation continues to be monitored by the respective SRAFRC agency(ies), with updates provided to the rest of the SRAFRC agencies as they become available. Additionally, the success of the chosen response actions taken to control/eradicate the infestation should be evaluated and modifications to protocols should be made, where needed, so that future response actions to

new infestations can be more effective. The hydroelectric companies and law enforcement agencies should also continue to be updated as it relates to fish passage operations and potential angler interactions, respectively. If the status of the infestation changes, it is likely that Action 5 would need to be repeated. Furthermore, if the new invasive fish infestation significantly alters how invasive fishes are managed in the basin, the SRAFRC Priority Invasive Fish Species Action Plan for the Susquehanna River Basin should be updated.

13.5. Example of Conowingo Pond Northern Snakehead Rapid Response

Agency lead: Pennsylvania Fish and Boat Commission Bureau of Fisheries

Background:

During Spring 2020, 21 Northern Snakehead were inadvertently passed over the Conowingo Dam during fish lift operations to facilitate passage of native migratory fish species. Prior to this, Northern Snakehead were not known to be present in the Conowingo Pond, besides a single individual that passed in 2017.

Phase 1: Removal– physical collections and public relations

- During May and June 2020, Pennsylvania Fish and Boat Commission staff and partners, including staff from the Susquehanna River Basin Commission (SRBC) conducted intensive electrofishing surveys in the Conowingo Pond to intercept Northern Snakehead. A total of six fish were captured and removed.
- In May 2020, a press release (copied below) was made asking for the public's help in containment and eradication of Northern Snakehead at the Susquehanna River in Conowingo Pond. The public was encouraged to contact the PFBC for any sightings or captures. Anglers were asked to kill any Northern Snakehead captured and not to release them and were reminded that possession, transport, or importation of live Northern Snakehead is illegal in Pennsylvania and Maryland. The press release also directed readers to information on identification and other resources. One angler report was received of a captured Northern Snakehead in the Conowingo Pond.

Phase 2: Monitoring and public relations

- In June 2020, PFBC staff and partners, including SRBC and MDNR, shifted to non-targeted work in the Conowingo Pond and lower Susquehanna River Basin to focus on other management objectives, but that would yield additional, incidental survey effort for Northern Snakehead. This included electrofishing surveys targeting the imperiled Chesapeake Logperch and surveys for black bass species. No Northern Snakehead were captured during these efforts.
- Beginning annually in 2019, SRBC staff began surveillance activities for Northern Snakehead and Blue Catfish throughout the lower Susquehanna River in collaboration with U.S. Fish and Wildlife Service.

- During Summer 2023, in response to angler reports of Northern Snakehead in the Conowingo Pond, the PFBC and partner agencies began again focusing on targeted monitoring efforts for Northern Snakehead by electrofishing surveys in the Conowingo Pond and select areas upstream of Holtwood Dam. The PFBC and partner agencies collected multiple Northern Snakehead in the Conowingo Pond, including multiple size classes and young-of-year fish, indicating an establishing population. No Northern Snakeheads were captured or observed upstream from Holtwood Dam.
- In August 2023, the PFBC issued a press release (copied below) alerting the public on the confirmed reproduction of Northern Snakehead in the Conowingo Pond to spread awareness and encourage angler harvest and reporting, as well as emphasize the impacts of this invasive species and the implications of illicit stocking. Additionally, the PFBC installed signs with similar messaging at fishing and boating access areas along the lower Susquehanna River.

Press Releases:

ANGLERS URGED TO REPORT, DISPOSE OF INVASIVE NORTHERN SNAKEHEADS IF CAUGHT IN LOWER SUSQUEHANNA RIVER

05/22/2020

HARRISBURG, Pa. (May 22) — The Pennsylvania Fish and Boat Commission (PFBC) is urging anglers to report and dispose of any invasive Northern Snakehead fish that may be caught in the lower Susquehanna River.

This advisory follows the documented movement of 21 Northern Snakeheads past the Conowingo Dam into the Conowingo Pool, a 14-mile-long section of the Susquehanna River located between the Conowingo Dam in Maryland and the Holtwood Dam in Pennsylvania. Fisheries management of this river section is shared between the PFBC and Maryland Department of Natural Resources.

(Pictured: PFBC Non-Game Fisheries Biologist Doug Fischer holds a Northern Snakehead collected from the Conowingo Pool in the Lower Susquehanna River on May 21, 2020)

In late March, operators of the fish passage systems used at the Conowingo, Holtwood, and Safe Harbor dams to assist migrating American Shad during their spring spawning runs indicated that due to restrictions associated with COVID-19, fish passage operations had been delayed from the original start date of April 1.

Fish passage operations commenced on the afternoon of May 12 at Conowingo Dam's east fish lift. Historically by this date, nearly 70% of the annual American Shad spawning migration would have already passed Conowingo Dam during a typical spring. Over the course of four days, lift operators observed 35 Northern Snakeheads within the east fish lift; 14 of the invasive fish were able to be netted and removed, while another 21 entered the Conowingo Pool. During this same time, only 485 American Shad were counted at the east fish lift. Due to the concern over increased invasive species passage and the lateness of the season for successful American Shad passage, the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) recommended that fish passage operations be immediately ceased to prevent further passage of snakeheads. Fish passage operations at the Holtwood and Safe Harbor dams upriver were also ceased immediately, although no snakeheads were observed at either location. During two days of operations, 21 American Shad passed the Holtwood Dam, while one shad was observed passing the Safe Harbor Dam fish lift.

"Further introduction of an invasive species such as the Northern Snakehead to the Susquehanna River watershed in Pennsylvania is something we take very seriously," said Joshua Tryninewski, Fisheries Biologist with the PFBC's Anadromous Fish Restoration Unit. "Unfortunately, a late start to fish passage operations followed by an increasing occurrence of the unwanted fish presented unfavorable conditions for successful shad passage and have posed a serious threat to the Commonwealth's aquatic resources."

Northern Snakeheads, native to parts of China, Russia, and Korea, first drew attention in the mid-Atlantic region in 2002 when a pair were discovered in a Maryland pond. Snakeheads were first confirmed in Pennsylvania in July 2004 in Meadow Lake, Philadelphia County, and are present in the connecting lower Schuylkill and Delaware rivers. In summer 2018, anglers began catching snakeheads in Octoraro Creek in Lancaster County, a tributary that enters the Susquehanna River below the Conowingo Dam; however, snakeheads are not known to occur in the upper Octoraro Creek Basin above the dam at Pine Grove. In September 2019, an angler reported catching of a single snakehead in the Monongahela River near Braddock, PA, and the specimen was verified by PFBC biologists.

In response to the known presence of Northern Snakeheads in the Conowingo Pool, the PFBC began conducting surveillance operations utilizing boat electrofishing to locate and remove snakeheads. On May 21, while targeting likely habitat areas for the species, the PFBC successfully located and removed one snakehead from the river. In addition, a private environmental consulting firm which had been conducting an unrelated survey on the same section of the river also collected one snakehead and provided the specimen to the PFBC.

“Moving forward, biologists will combine other ongoing survey work targeting other species within the lower Susquehanna River to serve the dual purpose of searching for and removing snakeheads in the Conowingo Pond and its tributaries,” said Kris Kuhn, Director of the PFBC Bureau of Fisheries. “Anglers also play a critical role in controlling the spread of the invasive species and we’re counting on their cooperation.”

Anglers are reminded that possession, transport, and importation of a live snakehead is unlawful in both Pennsylvania and Maryland. Any of these invasive fish that are caught should be killed and disposed of properly or consumed. Anglers who suspect they have caught a snakehead are encouraged to NOT release it, and report it to the PFBC at (610) 847-2442 or by sending an email to tgrabowski@pa.gov.

For more information on Northern Snakeheads in Pennsylvania, including an identification guide, visit the PFBC snakehead resource page on our website.

PFBC DOCUMENTS INVASIVE SNAKEHEAD FISH REPRODUCTION IN LOWER SUSQUEHANNA RIVER, ADVISES ANGLERS TO REPORT AND DISPOSE OF ANY FISH CAUGHT

08/02/2023

HARRISBURG, Pa. (August 2) – The Pennsylvania Fish and Boat Commission (PFBC) today issued a strong advisory to encourage anglers who catch invasive Northern Snakeheads in the lower Susquehanna River, and elsewhere in the Commonwealth, to report and dispose of any fish caught.

This advisory follows multiple Northern Snakehead captures in Conowingo Reservoir by anglers and natural resource agency biologists this summer, including the first evidence of Northern

Snakehead reproduction in the reservoir. The PFBC and partner natural resource agencies have been conducting surveillance monitoring for Northern Snakeheads in the lower Susquehanna River since May 2020, when 21 fish passed the Conowingo Dam during fish lift operations for native migratory fish passage. While Northern Snakehead abundance currently appears to be low in Conowingo Reservoir, documentation of reproduction is concerning.

(Photo: An invasive Northern Snakehead collected in the Conowingo Pool, lower Susquehanna River in July 2023)

The Northern Snakehead is an invasive species, in contrast to native species like American Eel that play an ecologically important role in the aquatic community, or species naturalized in the river system like Smallmouth Bass that support a world-class fishery.

"Northern Snakeheads are voracious predators and may cause declines in important sport fisheries, such as bass and panfish, and may inhibit recovery efforts for species of conservation concern in the region such as American Shad and Chesapeake Logperch," said Sean Hartzell, PFBC Aquatic Invasive Species Coordinator. "This is a critical time to protect the Susquehanna River from further expansion of invasive Northern Snakeheads by removing them to reduce adverse impacts."

In response to these recent findings in Conowingo Reservoir, which is managed jointly by the PFBC and the Maryland Department of Natural Resources, the PFBC is reminding anglers to harvest or properly dispose of any Northern Snakeheads caught and report captures from Pennsylvania waters to the PFBC at the following link: (https://www.fishandboat.com/Conservation/AIS/Pages/default.aspx).

Anglers are reminded that possession, transport, and importation of live snakeheads is illegal in both Pennsylvania and Maryland, and violations of these regulations may incur legal consequences following investigation by conservation law enforcement professionals. In

Pennsylvania and Maryland, Northern Snakeheads have no size or creel limits and may be taken by hook and line, as well as by bowfishing.

Harvest is strongly encouraged and anglers in possession of a Northern Snakehead must immediately kill the fish onsite. Because Northern Snakeheads are tough, air breathing fish which can survive outside of water for extended periods of time, it is recommended to kill them by removal of the head, removal of the gill arches, or removal of the internal organs. Northern Snakeheads produce white meat fillets that are considered desirable table fare. Carcasses may also be disposed of appropriately in the trash or used as garden fertilizer.

(Photo: An invasive juvenile Northern Snakehead collected in the Conowingo Pool, lower Susquehanna River in July 2023)

The PFBC, in collaboration with partner resource agencies, is following guidance in the *Rapid Response Plan and Procedures for Responding to Aquatic Invasive Species in Pennsylvania* and the *Northern Snakehead Control and Management Plan for the Chesapeake Bay Watershed* on strategies to mitigate the impacts of Northern Snakeheads in the lower Susquehanna River.

"Biologists are monitoring for Northern Snakeheads and removing individuals caught to reduce abundance both during targeted work and during fisheries surveys for other species," said Kris Kuhn, Director of the PFBC Bureau of Fisheries. "Anglers play a critical role in controlling the spread of this invasive species by harvesting and reporting any fish caught. We're counting on their cooperation."

The PFBC will also be posting signs at river access areas encouraging anglers to harvest and report Northern Snakeheads and providing instructions on how to distinguish them from similar looking species, such as Bowfin. The PFBC is also collaborating with other resource agency members of the Susquehanna River Anadromous Fish Restoration Cooperative and hydropower

facilities on strategies to prevent and control invasive fishes like the Northern Snakehead while also optimizing migratory fish passage on the Susquehanna River.

Northern Snakeheads are native to parts of China, Korea, and Russia. They were first reported in the Mid-Atlantic region in the early 2000s and have colonized waters in multiple states through unlawful introductions and dispersal among waters where no natural or artificial barriers occur. For more information on Northern Snakeheads in Pennsylvania, including an identification guide, visit the PFBC snakehead resource page on the PFBC's website: https://www.fishandboat.com/Fishing/All-About-Fish/Catch-PA-Fish/Pages/Snakehead.aspx

13.6 Supplemental Information: Incident Command System for Invasive Species Rapid Response

Source: Rapid Response Plan and Procedures for Responding to Aquatic Invasive Species in Pennsylvania

The Incident Command System (ICS) is a standardized, on-scene, all-hazards incident management approach that:

- Allows for the integration of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure.
- Enables a coordinated response among various jurisdictions and functional agencies, both public and private.
- Establishes common processes for planning and managing resources.

Certain AIS response scenarios may benefit from a highly coordinated and structured format, such as ICS. It is flexible and allows users to adopt an integrated organizational structure to match the complexities and demands of single or multiple incidents at varying scales. In AIS rapid response situations, ICS provides a systematic approach to guide departments and agencies at all levels of government, NGOs, and the private sector to work together. This section of the Pennsylvania AIS rapid response plan will give a brief overview of the organizational structure and function of the ICS process. If it is determined that ICS is appropriate for an AIS incident in Pennsylvania, please review the Federal Emergency Management Agency's (FEMA) ICS System for more information (FEMA 2018).

The ICS organizational structure has five major functional elements—command, operations, planning, logistics, and finance and administration. As deemed necessary, the Incident Commander (IC) may appoint "Command Staff" which may consist of a Legal Advisor, Science Advisor, Safety Officer, Liaison Officer, and Public Information Officer (PIO). The "General Staff" may consist of an Operations Chief, a Planning Chief, a Logistic Chief, and a Finance\Administrative Chief, or any necessary combination of these positions. The IC is ultimately responsible for establishment and expansion of the ICS organization, based on needs and requirements of the response.

Incident command is accomplished using one of two approaches. For example, when a new priority AIS invasion occurs within a single jurisdiction, and without jurisdictional or functional agency overlap, a single IC is designated with overall incident management responsibility by the appropriate jurisdictional authority. However, when a rapid response involves multiple jurisdictions, a single jurisdiction with multiagency involvement, or multiple jurisdictions with multiagency involvement, establishment of a Unified Command (UC) allows agencies with different legal, geographic, and functional authorities and responsibilities to work together without affecting individual agency authority, responsibility, or accountability. A UC is essentially the shared responsibility of command among several Incident Commanders.

If the following questions can be answered with "yes", then a UC is appropriate:

- Does my organization have jurisdictional authority or functional responsibility under a law or ordinance for this type of incident?
- Is my organization specifically charged with commanding, coordinating, or managing a major aspect of the response?
- Does my organization have the resources to support participation in the response or organization?
- Does the incident or response operation impact my organization's area of responsibility?

The systematic operation of AIS rapid response actions may require a repetitive schedule to promote internal and external continuity during and following staffing transitions. During each operational period, situation reports (SITREP) help staff understand the incident situation and responders' efforts. The Incident Action Plan (IAP) establishes goals for future operational periods. Figure 1 illustrates the initial typical ICS initial operational cycle ("Planning P"). Subsequent cycles skip the initiation procedures and resources are continuously identified and distributed based on guidance from the IC, Operations Section Chief, and the IAP.

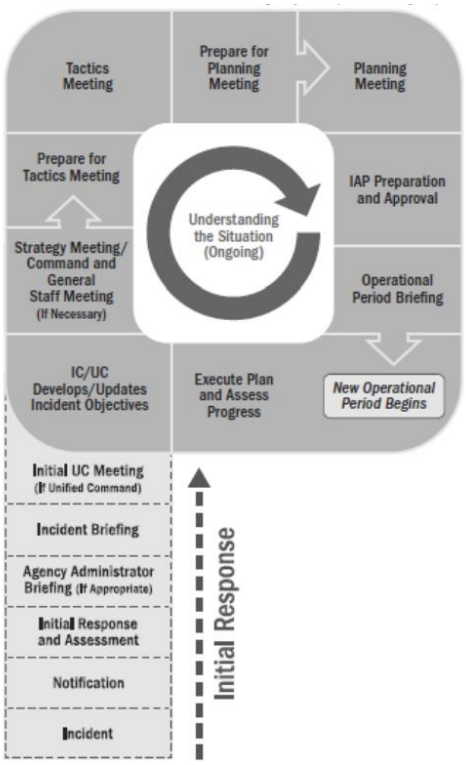


Figure 1: ICS "Planning P"

An IAP is the central tool for conveying planning and operational instructions for all response participants and should provide a clear statement of objectives and actions, a basis for measuring work effectiveness and progress, and a record of accountability.

14. APPENDIX C – CURRENT FISHERIES SURVEYS

14.1. Maryland

In Maryland, several fishery dependent and independent surveys exist that are used to monitor populations of invasive fish species, both throughout Maryland, and in the upper Chesapeake Bay and lower Susquehanna River. Surveys detailed in these sections are those that either occur in the upper Chesapeake Bay, and thus in close proximity to the Susquehanna River, or those where invasive fish species are the primary target of the survey.

14.1.1. Fishery-Dependent Monitoring

Commercial Harvest

Commercial harvest from Maryland waters is reported in weight to the MDNR. Commercial fishers are required to keep a daily log that documents landings, gear, fishing effort, and location. The daily logs are submitted monthly. Commercial fishers also have the option to electronically submit their daily fishing activities while still on the water. Commercial reporting requirements have changed throughout the years to better account for species-specific harvest. For instance, Blue Catfish and Flathead Catfish were previously reported in the non-specific catfish category but were given their own reporting categories in 2011.

Angler Creel Surveys

Several recreational creel surveys report catches and preferred targets of anglers who fish the tidal freshwater of the Chesapeake Bay. MDNR conducted creel surveys in the fresh upper Chesapeake Bay (1987; 2017), Choptank River (1988), and Potomac River (1990; 2017). The National Survey of Fishing, Hunting, and Wildlife-associated Recreation surveys were sponsored by the USFWS in 2006, 2011, 2016, and 2022. These surveys report angling efforts directed at particular species in freshwater and saltwater environments for the nation.

Access Point Angler Intercept Survey

NOAA Fisheries administers an Access Point Angler Intercept Survey (APAIS). This in-person intercept survey collects information from anglers as they complete their fishing trips in salt and brackish waters from Maine to Mississippi and in Hawaii. In Maryland waters, MDNR staff conduct the interviews and collect data using protocols designed by NOAA Fisheries. The survey is conducted at marinas, boat ramps, beaches, fishing piers, and other publicly accessible fishing sites. Interviewers collect information about the length, weight, and species of fish caught, the number and species of fish released, and information about the fishing trip, including the duration and mode (i.e., shore, private boat, charter boat, or head boat). While these surveys support management of species typically important for interstate commerce, data for other species are reported as well.

Online Angler Logs and Surveys

MDNR maintains a website and database of photos and reports submitted by anglers who have caught fish. This is a voluntary submission system whereby anglers report their name, hometown, photos, location information, and any additional content via email. MDNR also hosts a Freshwater Multispecies Survey. Anglers who are fishing recreationally are encouraged to report their catches using this on-line survey. The data provide some information on species targets and economic investment by anglers.

14.1.2. Fishery-Independent Monitoring

Tidal Bass Survey

The Tidal Bass Survey is managed by the Department of Natural Resources Tidal Bass Program to collect biological data used to manage Largemouth Bass fisheries in tidewater. As part of this survey, biologists collect information on the presence of other fish species, including invasive fish species. The survey occurs in September and October in several targeted tidal freshwater areas of rivers within the watershed, including the Susquehanna River and other upper Chesapeake Bay tributaries. Fishes are collected using boat electrofishing, with 140 shoreline sites surveyed each year. The Tidal Bass Survey also records data regarding habitat conditions, such as salinity, water clarity, submerged vegetation, submerged woody materials, and shoreline characteristics.

Juvenile Striped Bass Seine Survey

The MDNR Striped Bass Program conducts the juvenile Striped Bass seine survey to document the annual year-class success for young-of-the-year Striped Bass (*Morone saxatilis*) and the relative abundance of many other fish species in the Chesapeake Bay. Juvenile indices are derived annually from sampling at 22 fixed stations within Maryland's portion of the Chesapeake Bay. Stations have been sampled continuously since 1954, with changes in some station locations. They are divided among four of the major spawning and nursery areas: Potomac River, Head of Bay, Nanticoke River, and Choptank River. Sampling is monthly, with rounds (sampling excursions) occurring during July, August, and September. Replicate seine hauls, a minimum of thirty minutes apart, are taken at each site on each sample round. This produces a total of 132 samples from which bay-wide means are calculated. Auxiliary stations have been sampled on an inconsistent basis and are not included in survey indices. In 2021, Flathead Catfish, Blue Catfish, and Northern Snakehead were each encountered at Head of Bay sites for the first time in the survey’s history.

Striped Bass Spawning Stock Survey

The MDNR Striped Bass Program conducts the Striped Bass spawning stock survey to monitor and characterize Maryland's portion of the Chesapeake Bay's spawning stock of Striped Bass. Since 1985, biologists have been conducting the survey in historic Striped Bass spawning locations on the Upper Chesapeake Bay and the Potomac River. During the spawning stock survey, multiple fish species are sampled along with Striped Bass to help assess the health of the bay. The survey is conducted up to six days a week from late March to mid-May. Surveys are conducted using experimental drift gill nets. The experimental drift gill nets are a series of differently sized mesh, nylon multifilament

panels (3, 3.75, 4.5, 5.25, 6, 6.5, 7, 8, 9, and 10-inch stretch-mesh). Blue Catfish were first detected in the Potomac River in 1996 and in the upper Chesapeake Bay in 2005.

Upper Bay Winter Trawl Survey

The MDNR conducts a winter trawl survey that was initiated in 2000, and spans sites in the Chesapeake Bay from one mile below Tolchester, Maryland to Turkey Point at the mouth of the Elk River (10 total sites). Three river systems are also surveyed including the Elk River (4 sites), the Sassafras River (3 sites), and the Chester River (6 sites). The winter trawl survey comprises six rounds with all sites sampled in each round. The survey samples these sites from early January through mid-February with a 9.1-meter (29.8-foot) bottom trawl. Prior to 2020, Blue Catfish catches were minimal, but the 2020 sampling season produced over 2,000 Blue Catfish of various size-classes.

Maryland Biological Stream Survey

The MDNR Maryland Biological Stream Survey (MBSS) was initiated in 1995 to provide the information necessary to evaluate the health of Maryland's streams, to report on the diversity of life and habitats within them, and to inform stream ecological restoration and protection. The core of the MBSS consists of a statistical design that uses randomly selected stream locations throughout Maryland to provide a representative sample of overall stream health and biological diversity. From June through September, as part of their summer sampling season, the survey conducts quantitative fish sampling, which includes two pass electrofishing, complete counts of all game and non-game fish, and measuring of individual game fish lengths. These data are used for countless studies about freshwater ecology, including assessments of invasive species.

Upper Chesapeake Bay River Herring Spawning Stock Survey

The upper Chesapeake Bay river herring spawning stock survey is conducted in the North East River and targets adult river herring with anchored gill nets (2.25, 2.5, and 2.75-inch stretch-mesh). Since 2013, MDNR biologist have sampled four randomly chosen sites once per week from mid-March through mid-May. During the survey, lengths and counts from non-target species are recorded. Blue Catfish are occasionally encountered in the survey, with the highest total catch occurring in 2023.

14.1.3. New and Future Monitoring Programs

eDNA

In recent years, the MDNR has been conducting studies testing the efficacy of using environmental DNA (eDNA) to detect and monitor the distributions of various aquatic species in Maryland waters. Aquatic Invasive species, such as Northern Snakehead and Blue Catfish, have been and continue to be the focal points of many of these studies. In addition to studies involving invasive fish species that are already in Maryland waters, work is also being done to use eDNA to detect red alert aquatic invasive species that are not yet in Maryland, such as Alabama Bass.

14.2. Pennsylvania

Survey purpose	Water name	Sample site location(s)	Frequency of sampling	Survey method(s)
Channel Catfish population monitoring	North Branch Susquehanna River	Bloomsburg to Shickshinny	Every three years	Low frequency boat electrofishing and hoop nets
	Susquehanna River	Sunbury to MD border	Annually (for now) and eventually periodically	Baited, Tandem hoop nets
	West Branch Susquehanna River	Williamsport to mouth	Periodically (once every 2-3 years)	Baited, Tandem hoop nets
	Juniata River	Mapleton to mouth	Periodically (once every 2-3 years)	Baited, Tandem hoop nets
	North Branch Susquehanna River	Wysox to Shickshinny	Annually (for now) and eventually periodically	Baited, Tandem hoop nets
Adult black bass surveys	Susquehanna River	Sunbury to Highspire	Annually	High frequency boat electrofishing
	West Branch Susquehanna River	Williamsport to mouth	Annually	
	Juniata River	Mapleton to Greenwood	Annually	
	Susquehanna River	Conowingo Pond (in cooperation with MDNR)	Annually - every other year	
	Susquehanna River	York Haven to Lake Clarke	Multiple time annually (at least in short term)	
	North Branch Susquehanna River	Great Bend to Danville	Annually	
YOY black bass surveys	North Branch Susquehanna River	Wysox to Danville	Annually	High frequency backpack electrofishing
	Susquehanna River	Shady Nook to West Fairview		
	Susquehanna River	York Haven to Lake Clarke		
	Juniata River	Mapleton to Greenwood		
YOY Walleye surveys	Susquehanna River	Sunbury to Goldsboro	Annually	High frequency boat electrofishing
	Juniata River	Mapleton to Amity Hall		
	North Branch Susquehanna River	Wysox to Bloomsburg		
	Susquehanna River	Sunbury to Bainbridge	Periodically (once every 2-3 years)	

Survey purpose	Water name	Sample site location(s)	Frequency of sampling	Survey method(s)
Adult Muskellunge surveys	West Branch Susquehanna River	Lock Haven to mouth		High frequency boat electrofishing
	Juniata River	Mapleton to Amity Hall		
	North Branch Susquehanna River	Sayre to Danville	Annually	
YOY Muskellunge surveys	North Branch Susquehanna River	Sayre to Danville	Annually	High frequency boat electrofishing

14.3. New York

Survey purpose	Water name	Sample site location(s)	Frequency of sampling	Survey method(s)
Adult black bass surveys	Susquehanna River	Binghamton to Vestal	Annually	boat electrofishing
YOY black bass surveys	Susquehanna River	Kirkwood to Owego	Annually	Backpack and/or barge electrofishing
Rare fish, including American Eel, surveillance	Susquehanna River	Oneonta, Milford, Binghamton, Barton	Periodically	Backpack, barge and/or boat electrofishing, seine
Invasive species surveillance	Susquehanna River	Oneonta to Barton	Periodically	Backpack, barge and/or boat electrofishing
YOY Walleye surveys	Susquehanna River	Binghamton to Vestal	Annually	boat electrofishing
Adult Muskellunge surveys	Susquehanna River	Kirkwood to Owego	Periodically	boat electrofishing, angler tagging program

14.4. Basin-Wide

SRBC CIM Network Monitoring

SRBC maintains a network of over 60 real-time water quality monitoring stations located throughout the Susquehanna River Basin. These stations are sampled periodically for various biological and abiotic monitoring parameters of interest. Sites will typically receive an electrofishing survey every 5 years as part of the routine operation and maintenance of these stations.

14.5. Interim Monitoring Programs

While long-term surveys are the best way to both detect and monitor new invasive fish species, these surveys generally do not provide information other than counts and lengths for non-target species (i.e., species other than the survey's primary focus). As a result, important biological aspects of the invasive species, such as movement, age, growth, and diet, are often not explored. Interim studies and programs can provide key insights into the biology and ecology of a new invasive fish species, which can help managers better understand and predict how the invasive will impact local ecosystems.

Snakehead Tagging Program

The MDNR and USFWS has collaborated on a Northern Snakehead tagging project. Anglers who catch and report a tagged Northern Snakehead will receive between $10 to $200 per fish. The data from this project will provide managers with information on the species movements, harvest, and mortality in the Chesapeake Bay.

15. APPENDIX D – COMMENT RESPONSE DOCUMENT

SRAFRC solicited comments on the Priority Invasive Fish Species Action Plan for the Susquehanna River Basin from the hydroelectric companies in the lower Susquehanna River Basin. Comments were received on an earlier version of the plan from Constellation on February 26, 2024, and the SRAFRC agencies provided response to those comments on March 8, 2024. No additional comments were submitted from Constellation on the final draft of the plan, though SRAFRC has updated the comment response to the February 26, 2024, comments in this document. Brookfield provided comments on the final draft plan on February 18, 2025, and York Haven Power Company reviewed the draft plan and responded on February 17, 2025, that they had no comments. Below are SRAFRC responses to comments received from Constellation and Brookfield.

Comment Source	Plan Section	Comment	SRAFRC Response
Brookfield	Global	1. The document may benefit from a glossary that defines terms in context of the document. Examples include invasive species, resident species, migratory species, non-native species, etc.	A glossary was added, and the list of abbreviations was also expanded to include other acronyms.
Brookfield	Global	2. The document may benefit from the inclusion of figures showing the location of barriers, distribution of known invasive species of concern, etc.	A figure was added to the Introduction depicting the location of the barriers and the Susquehanna River Basin. Species distribution figures are addressed under comment #12.
Brookfield	Global	3. This document describes well the existing concerns and potential future concerns based on current information. However, given there are unknowns (e.g. potential for new invasive species, population increase/decrease of invasive species) the potential impacts can change over a short period of time as already observed in the lower Susquehanna River, therefore some degree of adaptive management may be necessary going forward.	Acknowledged. The adaptive nature of the plan is described in paragraph 4 of the Introduction. No changes were made regarding this comment.
Brookfield	Section 1, Introduction: Page 1	4. Suggest that the Introduction section note that the Plan applies to invasive fish species	The title of the plan already references 'invasive fish species' and 'invasive fish' are

Comment Source	Plan Section	Comment	SRAFRC Response
		only and that other aquatic invasive species such as plants, invertebrates, reptiles, and amphibians as well as pathogens are also potential threats to the Susquehanna River fishery.	specifically addressed in the vision statement of the introduction. In paragraph 2, the text was changed from "… and invasive species management." to "…. and invasive fish management."
Brookfield	Section 2, Background: On Page 7 the Plan states, "Currently, the fish passage facilities at Holtwood Dam and Safe Harbor Dam are not operational".	5. Suggest clarifying that the fish lifts at both Projects are operational (i.e., they can be operated) but are not being operated as a strategy to address the aquatic invasive species issue.	Text was modified to "Currently, the fish passage facilities at Holtwood Dam and Safe Harbor Dam are not being operated as a strategy to preclude upstream dispersion of invasive species."
Brookfield	Section 2, Background: On Page 7 the Plan states, "With 100% sorting in place at Conowingo Dam, invasive fishes are removed from the tailrace as a means of limiting their population growth."	6. For clarification**,** consider stating "invasive fishes are removed at the fish lifts". As currently stated, "*from the tailrace*" may give the impression that collections in the river downstream of Conowingo Dam are being conducted.	Suggested edit was made.
Brookfield	Section 2, Background: On Page 7 the Plan states, "During the spring anadromous fish migration period, predatory invasive fish species, are attracted by both flowing water and the vast quantities of anadromous fishes that congregate downstream of large dams."	7. These invasive species are attracted throughout the summer in Conowingo's tailrace according to visual observations made by fishway operators and fish lift catch data from Conowingo Dam. Northern Snakehead are typically observed in the spring however then leave the river for spawning habitat as summer approaches. Blue Catfish typically arrive in late spring and stay until late fall, then leave the tailrace for wintering habitat.	Acknowledged. This paragraph is specific to Conowingo operations, which are currently only being contemplated during the spring anadromous fish migration period, so that time is specifically referenced in the plan. It is true that invasive fishes, such as Blue Catfish, are likely in the tailwaters through the summer, though the fish lifts are not in operation during that time.
Brookfield	Section 2, Background: On Page 7 the Plan states, "Given their	8. Consider discussing the potential to limit population abundance of specific species further downstream of the	No changes were made based on this comment. The agencies are promoting removals through all available avenues, including

Comment Source	Plan Section	Comment	SRAFRC Response
	relatively high densities during this time, and the likelihood that they are feeding on already depleted migratory fish species, the removal of invasive fishes through the fish lifts is an effective way to reduce their populations in an area where they are particularly detrimental to native fishes."	fishways. For example, targeted harvest in spawning areas, or flow manipulations that could limit recruitment. While these types of actions are not always feasible, it may help to clarify that the existing aquatic invasive species are populating downstream of Conowingo Dam or outside of the Susquehanna River and that there may be some measures that could help to address these potential issues.	the fish lifts. The current species of concern do not have discrete spawning habitats that can be easily targeted for removals. Maryland has partnered with Constellation on the removal of invasives from the lifts at Conowingo. Maryland has also increased flexibilities in commercial and recreational fishing to increase harvest of invasives, including recently introducing a Blue Catfish For-Hire/Commercial Pilot Program and a Mid- and Lower-Bay Finfish Trotline Pilot Program. Because of the growing abundance of invasive fishes downstream of Conowingo over the past seven years, we believe it is clear that reproduction is occurring in Upper Bay and tributaries, downstream of Conowingo Dam.
Brookfield	Section 2, Background: On Page 8 the Plan states, "Fish can pass downstream through the turbines at the hydroelectric dams. Although passage through turbines is known to cause injury and/or mortality for many fish species (Mueller et al. 2022), turbines alone do not serve as a full barrier to migration. Thus, the downstream dispersal risk of an invasive fish species at hydroelectric dams in the Susquehanna River	9. Suggest clarifying that aquatic invasive species can also readily pass downstream via spill or open gates in addition to turbines.	Text was modified to "Fish can pass downstream through multiple passage routes at the hydroelectric dams, including through turbines, spill, and open gates."

Comment Source	Plan Section	Comment	SRAFRC Response
	Basin is extremely high."		
Brookfield	Section 2, Background: On Page 8 the Plan states, "Another management issue to consider is that the Susquehanna River has many well-established non-native species, some of which were intentionally stocked to support recreational fisheries for the basin states. In the New York portion of the Susquehanna River Watershed, 38% of the fish species present are non-native (Carlson and Daniels 2004). In the Susquehanna River as a whole, 28% are non-native species (Snyder 2005). Important recreational fisheries include Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*M. nigricans*), Channel Catfish (*Ictalurus punctatus*), Walleye (*Sander vitreus*), Muskellunge (Esox masquinongy), Northern Pike (*Esox lucius*), and others. None of these popular recreational species are native to	10. Suggest adding further discussion as it pertains to a consistent definition between individual States and the USFWS that not only includes consensus as to when non-native species become invasive but also when invasive species are reclassified as non-native. For example, while Flathead Catfish are considered invasive, they are present throughout much of the drainage. As such, a popular recreational fishery targeting these species has developed. Barring some unforeseen natural occurrence, this species will remain a component of the fishery and will remain a focus of recreational angling. In areas where the Northern Snakehead and Blue Catfish have become established downstream of Conowingo Dam, popular recreational fisheries have developed.	Although official definitions are not in place for the respective SRAFRC agencies, the agencies generally concur that species are non-native, but not invasive, if they are naturalized in the system and are not causing additional ecological harm. Agencies have discontinued the practice of intentionally stocking new non-native species into waterbodies. Populations of non-native species are considered invasive if they are expanding their geographic range and/or causing negative impacts to ecosystems that they are invading or currently occupying.

Comment Source	Plan Section	Comment	SRAFRC Response
	the basin but have become an established part of the ecosystem. Additional efforts in education on how agencies reach consensus on when non-native species become invasive and what aspects of invasiveness prompt concerns on changes in the ecosystem, specifically the Susquehanna River, are needed."		
Brookfield	Section 2, Background: On Pages 8 and 9 the Plan states, "Although there are several different potential pathways of introductions for these invasive fish species, the two primary pathways highlighted in this plan are passage through the fish lifts on the hydroelectric dams in the lower river and through releases from unauthorized stocking by the public.	11. Inadvertent / contaminated stocking by fish management agencies may warrant consideration as well as a potential pathway for introduction.	No changes were made based on this comment. In recent years, the resource agencies have developed policies and protocols to eliminate inadvertent and/or contaminated stocking by fish management agencies as a potential pathway of introduction.
Brookfield	Section 3.1, Species of Concern: On Page 9 the Plan describes each invasive species of concern.	12. Consider that the narrative of each species of concern include distribution figure(s).	Distribution maps were included in the plan for the Susquehanna River Basin for the species that have been observed in the basin.

Comment Source	Plan Section	Comment	SRAFRC Response
Brookfield	Section 3.1.3, Flathead Catfish: On Page 13 the Plan states, "Presently, Flathead Catfish are found throughout most of the Susquehanna River Basin (Fuller et al. 2023a) and introductions upstream of impoundments in the lower Susquehanna have been attributed to unauthorized introductions by anglers, while downstream populations are likely due to volitional dispersal."	13. Consider that dispersal mechanisms also include the hydroelectric dam fishways. This species has been documented at all lower Susquehanna River fishways based on fish lift catch data.	The text was edited to "Presently, Flathead Catfish are found throughout most of the Susquehanna River Basin (Fuller et al. 2023a) and introductions upstream of impoundments in the lower Susquehanna have been attributed to unauthorized introductions by anglers, while downstream populations are likely due to volitional dispersal upstream through the fishways and downstream through the dams."
Brookfield	Section 3.2.1.3, Safe Harbor Dam: On Page 20 the Plan states, "The Safe Harbor fish lift is operated during migratory fish passage season and initiates operation when 500 American Shad are passed upstream from the Holtwood Dam and the season ends one to two days after the last American Shad passes Holtwood Dam. The Safe Harbor fish passage facilities have operated annually from 1997-2020. In 2020, fish lift operations were suspended, per request of the resource agencies, since no American Shad were being	14. Suggest clarifying that the Safe Harbor Dam is the upstream most physical barrier in the lower Susquehanna River. Due to "open fishways" at York Haven Dam and Sunbury Dam, once a species passes Safe Harbor Dam, it has open access to most of the mainstem Susquehanna River and tributaries.	The following sentence was added to the last paragraph of that section "The Safe Harbor Dam is the most upstream dam that provides a complete physical barrier to upstream dispersal."

Comment Source	Plan Section	Comment	SRAFRC Response
	passed at Holtwood Dam. Per resource agency request, the Safe Harbor fish lift has not operated since 2020"		
Brookfield	Section 3.4.1.2, Other Dams: On Page 21 the Plan states, "There are several other dams on the Susquehanna River that are likely not complete barriers to fish movement. Some notable dams in the mainstem Susquehanna River include Muddy Run, York Haven, Dock Street, and Adam T. Bower Dams."	15. Consider adding Wilson Mill Dam on Deer Creek in Maryland, a tributary to the Susquehanna River, where Northern Snakehead has been observed above this dam.	Text was added at the end of this section to include Deer Creek and Octoraro Creek, tributaries to the Susquehanna downstream of Conowingo. "Two notable tributaries occur in the Susquehanna River downstream of Conowingo Dam. Both the Octoraro Creek and Deer Creek are known to have Northern Snakehead in their lower reaches. Octoraro Creek crosses into Maryland from Pennsylvania and fish have open access from the mainstem of the Susquehanna River to the Pine Grove Dam. No fish passage facilities exist on the Pine Grove Dam or the Octoraro Dam, though Northern Snakehead have been reported upstream of both dams in Octoraro Lake. Deer Creek is exclusively in Maryland and has a Denil fish ladder at its first barrier at Wilson's Mill Dam. Although no Northern Snakehead have been documented upstream of Wilson's Mill Dam, it is assumed that they use the fishway and are present in Deer Creek upstream of Wilson's Mill Dam."
Brookfield	Section 6.1.1.6, Action: On Page 26 under, "Require passage control technologies and/or strategies for invasive fish species to be added to the fish lifts at Holtwood and Safe Harbor	16. Effectiveness criteria should also be considered for any sorting facilities. Even trapping and sorting could be considered slightly less than 100% effective.	Comment acknowledged but no changes were made to the text. The goal should be to have 100% effectiveness, though other factors may allow for acceptance of criteria less than 100%. An example where reduced effectiveness criteria could be considered would be if an invasive species is already

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	Dams during their FERC relicensing process."		established upstream of a project and removals will not influence further upstream spread of the species. These exceptions may not be the same across species, for example, Flathead Catfish are established in the system, so there may be less sensitivity to moving them through fish passage facilities compared to the Blue Catfish which is not established upstream of Conowingo Dam.
Brookfield	Section 6.1.3, Strategy: On Page 26 under, "Minimize risk of introduction from non-fish passage pathways."	17. Suggest that the risk management strategy include potential contamination of authorized stockings as well.	See response to Comment #11.
Brookfield	Section 6.2.1, Strategy: On Page 26 under, "Coordinate annual invasive fish monitoring."	18. Consider a strategy to gather angler input e.g., a user-friendly website hosted by resource agencies for anglers to post photos and locations of catch. Photos can be geo-referenced, if needed.	No changes to the text were made. The respective state agencies already have dedicated reporting systems, which can be accessed through the agency websites. No additional Susquehanna-specific reporting strategy is being considered at this time.
Brookfield	Section 6.5.8, Strategy: On Page 31 under "Other control methods"	19. Suggest considering an Action pertaining to researching mechanisms for which populations of documented aquatic invasive species can be reduced downstream of Conowingo Dam (potentially in areas where these fish originate from). This could include researching potential alternatives for limiting the spawning and recruitment success of these species.	No changes were made based on this comment. Maryland has previously evaluated the efficacy of controlling invasives at areas of congregation, but for the invasive species currently being considered (Northern Snakehead, Blue Catfish, Flathead Catfish), they typically do not congregate in areas to facilitate large-scale removals (except for using the fish lifts at Conowingo). Removals through a suite of agency, commercial, and recreational efforts are supported in the Upper Bay and lower Susquehanna River.
Brookfield	Section 6.5.9, Strategy: On Page 32 under,	20. Suggest evaluating all habitat and/or passage enhancements	No changes to the text were made. Native fish restoration is

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	"Prioritizing control in ecologically sensitive areas."	for migratory fish species restoration for the potential to unintentionally benefit aquatic invasives species (e.g. zone of passage enhancements).	the priority of SRAFRC and reduction of habitat restoration plans and fish passage improvements are not being considered solely because they have the potential to benefit invasive species. Presumably any measures to enhance fish passage for native species will also promote passage of invasive species, which can facilitate their removal. Also, habitat enhancements, such as zone of passage improvements, can expedite fish passage and decrease the amount of time native species are subjected to high predation pressure from invasive species in a project tailrace, even if the migratory species needs to come in closes contact with predators when using a zone of passage facility.
Brookfield	Section 6.6.2, Strategy: On Page 33 under, "Improve public reporting for more consistent and advertised mechanisms to report AIS."	21. See Brookfield Comment No. 18.	See response to Comment #18.
Brookfield	Section 6.6.2.2, Strategy: On Page 33 under, "Ensure all outreach and educational messaging emphasizes public reporting through the preferred reporting mechanism to the appropriate jurisdictional agency by geography."	22. Consider that this strategy target not only angler groups and sportsmen clubs but also schools and youth organizations.	Alternatively, Action Item 6.6.5.7 was modified to explicitly include schools and youth organizations.

Comment Source	Plan Section	Comment	SRAFRC Response
Brookfield	Section 6.6.4.1, Strategy: On Page 34 under, "Develop messaging to convey the applicable legal penalties by jurisdiction for invasive fishes of concern. Potentially, publicize legal cases or citations to emphasize penalties and a conservation law enforcement presence and awareness of this issue."	23. Suggest that this strategy consider penalties (e.g., fines and loss of fishing privileges) for all states in the basin.	No changes to the text were made. All basin states have penalties established and those are listed in Section 11 (Appendix 1).
Brookfield	Section 6.6.4.2, Action: On Page 34 under, "Provide information to the public on where they may be able to direct tips to law enforcement regarding suspected possession or transport of banned AIS in the Susquehanna River Basin (e.g., contact information for appropriate regional offices)."	24. Suggest that this action include the use of rewards for those providing actionable information to law enforcement.	No changes to the text were made. There are logistical challenges for the states to implement a reward program for tipsters.
Brookfield	Section 7, Implementation Table: Page 37.	25. More bins are likely needed for the funding scale (e.g., between $100,000 to $500,000, $500,000 to $1,000,000, etc.), as the current ranges would not differentiate between relatively modest measures and more costly measures that may be considered. The table should delineate between one-time	No changes to the text were made. The agencies are not able to provide more fine-scale cost estimates to the items currently. The annual work plans of the Susquehanna River Migratory Fish and Aquatic Invasive Species Collaborative may be able to put better cost estimates on action items that are planned to be addressed that given year.

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		costs and recurring (i.e., annual) costs.	Further, some items may be presumed to be a one-time cost, but may require modification down the road, so a one-time cost cannot be assured. Some items are recurring for a set period before the project ends and some are long-term recurring. There are many uncertainties around the duration of activity on these action items as to not restrict the work to a defined time period or frequency of implementation.
Constellation	Action Plan Process	1. What are the next steps in the process to develop the Action Plan and what is the timeline for those steps?	SRAFRC finalized the draft Priority Invasive Species Action Plan for the Susquehanna River Basin in April 2024 and shared with the companies. The Concurrently, the SRAFRC Agencies and companies are now participating in the Migratory Fish and Aquatic Invasive Species Collaborative where annual work plans are being developed based on action items derived from the draft Priority Invasive Species Action Plan. SRAFRC requested final comments from the companies on the draft Priority Invasive Species Action Plan on January 10, 2025, in order to finalize the plan.
Constellation	Action Plan Process	2. Will the agencies leading the process for development of the Action Plan coordinate input from various NGOs and agencies that are not part of SRAFRC?	The draft plan was shared with other state agencies (i.e. Maryland Department of the Environment and Pennsylvania Department of Environmental Protection). No other input from outside agencies or organizations was solicited.
Constellation	Plan Elements	1. The Action Plan Outline contemplates an annual review by SRAFRC and plan updates will be considered annually, as needed. From a project owners' perspective, a longer planning	Acknowledged. The Priority Invasive Species Action Plan will be reviewed annually and updated as needed, though likely not every year. Annual work guidance will occur

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		horizon would be better for any activities involving fish lift or trap and truck operations. That need does not preclude annual reviews for small adjustments, but a longer planning horizon is needed for any significant changes.	through the Migratory Fish and Aquatic Invasive Species Collaborative annual work plan development where smaller adjustments can be contemplated.
Constellation	Plan Elements	2. What long-term measures will the Action Plan include to reduce the population of priority invasive fish species in the Chesapeake Bay in order to reduce the number of priority invasive fish species at Conowingo over time? Over what timeframe does SRAFRC see these long-term measures being implemented?	The SRAFRC agencies have been and will continue to control invasive species outside of the fish passage activities at the hydroelectric dams through a suite of actions contemplated in section 6.5 of the plan, including promoting increased recreational and commercial harvest of invasives and invasive removal during fishery surveys.
Constellation	Plan Elements	3. The Action Plan Outline calls for the continuation of 100% sorting at Conowingo until additional actions are identified and implemented. Constellation will need additional feedback on the length of this priority invasive fish species management measure as well as cost sharing mechanisms and commitments from the agencies to process and remove the invasive species from the site.	Until technologies are identified and implemented to preclude physical sorting at the fish passage facilities, continuation of the 100% sorting will be necessary to support migratory fish restoration while preventing the spread of invasive fish into the Susquehanna River. The SRAFRC agencies have been supporting invasive removals from Conowingo in recent years by providing a cooler to store the catch and removing invasives from the site. The SRAFRC agencies also have been working to identify funding sources that can be used to evaluate new technology to aid in fish sorting at the fish lifts. The SRAFRC agencies will continue to work with Constellation through the Migratory Fish and Aquatic Invasive Species Collaborative annual work planning process to identify potential areas for cost-sharing and continued support to remove invasives from the site.

Comment Source	Plan Section	Comment	SRAFRC Response
Constellation	Research	1. The Action Plan outline lists selective fish passage (including evaluation of upstream dispersal triggers, and methods for dissuading invasive species from entering the lifts), documentation of new occurrences, rapid response for early detections, control and management, population ecology, and outreach and communications. In addition, the outline identifies other research categories including determining detection probabilities for surveys, evaluating potential ecosystem and economic impacts of introductions, understanding habitat preferences of different invasive fish species, and evaluating effectiveness of capture and control mechanisms. It is not clear what is meant by evaluation of upstream dispersal triggers. Also, it is not clear what the funding sources will be for these various research projects and what the consultation process will be for research design and deliverables.	The Action Plan contains an implementation table that has more specific information on implementation of a suite of strategies and actions identified in the plan. The implementation table identifies the lead organization for that work and a generalized cost estimate for completing the work. Some actions are currently being funded with agency (or company) funding and some future actions may need to have funding sources identified to be implemented. SRAFRC plans to address the action items and source of funding of the Priority Invasive Species Action Plan through the Migratory Fish and Aquatic Invasive Species Collaborative annual work planning process in cooperation with the companies.