AMERICAN BLACK DUCK CONSERVATION PLAN

Partners working to conserve coastal marshes and the birds that depend on them.

Atlantic Coast Joint Venture
April 2022

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EXECUTIVE SUMMARY

Wintering black ducks in New Jersey. Jeremiah Heise

The goal of this implementation plan is to help partners better coordinate efforts to conserve the American Black Duck and the wetland habitats upon which it depends throughout the Atlantic Coast Joint Venture (ACJV) region. From Maine south to North Carolina, Black Ducks can be found in most inland and coastal wetland habitat types, including freshwater, brackish, and saltwater. They winter primarily along the U.S. Atlantic Coast, where they rely largely on coastal salt marsh and adjacent freshwater marsh habitats. Once the most abundant dabbling duck in eastern North America, Black Ducks declined by more than 50% between 1955 and 1985. Although the population has remained relatively stable since then, it remains below desired levels while threats to their habitat, such as sea level rise and expanding development, continue to increase.

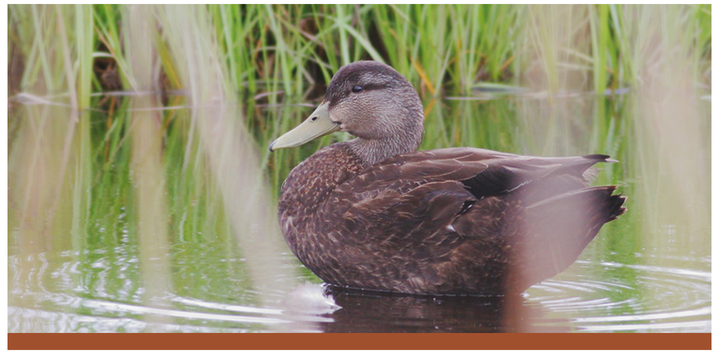
Given the large proportion of the Black Duck population supported on Atlantic Coast wintering grounds, the ACJV has a significant responsibility to conserve this species. As such, the ACJV Management Board selected the Black Duck as one of three flagship species in 2016 and established an ACJV Black Duck Working Group. The Working Group has since set population and habitat goals for the JV region and developed a set of six priority conservation strategies designed to most quickly and effectively help partners to reach and maintain those goals within the context of the major threats facing the species. These strategies include:

- Protect Marsh Migration Corridors
- Develop and Implement BMPs to Facilitate Marsh Migration
- Restore Tidal Wetland Hydrology
- Improve Water Level Management on Managed Wetlands
- Restore and Enhance Non-tidal Wetland Hydrology
- Control Exotic and Invasive Species

These strategies encompass the most important opportunities to improve habitat conditions, slow or reverse habitat loss, and protect high priority wetlands. Increasing and maintaining future Black Duck populations in the face of growing threats requires partners to make additional and/or more strategic investments in these conservation strategies. Most urgently, we must develop and test best management practices to restore and enhance existing and future salt marsh habitat in order to maintain the habitat acreage most vulnerable to sea level rise, and to facilitate migration of future salt marshes into upland habitats to offset inevitable wetland losses. Best management practices are already well-developed in non-tidal habitats. In these areas, work should focus on prioritizing watersheds for restoration, removing permitting barriers, and catalyzing implementation by engaging funders and landowners, and regularly sharing information among practitioners. Collectively, these strategies represent the most promising approach to maintaining and growing the Black Duck population along the Atlantic Coast.

INTRODUCTION

PURPOSE



American Black Duck. Tim Grey

The goal of this implementation plan is to help partners better coordinate efforts to conserve the American Black Duck and the wetland habitats upon which it depends throughout the Atlantic Coast Joint Venture (ACJV) region. Although the American Black Duck population has been relatively stable since the 1980s, its abundance is below desired levels. To increase and maintain future American Black Duck populations in the face of threats such as expanding development and sea-level rise, partners need to make additional and/or more strategic conservation investments. There are currently many opportunities to improve habitat conditions, slow or reverse habitat loss, and protect areas where salt marshes can migrate inland with sea-level rise. However, some of those opportunities diminish over time, such as protecting marsh migration corridors in areas with ongoing development pressure. Conservation investments must be made immediately and continuously. These investments in American Black Duck habitat conservation will also benefit many other high-priority and economically important fish and wildlife species and provide other valuable benefits to the public, such as improving water quality, providing outdoor recreational opportunities, reducing pollution, and protecting human infrastructure from coastal flooding.

BACKGROUND

The American Black Duck (*Anas rubripes*), hereafter Black Duck, was once the most abundant dabbling duck in eastern North America (Longcore et al. 2000) and was traditionally an important harvested species in the Atlantic Flyway. Black Duck populations began declining steadily in the 1950s and reached an all-time low by the 1980s, having lost more than half of their historical population (Figure 1). Breeding populations have stabilized since then, but they remain below North American Waterfowl Management Plan (NAWMP) objectives (Figure 2).

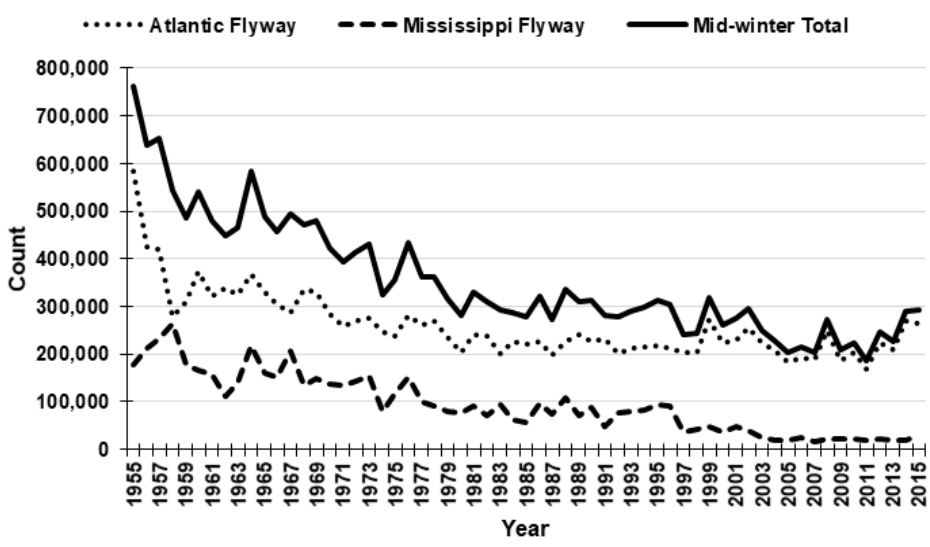


Figure 1. Trends in wintering Black Ducks counted during the Mid-winter Waterfowl Survey, 1955–2015 (Ringelman et al. 2015).

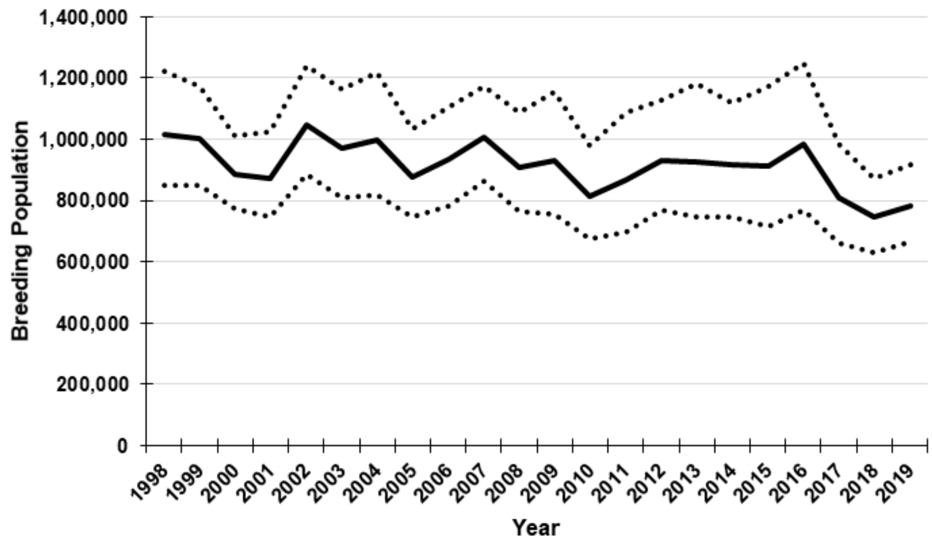


Figure 2. Trends in breeding Black Ducks and 95% confidence bounds for eastern North America based on the eastern survey area and Atlantic Flyway Breeding Waterfowl Survey, 1990–2019 (Fleming et al. 2019).

From Maine south to North Carolina, Black Ducks can be found in most inland and coastal wetland habitat types, including freshwater, brackish, and saltwater. The vast majority of Black Ducks breed in the boreal forests and wetlands of Eastern Canada. They breed throughout nearly all of Ontario, Quebec, and Newfoundland and the eastern U.S. states of Maine, New Hampshire, Vermont, and New York, though they breed as far south as North Carolina in smaller numbers. Black Ducks winter primarily along the U.S. Atlantic Coast, where they rely largely on coastal salt marsh and adjacent freshwater marsh habitats. The highest wintering Black Duck populations are found along the New England/Mid-Atlantic Coast from Maine to Chesapeake Bay (Link et al. 2006, Robinson et al. 2016).

The 50% decline in Black Duck populations between 1955 and 1985 was presumably due to a combination of over harvest, habitat loss and fragmentation on northern breeding grounds, increasing competition and hybridization with Mallards, and declines in the quantity and quality of wintering habitat (Ringelman and Williams 2018). Although more restrictive hunting regulations implemented in the 1980s stabilized Black Duck populations, they have not recovered (Ringelman and Williams 2018) and remain between ~700,000 and ~950,000 birds (USFWS 2020), which is below the long term average (1955-present).

CONSERVATION NEED

Though their population has been relatively stable for the last three decades, the failure of Black Ducks to recover following their 50% decline over the previous three decades remains a concern for managers. Although over-harvest is no longer a concern, the quantity and quality of Black Duck habitat has continued to decline for centuries. Wetland loss on Black Duck staging and wintering areas across the ACJV region has been considerable. Between the 1780s and 1980s, states within the ACJV lost an estimated 40% of historic wetlands (Dahl 1990). More recent wetland trend studies suggest continued wetland loss along the Atlantic Coast; between 2004 and 2009, an estimated 111,957 acres (-0.7%) of wetlands were lost (Dahl and Stedman 2013). Although there was no net loss of saltwater wetlands on the Atlantic Coast, sea-level rise projections suggest we can expect significant change and loss of salt marsh habitats in the future. In addition, continued urban expansion and agricultural intensification pose a significant threat to remaining wetland habitats. Recent research (Roberts et al. 2019) suggests that Black Duck populations may now be limited by the quality and/or availability of winter habitat.

Habitat-related influences may be exacerbated by competition with Mallards, an ecologically and genetically similar species to Black Ducks. Due in part to the release of millions of pen-raised Mallards for hunters , Mallards expanded eastward (Mank et al. 2004) throughout the 20th century and now breed in every Eastern state. Since 1969, Mallards surpassed Black Ducks as a proportion of waterfowl harvested in the Atlantic Flyway (Heusmann 1974). Because Black Ducks and Mallards are closely related, competition and hybridization pose potential threats to the less abundant Black Duck population. Although hybridization rates are high, actual gene flow is limited between these species and they continue to maintain genetic separation (Lavretsky et al. 2019). However, recent research suggests that Mallard dominance could decrease carrying capacity for Black Ducks on wintering areas through interference during foraging and displacement from feeding locations (Schummer et al. 2020).

SCOPE AND CONTEXT

This plan provides implementation strategies to conserve Black Ducks based on the best available science for the portion of the Black Duck range that falls within the boundaries of the ACJV. The ACJV region winters ~85% of the continental population of Black Ducks (Migratory Bird Data Center, 2019). Although Black Ducks breed as far south as North Carolina, the vast majority of the breeding population is supported outside of ACJV boundaries in the boreal regions of Canada. Because the ACJV region retains such a high responsibility for supporting wintering Black Ducks, the strategies in this plan focus exclusively on non-breeding season objectives. However, these strategies are expected to benefit breeding Black Ducks in parts of the region where they both breed and overwinter (i.e., from Maine to North Carolina).

Example of typical beaver dam and associated impounded wetland habitat in Virginia. Ducks Unlimited

The strategies in the plan represent the input and consensus views of many experts and partners involved in Black Duck and coastal wetland habitat conservation. Although wintering Black Ducks rely primarily on tidal wetlands, non-tidal habitats such as emergent and forested wetlands are also important for meeting wintering needs and play a key role in providing migratory stopover habitat (Ringelman et al. 2015). Therefore, this plan includes both tidal and non-tidal restoration strategies. Action is required now and will continue to be needed to meet the short- and long-term conservation goals and objectives described in this plan. Collective progress will be regularly tracked and provide the basis for updating this plan every five years to reflect the latest population status and management outcomes.

Salt Marsh Bird Conservation Plan

The Black Duck Plan builds upon and expands on the foundational strategies developed through the Salt Marsh Bird Conservation Plan (hereafter "Salt Marsh Plan") (Atlantic Coast Joint Venture 2019). The Salt Marsh Plan was developed to outline conservation strategies that will benefit the entire suite of salt marsh dependent bird species. When developing the Black Duck Plan, the Black Duck Working Group evaluated each of the eight strategies developed for the Salt Marsh Plan along with additional strategies proposed specifically for Black Duck. Although all of the strategies in the Salt Marsh Plan are designed to benefit salt marsh specialists, including the Black Duck, that plan does not comprehensively address Black Duck habitat needs. Working Group members selected those Salt Marsh Plan strategies that were considered most critical to achieving Black Duck population objectives. The Black Duck Plan also expands the habitat scope of the Salt Marsh Plan to include non-tidal habitats that are critically important to conserving Black Ducks. Although most of the strategies listed in this Black Duck plan will benefit (or have a neutral impact on) other species such as Saltmarsh Sparrow and Black Rail, there is the potential that a couple may conflict with conservation recommendations for these other species. This includes any strategy that potentially allows or causes a loss or conversion of high marsh habitat to low marsh habitat, such as restoration of tidal flow that submerges high marsh above a restriction.

Nexus With Other Flagship Species

The ACJV selected two additional flagship species, Saltmarsh Sparrow and Black Rail, to fully represent the coastal marsh system and ACJV geography. These two species are declining significantly due to sea-level rise impacts and are estimated to have lost more than 87% and 90% of their populations, respectively, since the 1990s. As a result, the Black Rail was Federally listed as Threatened under the Endangered Species Act (ESA) in 2020 and the Saltmarsh Sparrow has a scheduled ESA listing determination in 2024. Given sea-level rise, urbanization, differential losses of wetland types over the last century--and losses predicted in this century--high marsh habitat is particularly vulnerable (National Wetland Inventory 2021) relative to other coastal wetland types, particularly in the core Black Duck winter range (e.g., NJ, DE, MD, VA).

Additional ACJV flagship species: Saltmarsh Sparrow, Ray Hennessy and Black Rail, Sergio Bitron

Wintering Black Ducks use a wider variety of tidal habitat types--such as high marsh, low marsh, mudflats, and open water--than do Black Rail and Saltmarsh Sparrow, which are largely restricted to infrequently flooded high marsh for nesting. However, research on Black Duck winter habitat use in the ACJV (Ringelman et al. 2015) found that high marsh was one of the most frequently used and relied upon habitats for wintering Black Ducks, particularly at night. Additional analyses show that high marsh habitat generally provided more food energy per unit area than did other habitat types, with the exception of managed impoundments (Livolsi et al. 2015), underscoring the importance of this declining habitat to all three flagships.

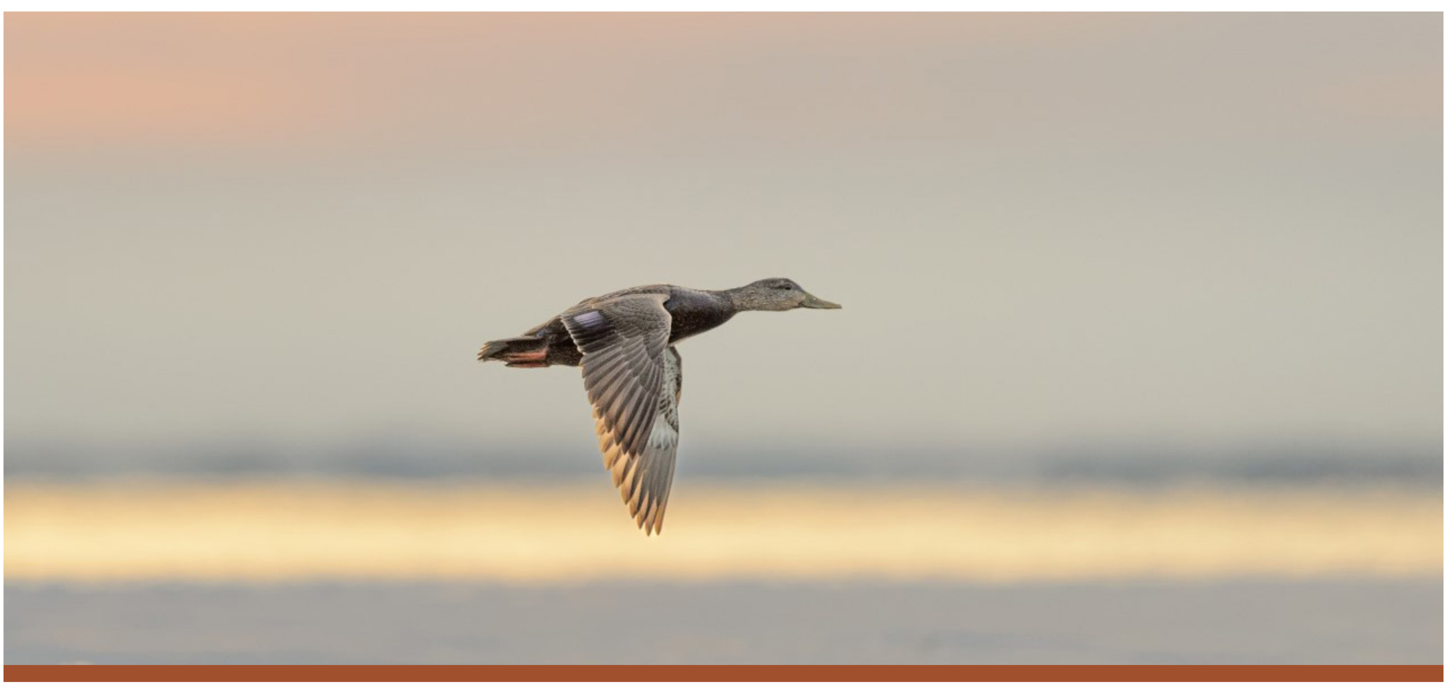
Any conservation efforts that protect, maintain, or improve the resiliency of high marsh habitat--even if directed at Black Rail and/or Saltmarsh Sparrow--should provide benefits to Black Ducks. Likewise, many habitat conservation projects focused on Black Ducks should also benefit Saltmarsh Sparrow and Black Rail. For instance, appropriately designed projects may offer both foraging habitat for non-breeding Black Ducks as well as breeding habitat for Black Rail and Saltmarsh Sparrow. Impoundment design and management in areas that overlap with Black Rail could include appropriate topography and water depths and/or be sufficiently large to accommodate both species needs.

Where potential conflicts do exist, land managers should evaluate the potential impact on all flagship species and avoid management and projects that result in a loss of Saltmarsh Sparrow or Black Rail habitat quality or quantity. For example, in some parts of the Black Duck winter range (i.e., from New Jersey south), impoundment management for Black Ducks could conflict with management for Black Rails if the impoundment does not include appropriate vegetation and water depths that would benefit Black Rail (areas <3cm). In the northeast, projects that remove tidal restrictions without a plan to maintain high marsh could result in loss of Saltmarsh Sparrow habitat. Projects maximizing cross-seasonal and/or multi-species benefits should be prioritized and in areas where two or more of the flagship species co-occur, efforts that would conserve high marsh should generally be considered first and prioritized. If you would like help identifying potential management conflicts or management opportunities for your project, please reach out to ACJV staff for further coordination.

Black Duck Working Group

In 2016, the ACJV established a Black Duck Working Group to develop population and habitat objectives and to promote effective conservation action among partners across the Black Duck range within the ACJV region. The ACJV works closely with and shares broad membership with the Black Duck Joint Venture (BDJV). The BDJV focus is on research and monitoring while the ACJV focuses on habitat implementation so this plan reflects the work of both Joint Ventures. Participation on the ACJV Black Duck Working Group includes members from each of the state wildlife agencies from Maine to Florida, federal agencies, and non-profit groups from across the ACJV. The following members comprise the Core and Extended Teams of the Working Group:

Connecticut Department of Energy and Environmental Protection, Delaware Division of Fish & Wildlife, Ducks Unlimited, Georgia Department of Natural Resources, Maine Department of Inland Fisheries and Wildlife, Maryland Department of Natural Resources, Massachusetts Division of Fisheries and Wildlife, New Hampshire Fish and Game Department, New Jersey Division of Fish and Wildlife, New York State Department of Environmental Conservation, North Carolina Wildlife Resources Commission, Pennsylvania Game Commission, Rhode Island Division of Fish and Wildlife, South Carolina Department of Natural Resources, Vermont Fish and Wildlife Department, USFWS, and Virginia Department of Wildlife Resources. A full list of Working Group members can be found here.



The Black Duck Working Group works to develop plans and tools to advance Black Duck conservation. Ray Hennessy

REGIONAL POPULATION GOAL

The ACJV aims to support 788,387 Black Ducks during the non-breeding period in order to support a continental breeding population goal of 1,025,528 ducks.

The NAWMP (2014) established Black Duck breeding population objectives for the eastern survey area (ESA) based on the long-term average (LTA) between 1990 and 2014 and scaled to the continental level. In order to ensure adequate habitat is conserved to meet the LTA, and sufficient habitat for when the population fluctuates above it, the ACJV Black Duck Working Group adopted the 80th percentile of the LTA (1,025,528 ducks, Fig. 3) as our goal. The 80th percentile goal is equivalent to a population level equal to that of the best 20% of all years (Fleming et al. 2019). This recognizes the inherent fluctuations in populations and provides greater confidence that we will consistently support the population during both peak and average years. The breeding population goal was then adjusted for winter survival (.85) (Fleming et al. 2019) to determine the 80th percentile non-breeding period population goal of 788,387 Black Ducks, which were then stepped down to the county scale using harvest data (Fleming et al. 2019) and subsequently rolled up to the state and Joint Venture scale.

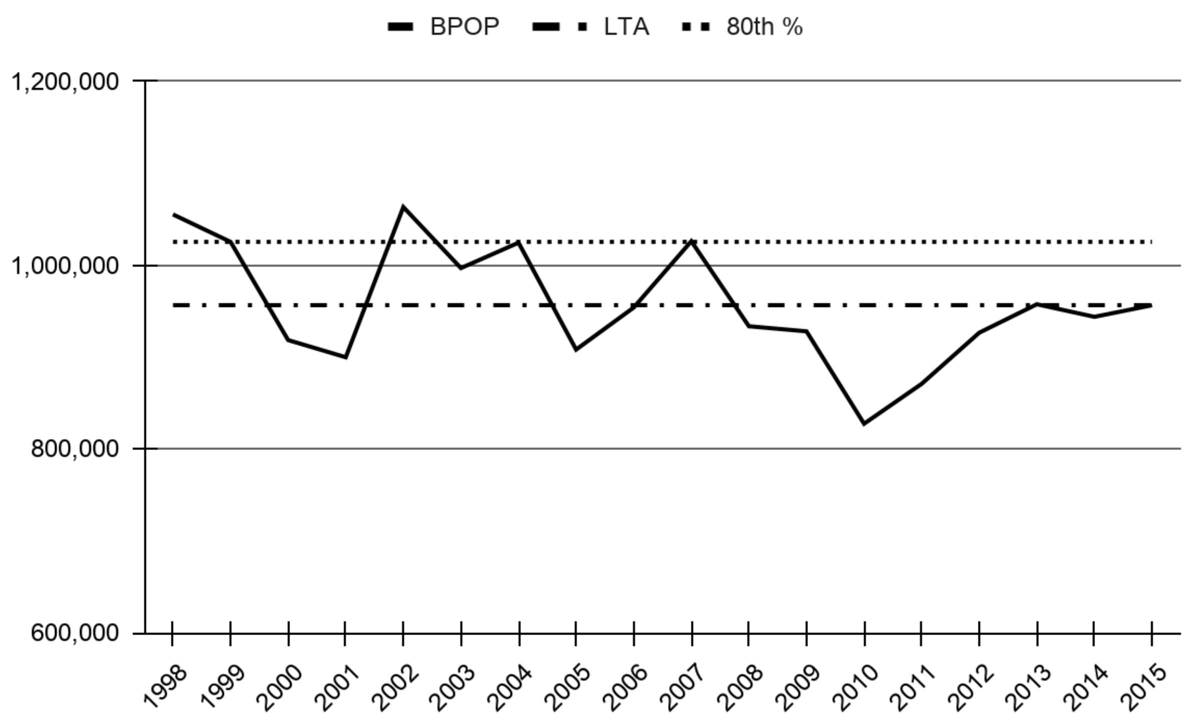


Figure 3: Continental breeding population estimates (BPOP), long-term average (LTA) and 80th percentile (80th %) population abundance objectives for Black Ducks, 1998-2014 based on Fleming et al. (2019).

Habitat Objectives

Black Ducks begin migrating south through the Atlantic Flyway from northern breeding grounds in early September, and winter along the coast (Devers and Collins 2011). They use a variety of wetland habitat types throughout the year, including beaver ponds, salt and emergent freshwater marshes, freshwater and brackish ponds, wooded wetlands, streams and flooded bottomland stands. Tidal flats and brackish marsh provide critical migration and wintering habitats along the Atlantic coast (Devers and Collins 2011). In all habitats, Black Ducks require adequate food, open water and shelter from low temperatures and human disturbance (Lewis and Garrison 1984).

Conservation planning for migrating and wintering waterfowl is largely driven by the food limitation hypothesis, which assumes that food availability during the non-breeding period influences survival and reproductive success through its effects on body condition and timely completion of annual life cycle events (Brasher 2010, Williams et al. 2014). It is assumed that by providing access to adequate food and reducing energetic costs during migration and winter that birds will maintain good body condition, experience high survival, and return to the breeding grounds in good condition without delays, thereby enhancing reproductive success. Although quality non-breeding habitat has many features, food energy has served as an established currency across habitat Joint Ventures with a non-breeding habitat focus. Food energy supply and demand were calculated for each 12-digit hydrologic unit code (HUC12) watershed and the energy balance for each HUC12 watershed was estimated by subtracting total energy demand from total energy supply. An energetics model was then used to calculate habitat restoration objectives for all watersheds with energy deficits and habitat protection objectives for all watersheds where an insufficient amount of total food energy need was under protected status (see Appendix for methodology).

Table 1: Black Duck Habitat Objectives by State

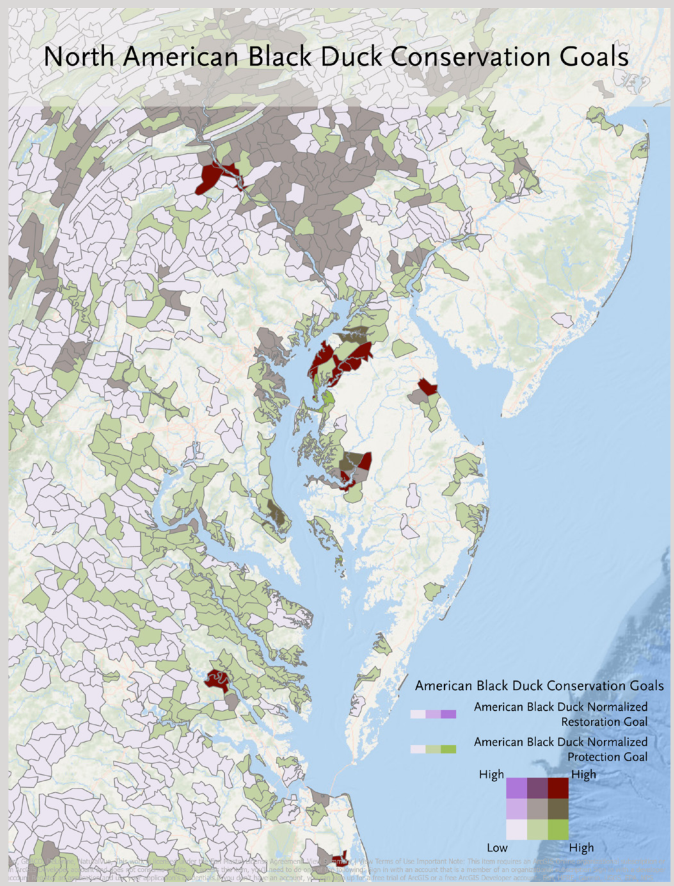
State	80% Population Objective	Protection Goal (ac)	Restoration Goal (ac)
Connecticut	29,126	18,372	4,300
Delaware	56,237	69,691	30,372
Florida	402	21,849	62
Georgia	6,869	206,217	28,210
Maine	41,900	46,231	1,974
Maryland	112,167	304,475	109,645
Massachusetts	30,571	5,048	2,137
New Hampshire	13,277	16,035	895
New Jersey	91,424	30,073	10,630
New York	145,894	685,568	158,681
North Carolina	71,101	535,224	119,950
Pennsylvania	59,193	537,359	286,269
Rhode Island	9,736	3,749	2,202
South Carolina	12,444	289,063	56,454
Vermont	13,664	86,635	37,441
Virginia	90,384	274,756	50,738
Grand Total	**788,387**	**3,130,346**	**899,959**

BLACK DUCK DECISION SUPPORT TOOL

Achieving our population objective will require that we restore or enhance ~900,000 acres and protect more than three million acres of Black Duck habitat, while continuing to maintain the good habitat that already exists (Table 1). The Black Duck Decision Support Tool (DST) (developed jointly with the Black Duck Joint Venture and Ducks Unlimited) identifies the number of acres to protect, restore or maintain at the small watershed scale and identifies which actions, and how much of them, should be applied in which watersheds. Through this tool, land managers can determine the best way to contribute to achieving Black Duck goals anywhere on the landscape. The DST uses remotely sensed wetland inventory maps to determine the energetic carrying capacity of HUC12 watersheds and compares this to energy demand based on the ACJV's Black Duck and other dabbling duck population objectives, stepped down to the county level. The model indicates areas where there is sufficient wetland quantity and quality to support the desired number of Black Ducks and other dabbling ducks in each HUC12 watershed, and where the habitat is insufficient to support the population at desired levels. It further indicates how much of the habitat is in conservation status, to show areas sufficiently protected and areas needing additional land protection, as well as the areas where wetland habitat needs to be restored or enhanced to support Black Duck and other dabbling duck population objectives. The DST provides clear guidance to partners as to both where and how much additional management and protection is needed.

American Black Duck ducklings are seen on Poplar Island in Talbot County, Maryland. Steve Droter/Chesapeake Bay Program

The Black Duck Decision Support Tool helps managers determine where to work and what to do there to achieve Black Duck goals



THREATS ASSESSMENT

Threats were identified and rated by the Black Duck Working Group. Threats represent only those thought to impact Black Ducks during the non-breeding period. Working Group members ranked each threat from one to four, with one being Low and four being Very High. These scores were then averaged and ranked (Table 2).

Table 2: Ranked list of threats to Black Ducks

Threat	Average Score	Categorical Rating
Loss of habitat due to sea-level rise*	3.78	Very High
Loss of habitat due to development◈	3.39	High
Land use incompatible with marsh migration*	3.17	High
Tidal restrictions that change hydrology*	2.78	High
Transportation infrastructure that restricts tidal flow*	2.67	High
Human disturbance◈	2.56	High
Non-native invasive species - Phragmites*	2.28	Medium
Dams that reduce sediment transport⨯	1.88	Medium
Mallard competition*	1.72	Medium
Oil spills⨯	1.33	Low
Harvest◈	1.11	Low

**Covered in the Black Duck Conservation Plan; ⨯Covered in the Salt Marsh Bird Conservation Plan; ◈Not covered in either plan*

Emerging threats such as climate change may exacerbate existing threats or introduce new ones (Devers and Collins 2011). Depending on the rate and magnitude of change (i.e., changes in seasonal temperature and precipitation patterns), climate change may simply intensify existing threats. For example, the combination of urbanization and rising sea level along the Atlantic coast will accelerate the loss of winter habitat and cause a decline in winter carrying capacity. Alternatively, new threats such as novel diseases introduced to eastern North America as a result of warmer and wetter conditions may emerge.

THREATS ADDRESSED IN THIS PLAN

The conservation strategies for this plan were developed to address the threats the Working Group determined to be most detrimental to Black Duck populations and that could be measurably influenced by the work of the ACJV partnership (i.e. habitat-focused work). Therefore, some high priority threats are not comprehensively addressed in this plan, such as Loss of Habitat due to Development, and Human Disturbance. Strategies were developed around two Medium threats related to Non-native Invasive Species (Phragmites) and competition with niche resources (Mallards). The Working Group agreed that, although these threats are not ranked as highly as others, they were important to address as they interrelate with several higher ranking threats and can compromise habitat quality if not treated comprehensively. Two of the medium and low priority threats not addressed in the Black Duck Plan (Dams that Reduce Sediment Transport; Oil Spills) are comprehensively covered in the Salt Marsh Plan (see Table 1 key), which is designed to benefit the entire suite of salt marsh-dependent birds. The text below summarizes each of the major threats addressed in this plan.

Loss of Habitat Due to Sea-Level Rise

Global mean sea level has risen about 20.3 to 22.9 cm since 1880, with approximately one-third of that rise occurring since 1993 (Sweet et al. 2017a). In the United States, the rate of sea-level rise has been higher than the global rate along the Northeast and Mid-Atlantic coast over the last several decades (Sweet et al. 2017b) and is projected to have amplified relative sea-level rise greater than the global average under almost all future sea-level rise scenarios through 2100 (Sweet et al. 2017b). From 1970-2009 the area between Boston, Massachusetts, and Virginia experienced rates of sea-level rise 2 to 4 times the global average. If this trend continues, it would translate to 0.45 m of sea-level rise by 2050 under the best-case scenario or 1.05–1.40 m sea-level rise by 2050 under the "worst case" scenario. This trend is exacerbated in the mid-Atlantic, where much of the coastal plain is experiencing subsidence due to isostatic rebound from the end of the last ice age (Sella et al. 2007).

Most models (Spencer et al. 2016) predict major changes in the distribution and abundance of tidal marshes in future decades, with large (90%) losses of tidal marsh (Crosby et al. 2016) expected by the end of the century.

Land Use Incompatible with Marsh Migration

Riprap lines a hardened shoreline on Hoopers Island, Maryland. Matt Rath/Chesapeake Bay Program

The ability to accommodate inland migration of tidal marshes is probably the single most important factor (Schuerch et al. 2018) that determines whether or not tidal marshes will be lost (Spencer et al. 2016) due to sea-level rise. The loss of existing salt marshes could be offset, in part, by inland migration of salt marshes into adjacent uplands or freshwater wetlands—a process that is likely to develop slowly over decades. Marsh migration is already happening in some areas but is generally blocked or impaired in areas with human development. From Massachusetts to Florida, over 40% of coastal land with an elevation of 1m or less is currently developed and almost 60% is expected to be developed in the future. Coastal landowners often protect their property from storm or tidal flooding by "hardening" their shorelines through berms, walls, or other barriers to tidal flow. Hardened structures are in place on 14% of the entire U.S. coastline and affect more than 50% of the shoreline in more developed areas (Gittman et al. 2015). Increased shoreline hardening can result in increased water depths and wave energy in the intertidal zone, eroding and degrading remaining areas of natural, unprotected shoreline, and can deprive inland areas from sediment supply necessary to help marshes keep up with sea-level rise (Schuerch et al. 2018). In some places this has left little or no vegetated marsh on the seaward side of barriers and effectively blocks the inland migration of tidal wetlands. Buildings and other development adjacent to salt marshes also reduce habitat quality through noise, disturbance, and human subsidized predator populations, while impervious surfaces increase run-off and flooding.

Tidal Restrictions that Change Hydrology

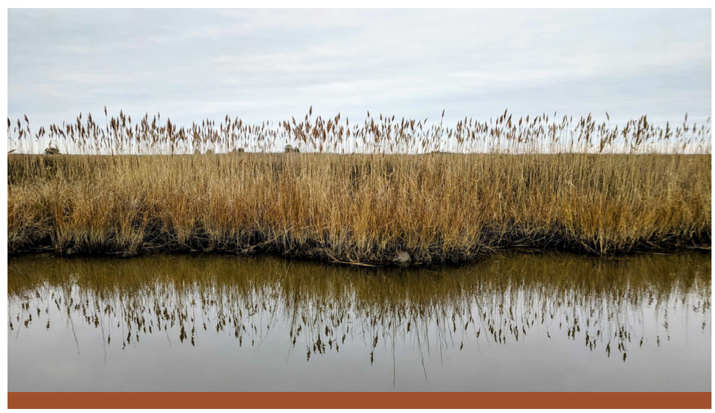
Restricting tidal flow alters hydrology and limits sediment supply to salt marshes, which is key to marsh accretion. Areas with severely restricted tidal flow often experience significant subsidence of the marsh platform due to oxygenation of marsh soils and higher rates of plant decomposition. Restoring healthy marshes in such areas is more challenging and can take longer because tidal flow may need to be gradually reintroduced to allow vegetation growth and accretion and prevent inundation and conversion to large areas of open water. Invasive Phragmites can also dominate areas upstream of tidal restrictions and significantly degrade the integrity of the marsh habitat.

Transportation Infrastructure that Restricts Hydrology

Roads and railways are among the primary drivers of salt marsh bird population declines (Correll et al. 2016). The construction of roads and railways (hereafter "transportation infrastructure") often uses earthen embankments that function as dikes and can dramatically affect wetland hydrology. These dikes hold water back, cut it off from uplands and prevent landward migration of marshes. Undersized culverts and/or tide gates at road crossings reduce tidal flow above restrictions as well as freshwater flow of upland floodwaters. Rising seas exacerbate these impacts through excess flooding and storm surge events. Restricted tidal flow degrades, fragments, or eliminates salt marsh habitat, and deprives upstream areas of natural sediment supply and salinity, often leading to subsidence and changes in plant species composition. Historical impacts from transportation infrastructure on salt marsh birds are considerable and new transportation infrastructure continues to encroach upon and degrade marsh ecosystems, such as through the spread of invasive species along transportation corridors (Hansen and Clevenger 2005).

Non-native and Problematic Species

Introductions of several non-native and/or problematic plants, mollusks, crabs, birds (e.g., Snow Geese) and mammals (e.g., nutria) have radically changed salt marsh communities in recent decades. Invasive plants now dominate many former salt marshes while invasive animals, especially birds, compete with Black Ducks for food and space on wintering grounds.



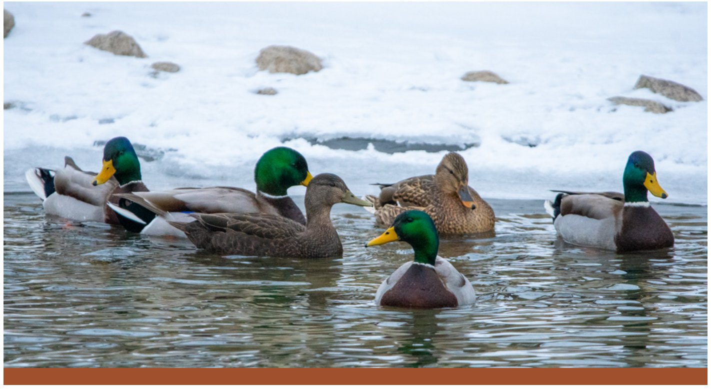
Phragmites australis in Maryland taking over saltmarsh habitat. Chesapeake Bay Program

Invasive Plants

Phragmites australis, an invasive form of common reed, colonizes and thrives in the lower-salinity areas behind tidal restrictions and in the marsh migration zone, where it can prevent the establishment of native marsh grasses. It now dominates many former salt marshes and warrants management attention as far south as South Carolina (Ward & Jacono 2009). Phragmites quickly forms a tall, dense monoculture, which excludes most other plant species and dramatically lowers the habitat value for Black Duck.

Interspecific Competition

Geese: During the past two decades, the distribution and abundance of Greater Snow geese (*Anser caerulescens atlantica*) and Canada geese (*Branta canadensis*) have increased across the Black Duck wintering range. Several populations of Canada geese are sympatric with Black Ducks on the winter range including the North Atlantic Population, Atlantic Population and temperate-breeding Population. The Atlantic Population experienced a rapid increase in size between 1999 and 2007 when the population grew from 77,000 pairs to > 196,000 pairs (a 260% increase). The primary wintering grounds of the Atlantic population are the Delmarva Peninsula, southeastern Pennsylvania, New Jersey and New York, which are also the primary Black Duck wintering grounds. Similarly, the temperate-breeding populations of Canada geese have increased throughout the Black Duck winter range. The rapid growth of geese has been fueled by milder conditions on their breeding and wintering grounds and increased food availability (particularly corn) on wintering grounds. The increased abundance of geese may be contributing to the degradation of Black Duck feeding areas along the Atlantic Coast, particularly in the Chesapeake Bay region. Geese, especially snow geese, feed in large flocks and typically feed on roots and rhizomes of important Black Duck food items including bulrushes and salt-marsh cordgrass. Control measures have been implemented to limit or reverse the growth of snow geese and temperate-breeding Canada goose populations (excerpted with permission from Devers and Collins 2011).


Black Duck mingling with Mallards. ©Laurie Michaelman

Mallards: While Black Ducks were declining during the latter half of the 20th century, mallards were simultaneously expanding into eastern North America. The expansion of the mallard's range and increased abundance is believed to be due to human alteration of the landscape (i.e., agricultural development, forest fragmentation, and urbanization) throughout the Black Duck range and the release of pen-reared mallards throughout the 20th century. The two species are very similar genetically and ecologically, thus setting the stage for competition. Although mallards have expanded into Black Duck wintering habitats, it is unclear how much mallards and Black Ducks compete in these areas or if the overall increase in mallards is the ultimate or proximate cause of the Black Duck decline or simply a concurrent event.

THREATS NOT ADDRESSED IN THIS PLAN

Human Disturbance

Black Ducks exhibit heightened sensitivity to human disturbance (including recreation and presence of buildings) compared to other waterfowl species (Conomy et al. 1998, Morton et al. 1989a). Black Ducks respond to human activities with increased alertness, flushing, and less time spent feeding or loafing (Morton et al. 1989a, Cramer 2009). This relationship may cause increased mortality by limiting energetic intake during critical periods, such as winter (Morton et al. 1990, Barboza and Jorde 2018) or by exposing Black Ducks to predators during flushing events. In southern New Jersey, it is predicted that adult females could survive extensive cold and icing conditions, which severely limit food resources, for 2.8–3.9 days based on energy reserves. The same study found juvenile females could survive for 1.4–2.1 days (Cramer 2009). Increased human disturbance in loafing or feeding areas could result in reduced energetic reserves and increased mortality during freeze events (excerpted with permission from Devers and Collins 2011).

Reduced Sediment Supply

The accumulation of fine-grained, suspended sediment (Friedrichs & Perry 2001) plays a fundamental role in the formation and maintenance of estuarine ecosystems (Dame et al. 2001). Salt marsh plants capture suspended sediments from tidal water, which, along with accumulated organic matter, form the marsh platform upon which plants grow. Sediment supply (Kirwan et al. 2010) and biomass production drive the accretion, or vertical growth, of the marsh platform and allow it to keep pace with sea-level rise. If seas rise faster than sediment and organic material can accumulate, marshes will be flooded more frequently and may become permanently submerged. In the past, marsh elevations generally kept up with sea-level rise, but the recent acceleration of sea-level rise and flooding (Ezer & Atkinson 2014) may exceed accretion rates (Beckett et al. 2016) and threaten to inundate salt marshes (Schepers et al. 2016). Much of the area in the Black Duck wintering range does not have sufficient sediment supply to keep up with sea-level rise (Kirwan et al. 2010). Some scientists have argued that sediment accretion will allow many tidal marshes to keep up—even with accelerated levels of sea-level rise—and the low marsh used by Black Ducks has a greater capacity to do this than high marsh (Kirwan et al. 2016).

In many areas, sediment supply has been reduced or blocked from entering marshes due to human activities and infrastructure, such as roads that restrict tidal flow, sea walls, development or paving of dune areas that prevents overwash, and regular dredging of navigational channels. The construction of dams on coastal river systems was widespread from colonial times until the late 20th century. Removing such barriers to sediment transport could provide an important source of nourishment to some salt marshes, which may be in need of sediment inputs to keep up with sea-level rise. However, it is important to understand the importance of landward sediment sources—and the likelihood that they will end up in a particular marsh—before undertaking dam or upland barrier removal projects. Many salt marshes occur in geomorphic settings that receive sediment primarily from marine source and upstream barrier removal in those marshes may have little benefit.

Oil Spills

Although uncommon, oil spills are a constant potential threat to Black Duck populations. An oil spill during the non-breeding season in the Mid-Atlantic marsh systems of coastal New Jersey, Chesapeake, or Delaware Bay could affect a substantial proportion of the Atlantic population. It is important that priority marshes are integrated into spill response plans. Relative to other threats to Black Duck, however, oil spills were not viewed as a high-priority threat to address in this plan.

Harvest

Overharvest of Black Ducks has been suggested as a factor responsible for Black Duck declines between the 1950s and 1980s (Grandy 1983, Rusch et al. 1989). Consequently, harvest restrictions were instituted in the early 1980s, which decreased harvest rates thereafter (Francis et al. 1998). Harvest is now closely monitored and evaluated through an Adaptive Harvest Management framework so that harvest rates can be balanced with population sustainability (USFWS 2020). However, Black Ducks have not recovered to pre-1950s levels, suggesting that other factors are having a greater impact on the population.

American Black Duck and Tundra Swan on Pea Island, North Carolina. Don Faulkner, Creative Commons

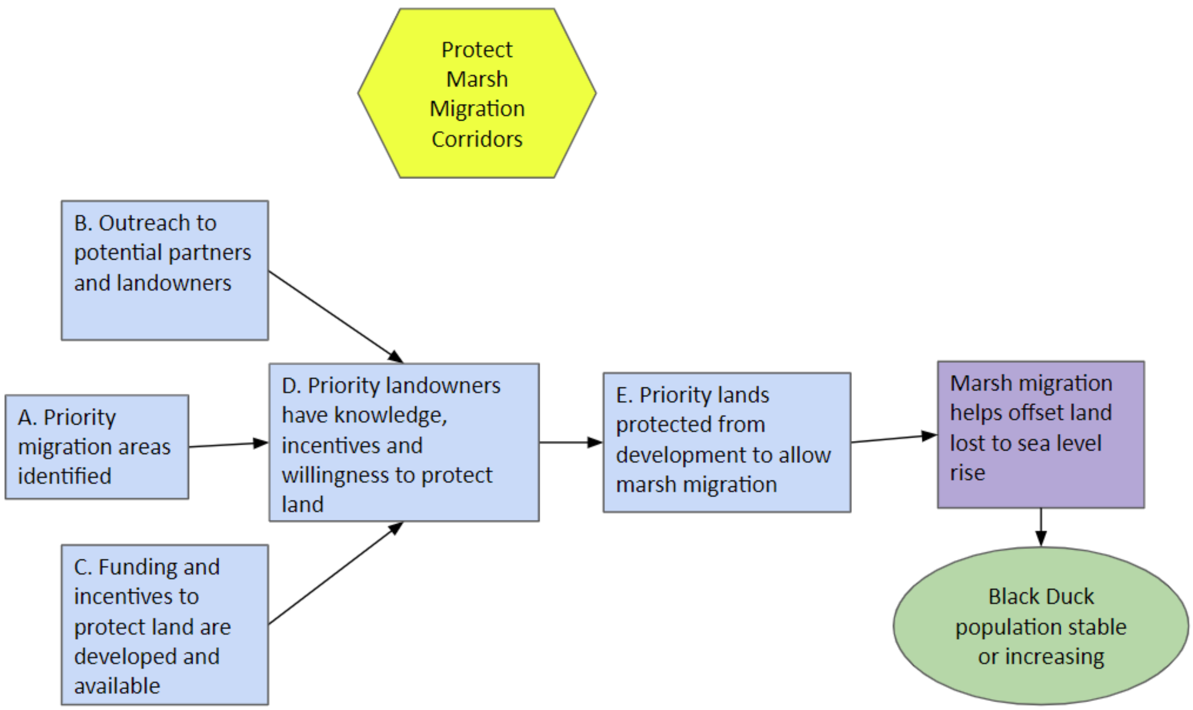
IMPLEMENTATION STRATEGIES

Deal Island. Ducks Unlimited

PROTECT MARSH MIGRATION CORRIDORS

As sea levels rise, landscapes change and salt marsh acreage is lost. Regional (Craft et al. 2008) and global (McFadden et al. 2007) assessments of salt marsh loss due to sea-level rise predict a 20% to 50% loss of salt marsh habitat by the end of the century. Modeling simulations (Kirwan et al. 2016) suggest that marsh migration into neighboring uplands in the continental U.S. could offset as much as 78% of marsh loss. However, these models do not include future development and shoreline hardening that might disrupt marsh migration processes. To maximize the potential for future marsh development, the highest priority marsh migration corridors must be protected from future development that could further reduce the potential extent of marsh migration.

Strategy Logic



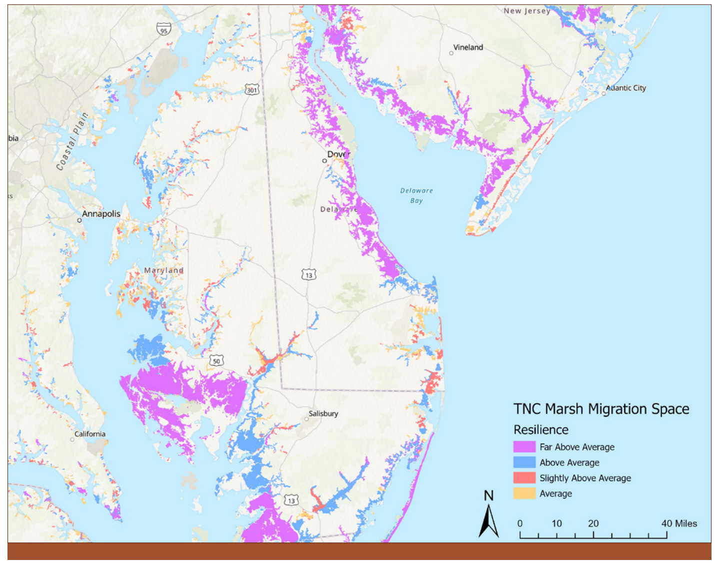
Strategy Description

This strategy is designed to help identify the highest priority marsh migration corridors to protect in order to maximize future salt marsh habitat potential and ensure that sufficient and suitable marsh habitat is available for Black Ducks in the marsh migration zone. By implementing this strategy, we will be able to identify the highest priority areas to protect in the marsh migration zone (A). Sufficient funding and incentives (C) along with outreach to priority landowners (B) should result in knowledge and willingness to protect land by priority landowners (D). This will result in priority lands being protected from development (E) and marsh migration process being allowed to occur, which will help offset land lost to sea-level rise and help to maintain or increase the overall population of Black Ducks.

Targeting Marsh Migration Corridors

Land protection efforts aimed at maintaining marsh migration opportunities must focus on those areas that are most resilient to rising seas. Examples of attributes that lead to resiliency include a large existing tidal complex, large migration space, little to no hardened shorelines and a greater number of tidal classes (e.g., low marsh, high marsh, brackish marsh) along with functional marsh processes such as adequate sediment supply and freshwater flushing (Anderson and Barnett 2017, 2019).

High-priority marsh migration zones have been identified and mapped by The Nature Conservancy for the North Atlantic and the South Atlantic regions. These products provide a roadmap for practitioners to prioritize land protection under one-foot to six-foot sea-level rise scenarios. These are no-regrets actions that will help to shape the future extent of salt marshes while preventing development in high risk areas for coastal storms and flooding. Opportunities to protect large, unfragmented areas capable of supporting marsh migration will become increasingly rare under current development scenarios, underscoring the urgency to protect key areas as quickly as possible.



Priority marsh migration space (The Nature Conservancy 2019).

The following four objectives were established to achieve the marsh migration goals:

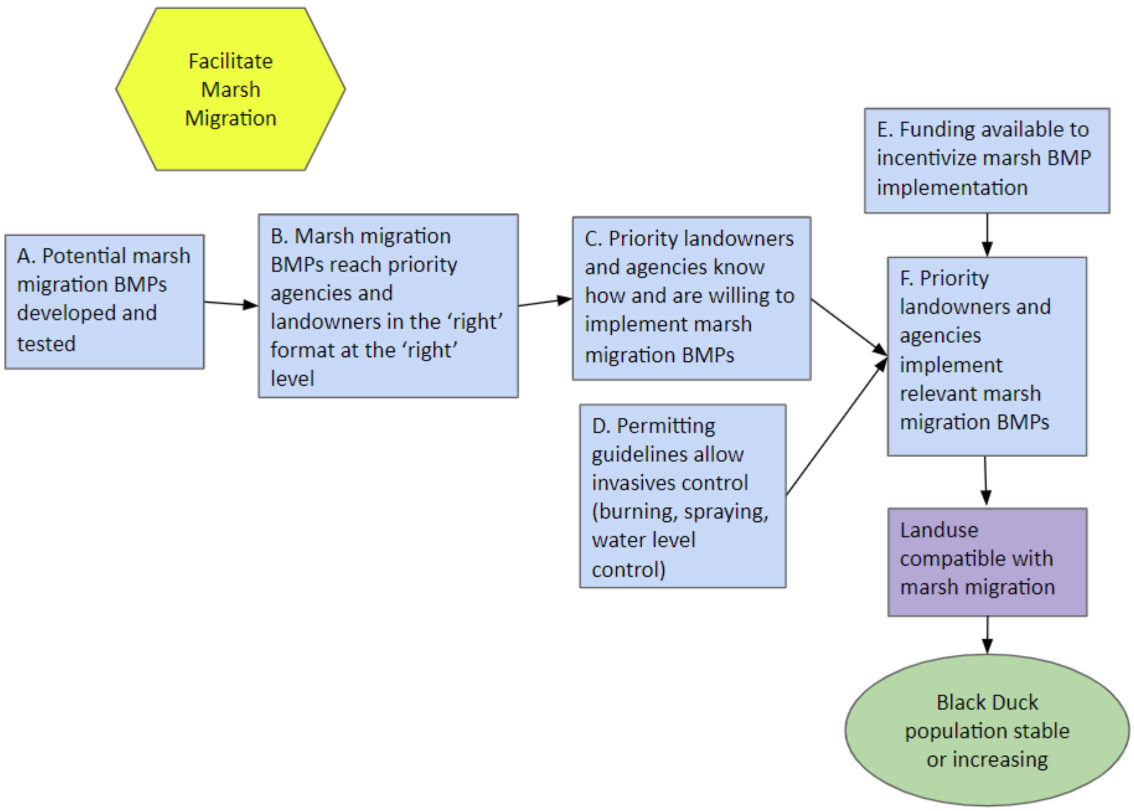
Key Objectives and Activities

Type	Description	Timing
Action	Identify Marsh Migration Priorities	
Objective 1	Identify where priority Black Duck patches align with adjacent lands suitable for marsh migration in the current ACJV Black Duck range.	2022
Activity 1.1	Map protected status of priority marsh migration corridors.	2021
Action	Secure Resources to Protect Migration Corridors	
Objective 2a	Identify funding sources to pursue to protect prioritized marsh migration habitat, in fee or easement, to meet Black Duck population goals.	2022
Activity 2.1	Evaluate opportunities for funding that could be aligned with marsh migration work (e.g., Rural Legacy in MD).	2022
Objective 2b	Secure enough funding to ensure that we can protect 50% of priority marsh migration corridors.	2032
Action	Engage Landowners in Protecting Migration Corridors	
Objective 3	Sufficiently protect at least 50% of priority corridors to allow marsh migration to help offset expected losses due to sea-level rise over the next 30 years.	2037
Objective 4	Agricultural preservation agencies (e.g., NRCS, state agencies) prioritize marsh migration priority areas for land protection funding.	2025

DEVELOP AND IMPLEMENT BMPS TO FACILITATE MARSH MIGRATION

In many tidal marsh systems, the upland/marsh transition may be the best hope of sustaining high marsh habitat into the future. If managed appropriately in areas with suitable elevation to allow marsh migration, these areas could be expanded to continue to provide new habitat and help offset losses due to sea-level rise. However, simply protecting land in the marsh migration zone may not be sufficient to ensure that marshes of appropriate quality and quantity can migrate inland. In many places, these processes may need facilitation in order to allow appropriate habitat to develop. We must determine whether and how to facilitate marsh migration into suitable areas to ensure that adequate Black Duck habitat exists. Best Management Practices (BMPs) need to be developed in an adaptive management framework so that the most effective BMPs can be promoted and implemented widely.

Strategy Logic



Strategy Description

As sea levels rise and landscapes change, salt marsh acreage is being lost. A portion of the acreage lost can, theoretically, be replaced with new marsh that forms along the upland edge. However, this process can be compromised by incompatible land use, invasive species, and the presence of dead and dying trees. This strategy is designed to help identify BMPs to facilitate marsh migration to ensure that sufficient and suitable marsh habitat is available for Black Ducks in the marsh migration zone. We expect that by implementing this strategy, we will be able to identify, develop, and test best management practices to effectively facilitate marsh migration that meets the habitat needs of Black Ducks (A). These BMPs will then need to be shared with priority landowners and agencies in a format that is suitable for their needs and which provides the guidance they need to take action (B). Outreach to priority audiences should include an emphasis on practical guidance and access to experts, funding options, incentives, and equipment so that landowners know how to implement the marsh migration BMPs (C). Landowners will also need the right regulatory framework (D) (i.e., permitting guidelines that allow marsh migration efforts) and monetary incentives (E) to support implementation of these marsh migration BMPs (F). If landowners implement these BMPs, we expect that land use will be compatible with marsh migration, marshes will migrate, and high marsh areas suitable for Black Ducks will increase and/or high marsh losses will decrease, ultimately leading to maintaining or increasing the overall population of Black Ducks.

Successful Migration Requires Management

Marsh migration is occurring naturally in many places, particularly in areas of gentle topography where saltwater intrusion is rendering cropland unusable and creating "ghost forests" of dead and dying trees. However, in some areas, salt marsh has not migrated into adjacent uplands presumably because of steeper slopes (Field et al. 2016), lower rates of saltwater intrusion (Smith 2013), or the occurrence of Phragmites. Even where topography promotes saltwater intrusion, uplands do not always convert effectively to high marsh habitat. Ghost forests can persist for many years after high marsh vegetation has colonized the ground layer, and transitional zones are particularly vulnerable to Phragmites invasion (Smith 2013) because of their lower salinity and partial shade. Transition zones can also become waterlogged and convert to open water instead of high marsh.

Phragmites in tidal marshes of Dorchester County, Maryland. Ducks Unlimited

Examples of experimental management techniques to facilitate marsh migration are limited and more work is needed to understand how and where to facilitate this process where possible (Anisfeld et al. 2017) and to ensure that new marsh created includes adequate high marsh. Given the rapid rate of sea-level rise and how long it takes for plant communities to form, there is a pressing need to implement replicated pilot projects throughout the Atlantic Flyway to develop effective management methods for facilitated marsh migration. Several different management actions could facilitate the transition of salt marsh into adjacent uplands. The optimal strategy will depend on a variety of site-specific factors such as slope and geomorphology. These include:

Remove snags in "ghost forests"

In many areas of the Black Duck range, "ghost forests" have formed where rising seas have resulted in saltwater intrusion into forested uplands. The presence of snags may deter colonization by salt marsh birds and increase nest predation rates by providing elevated perches for avian predators.

Remove Phragmites in priority marsh migration zones

Areas in the marsh migration zone can become dominated by invasive Phragmites, which inhibits establishment of native tidal marsh plants. Ensuring that habitat in migration zones becomes suitable high marsh may require control of Phragmites on an ongoing basis until salinity levels rise sufficiently to control it naturally.

Terrace/contour slopes adjacent to existing marshes to expand marsh platform and increase accretion rates

Vertical marsh development processes are critical (Cahoon et al. 2019) to keep pace with sea-level rise. That process is typically driven by sediment capture and accumulation of organic matter—both above and below ground— through vegetation growth. The width and total area of tidal marsh adjacent to upland areas is directly related to the marsh's ability to buffer wave erosion and keep up with sea-level rise. Narrow marshes do little to attenuate waves or prevent saltwater from reaching adjacent uplands. They also have limited accretion potential compared to wider and larger expanses of marsh grass. Contouring areas adjacent to salt marshes could have several benefits, including: expanding the horizontal extent of marsh vegetation, increasing the marsh's capacity for buffering and accretion, creating suitable slopes to facilitate marsh migration, and protecting agricultural fields at higher elevations from saltwater intrusion. A series of flat terraces (i.e., step-like shelves of similar elevation) may provide greater size and functionality of salt marsh at any given time compared to a narrow fringe of marsh. Narrow marsh zones may have greater ability to gradually migrate up a linear slope as sea-level rises but they provide little ecological or economic value during that process. A terraced slope may facilitate greater accretion and would presumably still allow for marsh migration.

Remove barriers that are impeding marsh migration

Barriers include any structures (e.g., berms, dikes, undersized culverts) that impede inland migration of marsh habitat. Removing barriers has great potential to restore and improve salt marsh habitat where sediment supply and elevation are conducive to restoring tidal flow and creating high marsh habitat. However, care must be taken with this practice to avoid unintended conversion of high marsh behind a barrier to low marsh (Hinkle & Mitsch 2005) or open water. This can happen if there is not sufficient migration space, sediment supply, or elevation behind the barrier, all of which are required to ensure that high marsh habitat is created. Care must also be taken to avoid degrading impoundments in the marsh migration zone that are providing high quality habitat for Black Ducks. Done appropriately in sites with the right conditions, barrier removal can have great potential in allowing migration.

Dam removal. USFWS

Convert agricultural/open areas to marsh habitat

Marsh migration may occur most rapidly at sites with open conditions that facilitate a transition to salt marsh habitat. This includes agricultural areas that are experiencing crop failures due to salt water intrusion and fallow or old fields adjacent to existing salt marshes. Such areas present opportunities to facilitate migration as salinity and elevation conditions are already conducive to supporting marsh grass development, provided that invasive Phragmites is controlled. Open areas experiencing marsh migration may be occupied by salt marsh birds much faster than ghost forests, which may have very slow rates of avian colonization (Taillie et al. 2019).

Extend tidal creeks in transitional marshes to drain areas that have become ponded

In low-lying landscapes, the gentle topography that promotes saltwater intrusion can also jeopardize the persistence of newly established high marsh on former uplands. This can happen at sites where tree mortality is accompanied by root ball shrinkage and ground surface collapse. These sites become waterlogged because they are isolated from the tidal creek network, causing interior erosion of high marsh vegetation (Lerner et al. 2013). Audubon has identified many such sites on the Delmarva Peninsula using spatial modeling and has piloted the extension of tidal creeks into ponded areas to drain surface water and reinvigorate marsh vegetation.

The following objectives will be necessary to achieve our goals:

Key Objectives and Activities

Type	Description	Timing
Action	Develop and Test BMPs	
Objective 1a	Implement experimental projects in at least 25% of priority marsh migration corridors within Black Duck priority areas identified by the DST to identify effective management methods to facilitate marsh migration.	2024
Objective 1b	Institute monitoring protocols to evaluate the effectiveness of various management actions and develop BMPs for marsh migration.	2023
Objective 2a	Convene partners to exchange information and recommend regional BMPs for marsh migration.	2028
Objective 2b	Ensure that 100% of landowners and managers of priority areas can access BMPs in usable format.	2031
Action	Facilitate Knowledge, Information, and Equipment Exchange Among Land Managers	
Objective 3	Within five years of BMP development, ensure that landowners of properties covering at least 50% of priority areas have the capacity (e.g., knowledge, equipment available to use, incentives, funds, etc.) to manage marsh migration.	2032
Activity 3.1	Develop and circulate a list of experts in facilitated marsh migration.	2028
Activity 3.2	Develop and circulate a list of funding options for facilitated marsh migration.	2028
Activity 3.3	Develop and circulate a list of contractors by state/region who are available to do this kind of work and have the equipment to do it.	2028
Activity 3.4	Conduct workshops to promote the most promising techniques, share valuable lessons learned, and stimulate additional work, in at least five high priority landscapes.	2028
Activity 3.5	Use the publicly accessible ACJV Project Inventory Tool to house information on marsh migration projects throughout the ACJV.	ongoing
Activity 3.6	ID priority private lands for outreach .	2025
Action	Engage Landowners in Implementing BMPs	
Objective 4	Within five years of BMP development, all state permitting agencies develop permitting guidelines that allow BMP activities.	2032
Objective 5	Within 10 years of BMP development, ensure priority land managers and landowners are managing marsh migration on at least 25% of priority marsh migration corridors.	2038
Activity 5.1	ACJV States, federal and state agencies, and conservation organizations include facilitated marsh migration in their annual plans.	2031
Objective 6a	Engage NRCS in incorporating BMPs into existing framework and aligning funding with marsh migration needs.	2028
Objective 6b	Within 10 years of BMP development, assist priority landowners with NRCS sign-ups to implement BMPs on at least 10% of priority marsh migration areas.	2038

REGULATORY ISSUES

Black Duck ducklings. USFWS

Many conservation measures included in this plan will require environmental permits from local, state, and national agencies. Permits are designed to prevent projects that would damage wildlife, people, lands, and waters from moving forward. However, existing permitting systems are not always equipped to handle the novel and complex nature of wetland restoration projects designed to improve climate resiliency. Projects that involve novel technologies can cause short-term damage to some resources but will ultimately result in improved long-term function. For example, a thin-layer deposition project may harm some vegetation but improve long-term resiliency. Such wetland restoration projects often encounter challenges during the permitting process (Ulibarri et al. 2017). Even those restoration and enhancement projects that are more traditional in scope (e.g., impoundment management) are often subject to the same rigorous permitting requirements as development projects.

Navigating challenging permitting requirements causes delays, inefficiencies, or outright denials that increase costs, impede project benefits and prevent achievement of resiliency benefits. This can result in substantially increased workloads, extended timelines and missed windows of opportunities for already staff-limited conservation organizations and agencies working to implement important habitat conservation practices. It also creates significant confusion for private landowners with no experience navigating the regulatory process.

Overcoming permitting obstacles will require engagement and buy-in from a diversity of regulators and decision-makers to ensure that wetland protection policies do not serve as a barrier to conserving wetlands. Projects that include collaboration—meeting early and often with regulators—tend to move more efficiently through the permitting process (Ulibarri et al. 2017). This helps permitting agencies and wetland conservation practitioners manage expectations and define permit requirements, which can be incorporated into early project planning. Showcasing permitting successes in progressive permitting districts can also help to build relationships between permitting agencies and practitioners in other districts.

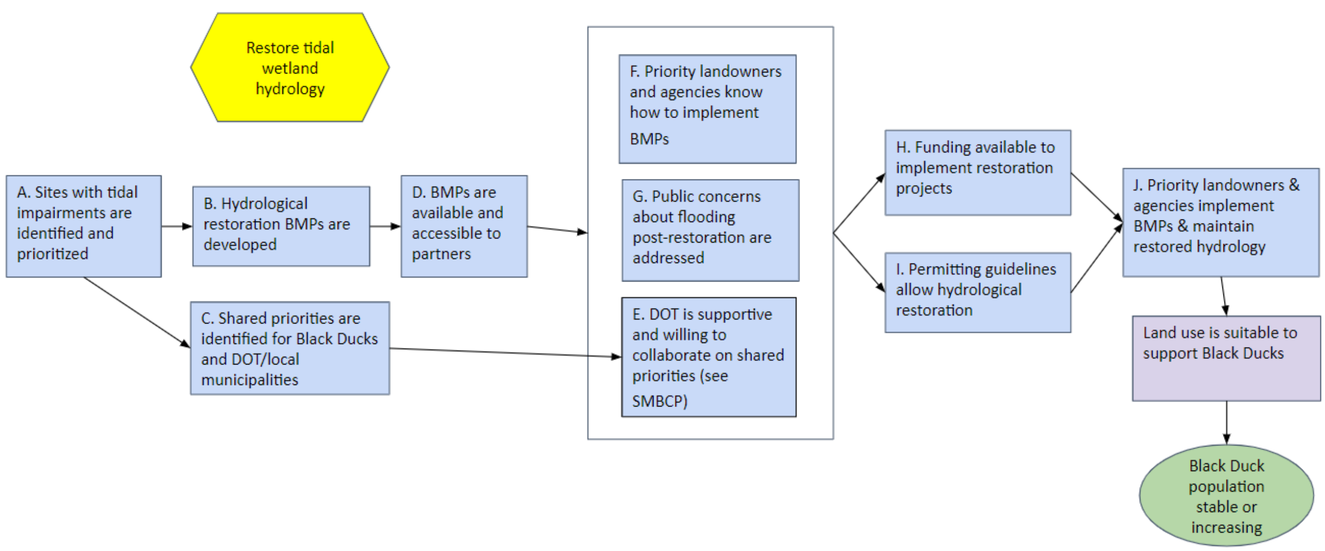
As a necessary first step, the laws, policies, and processes that are impeding conservation efforts must be identified on a state by state basis and made readily available to practitioners. This will help regulators identify opportunities to modify them and to develop guidelines to help practitioners more efficiently navigate the permitting process. One example of a successful outcome is development of a series of “Programmatic Permits”, where regulators agree on a set of management practices that can be largely exempt from permitting if they follow established guidelines. This can begin with federal and state agencies, but ultimately needs to be done at many levels to be effective.

RESTORE TIDAL WETLAND HYDROLOGY

The majority of wintering Black Ducks are found in the vast tidal wetland systems of the Mid-Atlantic. These systems have been extensively altered over the course of hundreds of years (Gedan et al. 2008) first for agriculture and then later for various forms of human development. Approximately 90% of salt marshes from Virginia to Maine have been ditched - first for salt marsh haying and later to control mosquito populations (Tonjes 2013). Associated agricultural infrastructure such as low dikes and berms that date as far back as 400 years, crisscross marsh systems and alter the flow of water and sediment across the marsh platform. Roads and railways fragment or border many tidal marshes, creating berms that hold water back, cut it off from uplands or prevent landward migration. Where transportation infrastructure crosses tidal channels, restrictions are often created where undersized culverts or tide gates reduce tidal flow above restrictions as well as freshwater flow of upland floodwaters. More recently, rising seas are adding additional pressure to marsh systems through increased flooding and storm surge events that exacerbate historic modifications.

The extensive flooding, draining or alteration of natural tidal processes across marsh systems has had dramatic impacts on vegetation composition and the loss of both structure and function of the marsh and its habitats. Reaching the goal of maintaining a stable population of Black Ducks will require restoring and enhancing a sufficient amount of salt marsh over short (<5 years), medium (5—10 years), and longer (> 10 years) time scales to ensure that sufficient high quality habitat remains. Wintering Black Ducks rely more on low marsh and mudflats, however, high marsh conservation should also be a priority as these areas are expected to convert to wetter habitats under future sea-level rise scenarios. The most immediate need for all marsh habitats is to develop and implement a variety of promising management actions to restore natural hydrology and improve ecosystem resilience.

Strategy Logic



Strategy Description

This strategy is designed to help identify and test Best Management Practices (BMPs) to restore tidal wetland hydrology to create suitable habitat for Black Ducks. By implementing this strategy, BMPs will be identified and disseminated to restoration practitioners and priority landowners and obstacles to implementing BMPs will be removed to ensure sufficient habitat is available to meet population objectives. In order to do this, sites with tidal impairments must be identified and prioritized (A). Restoration BMPs must then be developed (B) and made available to partners (D). Because transportation infrastructure is a major cause of tidal restrictions, restoration priorities must also be shared with local municipalities and Departments of Transportation to identify those priorities that are of mutual interest for restoration (C). BMPs should consider the concerns of the public about post-restoration flooding (G). If BMPs are accessible, priority areas identified on which to implement them, and public concerns addressed, this should result in priority landowners knowing how to implement them (F) and DOT being supportive and willing to collaborate (E). Landowners will also need monetary incentives (H) and the right regulatory framework (I) (i.e., permitting guidelines that allow management actions) to support implementation of these BMPs (H). If landowners implement and maintain these BMPs (J), then wetlands will provide suitable habitat for Black Ducks, ultimately leading to maintaining or increasing the overall population of Black Ducks.

Hydrological Impacts

In recent decades, sea-level rise and flooding events have increased throughout the Black Duck tidal range, leading to conversion of marsh types to wetter habitats (e.g., high marsh converting to low marsh, low marsh converting to open water or mud flat). This climate-driven change is exacerbated by the legacy of historic marsh modifications (e.g., roads, berms, ditches) that often accelerate this conversion. Dikes and berms impound tide or floodwaters and delay their exit. Ditches can drain marshes more quickly and reduce natural sediment deposition across the marsh platform while increasing it along ditch edges. Water can also get trapped on the marsh platform, leading to waterlogged conditions that result in vegetation die-off and elevation loss (Vincent et al. 2013). Ditches can also act as conduits, enabling tides and storm surge to reach areas of the marsh not historically flooded. Tidal restrictions such as culverts and tide gates can back water up both above and below the restriction from tides, storm surges or major rain events leading to vegetation die off over time. Addressing these human impacts in priority marshes will help to restore and enhance the functionality and resilience of salt marshes - a critical need that must be addressed to stabilize habitat losses and maintain the population of Black Ducks.

Because the impact of sea-level rise and its compounding impacts with human infrastructure on marsh function are relatively novel threats, there are few prescriptions of how to restore and manage degraded marshes to build resiliency over meaningful timescales. Every marsh has unique hydrology, salinities, sediment dynamics, and history of modifications that may dictate which strategies are likely to be most successful. Therefore, partners must work to test promising management actions to determine which are the most effective to apply in each priority area through pilot testing in an adaptive management framework.

The following objectives will be necessary to achieve our goals:

Key Objectives and Activities

Type	Description	Timing
Action	Develop and Test BMPs	
Objective 1	Identify and prioritize potential tidal restrictions/ditched marshes that may offer restoration opportunities in the ACJV region, by state, using the Black Duck DST.	2022
Activity 1.1	Create state by state maps of priority restrictions.	2022
Objective 2	Work with DOT and local municipalities to identify shared restoration priorities.	2024
Activity 2.1	Hold meetings with each state DOT office and relevant municipalities where joint priorities are identified to discuss restoration.	2022
Activity 2.2	Hold at least two regional DOT/municipality workshops to share information about current BMPs and shared implementation priorities for Black Ducks.	2024

Objective 3	Begin to implement at least six experimental projects, spanning at least five states, that address high priority restrictions and which can be evaluated in an adaptive management framework, to develop BMPs.	2026
Activity 3.1	Working Group agrees on use of standardized monitoring protocols (e.g., vegetation, hydrology, bird use, carrying capacity).	2022
Activity 3.2	Synthesize literature and project management outcomes and generate BMPs.	2024
Action	Facilitate Knowledge, Information, and Equipment Exchange Among Land Managers	
Objective 4	Ensure that 100% of landowners and managers of priority wetlands can access BMPs in usable format.	2025
Objective 5	Hold at least two regional landowner workshops to share information about current BMPs and shared implementation priorities for Black Ducks.	2024
Action	Remove Permitting Obstacles	
Objective 6	Within five years of Plan release, begin developing permitting guidelines in partnership with permitting agencies to allow BMP activities.	2026
Activity 6.1	Work with permitting agencies to create state and federal flowcharts that provide step by step guidance on what to expect in regards to permitting requirements when implementing management projects.	2024
Activity 6.2	Assess status of State and Federal permitting to determine which are in need of better guidelines.	2024
Activity 6.3	Communicate successes from progressive districts to other districts and from successful restoration projects to permitting agencies.	2024
Action	Engage Landowners in Implementing BMPs	
Objective 7	Within five years of Plan release, ensure that state DOTs and local municipalities of top 20% of priority wetlands direct funds to carry out priority restoration projects.	2026
Activity 7.1	Raise awareness and provide technical expertise among DOT and municipalities so that transportation funding is applied and additional funds are leveraged to support priority restoration projects (see Objective 2).	2024
Objective 8	Within 10 years of Plan release, ensure 25% of prioritized infrastructure projects have been restored.	2031
Activity 8.1	Hold managers workshops every five years to ensure distribution of lessons learned, sharing of new information and prioritization of new areas.	2026

RESTORE TIDAL HYDROLOGY: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

AT A GLANCE: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING RESTORE HYDROLOGY

What is needed to improve habitat differs by site, including how—and how much—its hydrology, topography, and/or elevation was altered by historic marsh modifications or other impacts. Depending on the site, one or more of the following actions is likely to improve habitat quality for Black Ducks through hydrological restoration (additional details provided below):

- Remove tidal restrictions to restore tidal flow.
- Improve hydrology by remediating ditches, trunks, and dikes.
- Create runnels to improve drainage and tidal flushing.
- Maintain and build marsh resiliency (e.g., living shorelines)

Some actions have been shown to be successful on a small scale or in other geographies but need to be tested in the Atlantic Coast on more meaningful scales; others have never been tested but seem promising to tidal marsh experts. All actions must be tested in as many marshes and as many states as possible to quickly learn which are most effective to enable partners to refine and improve implementation efforts. The efficacy of each action likely will depend on site-specific factors like geomorphology, sediment supply, and the nature and degree of marsh degradation.

Tools have been and continue to be developed to assess tidal marsh health and resiliency, identify good candidate sites for restoration, and guide which techniques (e.g., digging runnels or removing restrictions) are likely to be needed (Raposa et al. 2016; Ganju et al. 2017; Wasson et al. 2019). Restoration is likely to be most effective when carried out at sites where conditions such as accretion rates, tidal amplitude, erosion, and relative sea-level rise indicate that the site is relatively resilient and likely to be around for decades to come.

Remove Tidal Restrictions to Restore Tidal Flow

Where tidal flow has been restricted, salt marsh formation and/or native processes are often limited or prevented. Salt marsh extent, integrity, and resilience can be restored or improved by removing or enlarging the restriction (e.g., replacing culverts with an open span or larger box culvert). Areas upstream of tidal restrictions have often experienced subsidence due to reduced sediment supply, decomposition of the peat layer or excessive flooding that leads to plant die offs (Roman et al. 1984). Therefore, restoration projects should be planned carefully to avoid inundating areas where the marsh platform has been lowered. Full tidal flow may need to be reintroduced gradually or incrementally to provide an optimal depth for marsh grass production and accretion to avoid creating extensive areas of open water. Although restoring tidal flow can provide both short-term (e.g., increasing salinity to reduce Phragmites) and long-term (e.g., increasing sediment supply and marsh migration) benefits to marsh resiliency, careful consideration must be given to avoid unintended conversion to open water (Hinkle & Mitsch 2005).

Improve Hydrology by Remediating Ditches, Trunks, and Dikes

Restoring more natural hydrology is very important in tidal marshes that have been substantially modified, and is often critical to improving or ensuring their resilience in the face of sea-level rise. Ditches, dikes, and historic water control structures all can impede hydrology and degrade salt marshes, especially when compounded by sea-level rise. Extensively ditched marshes can be improved or restored by filling some—

RESTORE TIDAL HYDROLOGY: PROMISING MANAGEMENT ACTIONS IN NEED OF TESTING

but not all—ditches with sand or sediment, working from the upland edge, or repeatedly cutting and raking salt hay into selected ditches over a period of years (Burdick et al. 2019) to trap sediment. This can increase sheetflow of tidal water across the marsh, which increases sediment capture and accretion of the marsh platform. Trunks or water control structures and dikes can be removed or breached to allow tidal flow, or replaced with tide gates to facilitate gradual reintroduction of tidal flow over time, which may be necessary to restore areas that have experienced subsidence.

Saltmarsh restoration project that involved meanders and panne installation. Ducks Unlimited

Create Runnels to Improve Drainage

Where tidal marshes have impoundments from historic dikes or other infrastructure, or are frequently or excessively flooded due to impeded drainage, marsh hydrology, tidal flushing and sediment deposition can be improved by creating runnels— shallow channels that connect to existing tidal creeks. Relatively short and shallow (6-12") runnels can be made by hand using shovels, although long or deep runnels (~1m deep or wide) will require heavy equipment. Early experimentation with runnels in New England and the Mid Atlantic has yielded promising results that suggest this technique is effective at restoring healthy marsh habitat (Wheeler 2017).

Maintain and Build Marsh Resiliency

In some areas, erosion from waves (e.g., from the wake of large ships) or currents reduces the size and integrity of large salt marshes, both through direct marsh loss and by fragmenting large marsh complexes into smaller, less resilient patches, accelerating the conversion of marsh to wetter types and causing widespread marsh loss. Sea-level rise often exacerbates this problem. Resilience can be maintained or improved either through hardened infrastructure (such as breakwaters or other wave attenuation structures) or by various approaches collectively referred to as living shorelines (Davis et al. 2015). Traditional hardened erosion control structures such as bulkheads or seawalls that focus on deflecting wave energy away from a site may actually increase erosion (Naturally Resilient Communities 2021), whereas living shorelines are designed to reduce wave energy while allowing important natural processes to continue and maintain ecosystem health. Living shorelines include creating oyster reefs or rock sills that are permeable and provide fish habitat, yet can reduce erosion and provide long-term benefits to the integrity of the salt marsh ecosystem. These practices have been effective at reducing erosion, capturing sediment, and increasing marsh extent (Davis et al. 2015). Regional approaches may differ, but are increasingly available and being studied (Smith et al. 2020) and promoted by federal agencies such as NOAA and state coastal management agencies and NGOs (e.g., Woods Hole Group 2017, Living Shorelines Academy 2020).

IMPROVE WATER LEVEL MANAGEMENT IN IMPOUNDED WETLANDS

Example of freshwater moist soil impoundment in MD. Prior to restoration this site was in active agriculture. Ducks Unlimtied

Recent research (Roberts et al. 2019) suggests that Black Duck populations may be limited by the quality and/or availability of migration and wintering habitats. Black Ducks use a broad diversity of wetland habitats to sustain themselves through the non-breeding period and preferred habitat types can vary substantially based on specific wintering locations. Nonetheless, intensively managed impounded wetlands, or impoundments, are among the most frequently used habitat types for migrating and wintering Black Ducks in the ACJV. For example, Black Ducks at Chincoteague NWR in Virginia were documented as using impounded wetlands more than any other habitat type except for salt marshes (Morton et al. 1989b). Livolsi et al. (2021) asserted that coastal impoundments in Delaware, if maintained over time, will provide increasingly important habitat for wintering dabbling ducks, including Black Ducks, as other desirable coastal habitats are lost or converted by rising sea levels.

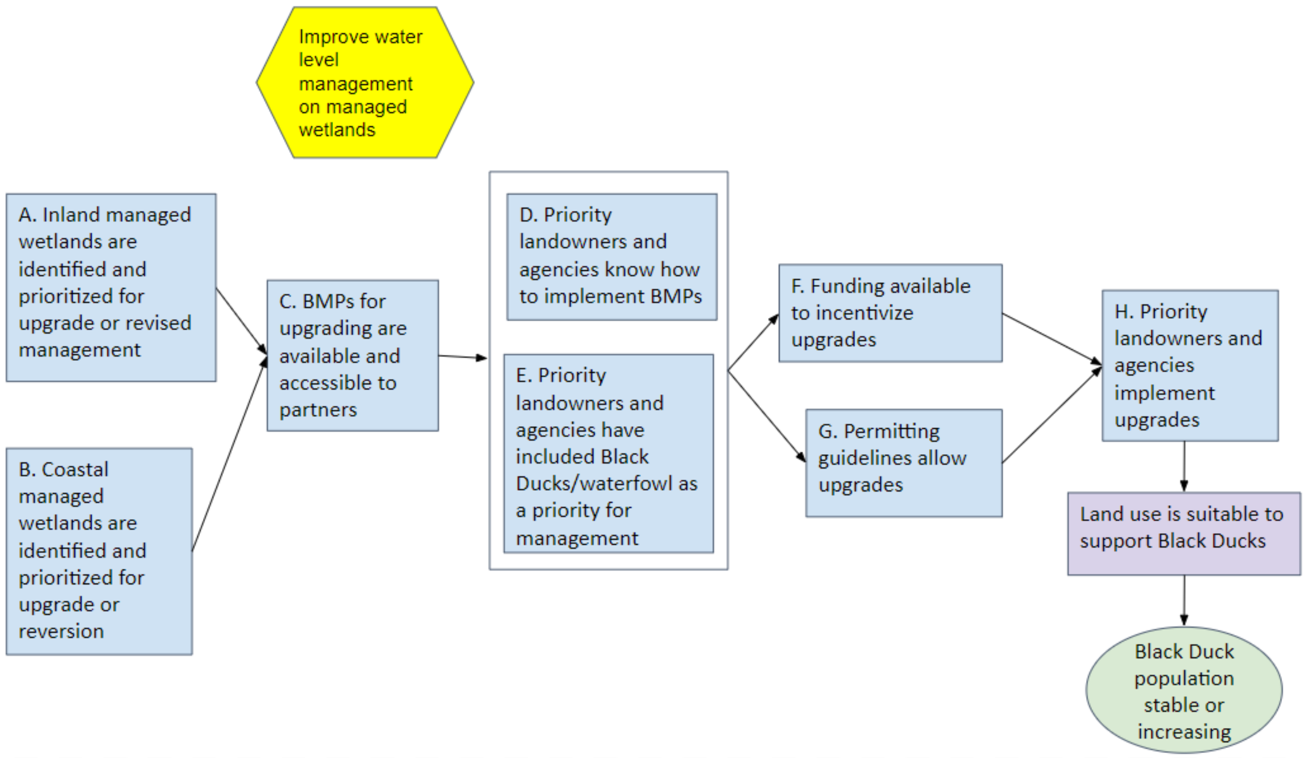
In the context of this strategy, impounded wetlands are defined as wetlands which, at minimum, include 1) some form of human-made infrastructure which physically impounds water (e.g., berms, dikes, levees, ditch plugs, etc.) and 2) the ability to physically manipulate water levels using some form of water control structure. Throughout the range of the Black Duck, hundreds of thousands of acres of impounded wetlands exist, with individual impoundments ranging in size from <1-acre to thousands of acres. Historically wetlands were impounded for a variety of reasons (agriculture, pest control, flood control, etc.), but today many impoundments are managed specifically to benefit waterfowl and other wetland dependent wildlife. Through the manipulation of vegetation (i.e., mechanical or chemical treatments), water depth, and sometimes salinity, impoundments can be managed to provide desired water levels and vegetation composition to support Black Ducks, other waterfowl and wildlife species.

Although impoundments can be managed specifically to benefit Black Ducks and other waterfowl, success is often compromised by the following challenges:

- Limited knowledge by managers and landowners about Black Duck habitat preferences and life history requirements;
- Lack of impoundment management expertise to achieve optimal habitat for Black Ducks and other waterfowl;
- Competing interests or impoundment management strategies that prioritize other species over Black Ducks;
- Lack of formal impoundment management plans;
- Deteriorating infrastructure, which inhibits water level/vegetation management, caused by lack of maintenance and often exacerbated by environmental stressors such as sea-level rise and increasing storm surges;
- Lack of know-how and resources needed to identify and address deteriorating infrastructure;
- Lack of sustainable and sufficient dedicated funding to support adequate staff and the management/maintenance actions required to achieve long-term optimal Black Duck habitat in impoundments; and
- Permitting challenges, particularly for coastal impoundments, that create obstacles to maintaining impoundment infrastructure.

This strategy will provide an overview on improving habitats in existing impounded wetlands and offer resources and recommendations to address the challenges described above.

Strategy Logic



Strategy Description

This strategy is designed to help synthesize and apply Best Management Practices (BMPs) to improve water level management on impounded wetlands for the benefit of Black Ducks and other migratory waterfowl. We expect that by implementing this strategy, we will be able to disseminate BMPs to priority landowners and remove obstacles to implementing BMPs to ensure sufficient habitat is available to meet population objectives. In order to do this, impoundments in need of upgrades or revised management must be identified and prioritized in both tidal (B) and non-tidal (A) settings. Restoration and enhancement BMPs must then be made available to partners (C). If BMPs are accessible and priority areas have been identified on which to implement them, this should result in priority landowners knowing how to implement them (D) and being willing to include them as management priorities (E). Landowners will also need monetary incentives (F) and the right regulatory framework (G) (i.e., permitting guidelines that allow management actions) to support BMP implementation (H). If landowners implement and maintain these BMPs, then wetlands will provide suitable habitat for Black Ducks, ultimately leading to maintaining or increasing the overall population of Black Ducks.

Habitat Preferences and Life History Requirements in Context of Impounded Wetlands

Properly managed impounded wetlands maximize foraging resources and provide a consistent, annual source of energy and nutrients for migrating and wintering Black Ducks. Impoundments that provide high quality habitat are managed in a manner that meets Black Duck life history requirements, including flooding and dewatering schedules that align with fall arrival, peak populations, and spring departure. Because Black Ducks tip up to forage, shallow water depths (≤ 15 in; preferred 3–7 in) are essential to maximize foraging opportunities (Fredrickson 1991). In addition, hemi-marsh conditions (50:50 interspersal of open water to vegetation) are desirable (Kaminski and Prince 1981, Pearse et al. 2011). To meet the energetic and nutritional demands of Black Ducks, impoundment managers should also strive to provide a diversity of animal and plant foods (Costanzo 1988, Costanzo and Malecki 1989, Jorde and Owen 1988; 1990, Cramer 2009, Lewis 2015). Finally, due to its wary nature, Black Ducks are intolerant of human disturbance (Longcore et al. 2000) so care should be taken to minimize nearby disturbance.

Key characteristics of managed impoundments with strong potential for supporting Black Ducks include:

- Managed for shallow water depths (≤15 in; 3–7 in) to maximize foraging opportunities;
- Flooding and drawdown schedules synchronized with fall arrival, peak population presence, and spring departure;
- Managed for hemi-marsh conditions (50:50 ratio of interspersed open water and vegetation);
- Managed to produce a diversity of high energy, nutrient rich foods (seeds, vegetation, and animals);
- Largely free of invasive plants (e.g., Phragmites);
- Near estuarine and marine wetlands, tidal flats and creeks, and palustrine forested, scrub-shrub and emergent freshwater wetlands;
- Sheltered from severe weather and resilient to storm surges and flood events;
- Buffered from disturbance associated with human infrastructure and activity (e.g., housing, roads, etc.);
- Associated with complexes (≥ 5) of managed impoundments;
- Sized between 5 and 100 acres to facilitate management and Black Duck use; and
- Have reliable, functioning infrastructure and independent water supply and discharge capabilities.

Moist soil management and perennial hemi-marsh management are two of the most important impoundment management strategies for Black Ducks wintering in the ACJV region. When considering management approaches for an impoundment in the ACJV region, these two strategies should be prioritized to maximize benefits to Black Ducks. Moist-soil management utilizes seasonal drawdowns to promote productivity of desirable annual seed-producing plants, which maximizes food availability for Black Ducks and other waterfowl. Fredrickson (1991) and Fredrickson and Taylor (1982) offer more detailed information on moist soil management. Perennial hemi-marsh management seeks to maximize production of perennial plant communities, which provide seeds, roots, and other plant materials that are valuable food resources for Black Ducks. Ideally, hemi-marsh wetlands maintain a 50:50 ratio of emergent vegetation and open water (Nelms 2007).

Agricultural crops are also an important food source for wintering Black Ducks in the ACJV region. Agricultural crops like corn and millet are planted in impounded wetlands and flooded specifically to provide a high-energy food source for migratory waterfowl. Although to a lesser extent than species such as Mallards, Black Ducks are documented using these habitats extensively. Ringelman (1990) offers additional information about managing agricultural crops to benefit waterfowl.

Impoundment at Blackwater six months after contruction. Ducks Unlimited

Other impoundment management strategies that can benefit Black Ducks but that are less common in the ACJV region are submerged aquatic vegetation (SAV) management and green-tree reservoir (GTR) management. Detailed information regarding SAV and GTR management can be found in Bauer et al. (2020) and Fredrickson and Bateman (1992), respectively.

Water control structure on Hog Island, Virginia. New Jersey Audubon Society

Increasing Impoundment Management Experience Among Managers and Landowners

To manage impoundments for wetland wildlife effectively, a basic understanding of the life history and habitat requirements of the target species is required. The ability to effectively deliver desirable benefits established for an impoundment area must include high level expertise, staff willing to implement activities, and dedicated funding for management actions (see Dedicated Funding p. 36 below), maintenance needs, and staff support. While basic impoundment management concepts and techniques are relatively straightforward, managers should recognize that only site-specific assessments and subsequent adaptive management decisions can achieve objectives successfully.

Experience managing impounded wetlands is best gained through hands-on opportunities. In recent years, many agencies with impoundment management responsibilities have experienced institutional knowledge losses via retirement of experienced wetland managers. Concurrent to this transition to a younger, less experienced land management staff, the North American Waterfowl Management Plan has acknowledged a marked decline in collegiate programs that focus specifically on waterfowl research and management (Kaminski 2002). In addition to professional wetland managers, private landowners also bear management responsibilities for countless acres of impounded wetlands in the ACJV region. Offering hands-on opportunities for professional managers and private landowners to acquire experience in impoundment management will result in improved habitats on the landscape supporting Black Ducks and other waterfowl species.

Emphasis should be placed on supporting efforts to maintain existing university waterfowl research and management programs and on expanding these programs into additional universities in a manner that ensures their long-term sustainability. This will improve the knowledge base of upcoming wetland management professionals who are tasked with managing impoundments for the benefit of waterfowl.

Impoundment management workshops for private landowners and agency staff are offered by Wetland Management and Educational Services, Inc. and other similar consultants. At a broader level, Wetland Reviews are a newer approach to wetland management which seek to “link people and habitat management to biological outcomes across public and private lands” (Tashjian et al. 2018). Management workshops and Wetland Reviews help to improve expertise of the existing workforce. In the past, these workshops have been more widespread in the Mississippi Flyway and numerous south Atlantic states but focus should be placed on coordinating similar opportunities at centralized locations in the ACJV region to promote hands-on learning opportunities for individuals with impoundment management responsibilities.

Define Management Goals, Develop Formal Management Plans, Implement Adaptive Management

Successful Impoundment Management Plans must detail target management activities, clear goals, a path to accomplish their objectives, minimize expenses, and ensure the long-term productivity of the site for wildlife and other resources. Black Ducks are highly mobile species with diverse habitat needs, which may change seasonally or even daily. Providing diverse, high-quality habitat is critical to ensuring populations continue to thrive. To achieve this, private landowners and professional wetland managers must establish clear priorities and objectives for impoundment management and document them in a formal management plan. Where appropriate, multi-species management approaches that benefit multiple priority species should be prioritized, however, managers should acknowledge that it is possible for conflicting management interests to result in reduced habitat quality for all focal species. This outcome can be avoided by establishing clear goals and objectives in well-defined management plans to help minimize the possibility of conflicting species management. Questions that should be considered when developing a management plan include — "What do we want to achieve?", "What are the resources needed to complete the project— what will it take?", "How will we adapt— what seasonal variations do we need to consider?", and "What should be considered for future years — how will we monitor and adapt?".

Infrastructure Maintenance Considerations

Impoundment infrastructure is critical to enabling managers to maximize habitat benefits for Black Ducks and other waterfowl. Infrastructure requires recurring maintenance over time. Managers of publicly owned impoundments should incorporate these maintenance requirements and costs into long-term management plans and private landowners should consider these factors before pursuing impoundment development. Foregoing recurring maintenance can result in larger-scale problems, contribute to compounding costs, and can significantly degrade habitat value.

Storm-related damage to impoundments at Forsythe NWR in New Jersey. New Jersey Audubon Society

Recurring maintenance includes annual monitoring of dikes and water control structures to identify potential issues. Maintenance costs can be minimized by addressing potential issues (e.g., burrowing mammal activity, woody vegetation growth on dikes, beaver activity, erosion from wave energy, deteriorating water control structures, etc.) as they arise and before they create larger problems. Fredrickson and Taylor (1982) offer more detailed explanations of specific maintenance considerations associated with developing and managing impoundments.

Some impoundments, particularly those located in coastal settings, are subject to additional environmental stressors such as sea-level rise and storm surges which can negatively affect impoundment infrastructure and resiliency, resulting in more frequent maintenance needs. When considering the long-term viability of an impoundment, resiliency to these types of stressors should be paramount. In some cases, it may be determined that an impounded wetland may not be ecologically or economically sustainable and that continued investment toward infrastructure maintenance cannot be justified. In these cases, improved habitat may be achieved by restoring historical tidal wetland processes rather than maintaining impoundment infrastructure. This is particularly true for Black Ducks as they exhibit high associations with tidal salt and brackish wetlands. See the Restore Tidal Marsh Hydrology strategy (p. 35) for additional details on techniques for reverting impounded wetlands to tidal systems when suitable.

The wetland conservation research and implementation community has invested resources into understanding the sustainability and resiliency of individual coastal impoundments. Examples include:

- New Jersey Audubon's Coastal Impoundment Vulnerability and Resilience Project, which attempts to catalogue all state, federal, and privately owned coastal impoundments from Maine to

Virginia. (https://njaudubon.org/coastal-impoundments/)
- USFWS's Region 5 Impoundment Vulnerability Assessment Project, which considers the vulnerability of USFWS owned impoundments in the Northeastern U.S. (USFWS 2018)
- Various state agencies have performed resiliency analysis for their own state-owned impoundments and information may be obtained by contacting relevant state agencies directly.

Fairmount Wildlife Management Area in Maryland. New Jersey Audubon Society

Many federal and state wildlife agencies, as well as non-government organizations such as Ducks Unlimited, have staff experienced in impoundment management and maintenance requirements. If impoundment infrastructure has deteriorated to the point that landowners and managers are unable to address concerns directly or if there are questions about the long-term sustainability of a particular coastal impoundment, consultation should be sought from these organizations.

Dedicated Funding

Managing and maintaining wetland impoundments requires significant and dedicated funding for management actions, maintenance needs, and staff support. Sustainable funding for wetland conservation is strongly connected to traditional funding sources, often state or federal, that advance conservation programs for land and water protection. Advocating for continued sustainable government funding and programs, such as federal appropriations for the North American Wetland Conservation Act, will ensure landscape level conservation of wetland resources to meet the needs of Black Ducks. However, the availability of public funding can often be limited by high demand, complex and bureaucratic processes, budgetary pressure, and political climates. Non-traditional funding through corporations and foundations is often required to support large programs and leverage public dollars. Expanding non-traditional funding sources while advancing traditional sources will require ongoing outreach and education highlighting the value of restored, enhanced, and managed impoundments.

As part of a landscape level cooperative effort to manage impoundments for Black Ducks, agencies and private organizations should also include private lands programs (Schultz 1990). Numerous federal and state programs are specifically designed to help support restoration, management, and enhancement of wetland impoundments on private lands. Private landowner incentive programs, such as NRCS and USFWS Partners Program, will ensure continued investment into landscape level needs for Black Ducks, although the accessibility and efficiency of these programs should be reviewed and improved where possible.

Permitting

As with most of the strategies laid out in this plan, permitting can pose significant challenges to implementing restoration projects (see Regulatory Issues, p.13). Although some accommodations have been made at the federal level for impoundment enhancement projects, the same does not always hold true for state and local permitting agencies. Moreover, it is uncommon for agency permit review staff to have backgrounds in wildlife conservation or for them to review such permit applications in the context of the project's intent – wildlife habitat improvement – instead of net wetland loss.

The following objectives will be necessary to achieve our goals:

Key Objectives and Activities

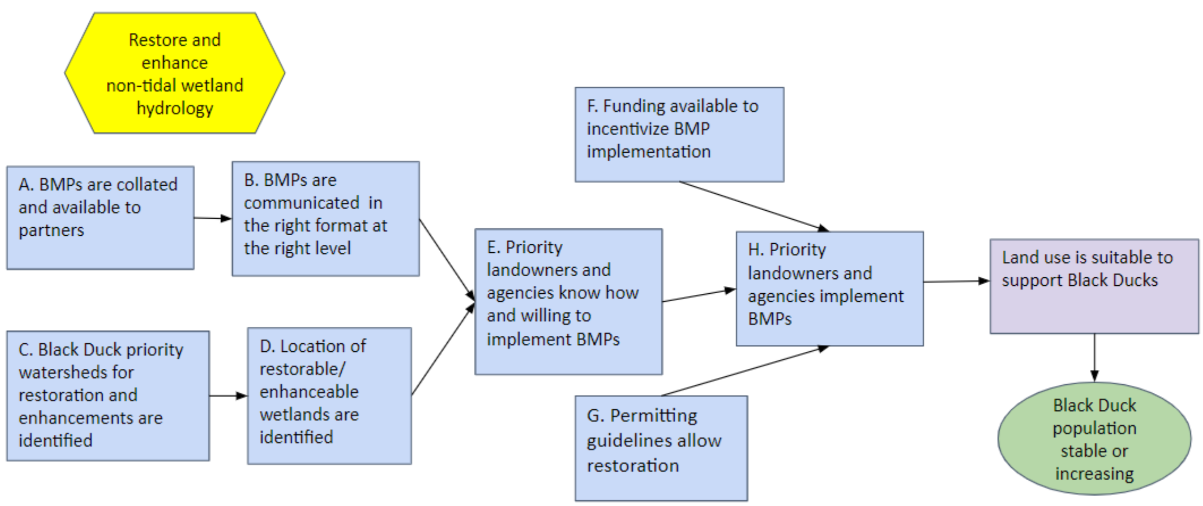
Type	Description	Timing
Action	Develop and Test BMPs	
Objective 1	Create an updated spatial layer/inventory of all managed wetlands within the ACJV.	2022
Activity 1.1	Identify those wetlands that are in need of upgrades within DST priority HUCs.	2022
Action	Facilitate Knowledge and Information Exchange Among Land Managers	
Objective 2	Ensure that 100% of landowners and managers of priority areas can access BMPs for upgrades in usable format.	2023
Objective 3a	Hold at least two regional land managers' workshops to share information about current BMPs and implementation priorities for Black Ducks/waterfowl and every five years thereafter.	2024
Objective 3b	Evaluate planning processes, by agency, to tie Black Ducks/waterfowl into planning priorities and engage decision- makers where necessary to elevate Black Duck/waterfowl as a priority.	2025
Action	Remove Permitting Obstacles	
Objective 4	Initiate dialog with permitting agencies to better understand and potentially improve the permitting process to achieve wetland management goals.	2022
Activity 4.1	Work with permitting agencies to create state and federal flowcharts that provides step by step guidance on what to expect in regards to permitting requirements when implementing management projects.	2024
Activity 4.2	Assess status of State and Federal permitting to determine which are in need of better guidelines.	2024
Activity 4.3	Communicate successes from progressive districts to other districts and from successful restoration projects to permitting agencies.	2024
Action	Engage Landowners in Implementing BMPs	
Objective 5	Ensure that landowners of the top 25% of priority managed wetlands have the funds to carry out upgrades.	2026
Activity 5.1	Engage funders to ensure that funding policies prioritize enhancement as well as restoration work.	2023
Activity 5.2	Engage funders (e.g., private foundations) to educate them on the value of wetland management for Black Ducks/waterfowl and alignment with funding priorities.	2023
Objective 6	Ensure priority land managers have upgraded at least 25% of prioritized managed wetlands.	2031

RESTORE AND ENHANCE NON-TIDAL WETLAND HYDROLOGY

Throughout the species' range and annual cycle, Black Ducks rely heavily on non-tidal freshwater wetlands, streams and rivers, as well as tidal habitats. The US experienced its greatest wetland loss between the 1950s and 1980s (Frayer 1983), which corresponded with the >50% loss of Black Ducks (Baldassarre 2014) during that period. Throughout much of the 20th century, state and federal programs and private landowners systematically drained wetlands for agricultural and other human uses (e.g., buildings, roads). For the last few decades, state and federal agencies and NGOs have been restoring and enhancing wetlands in an attempt to improve the quantity and quality of wetlands for waterfowl and other wildlife. The availability of high quality non-tidal wetland habitats is necessary to maintain and increase Black Duck populations, and will become increasingly important as these habitats continue to be lost or degraded due to development, pollution, excessive nutrients, algal blooms and other stressors.

Achieving our population objective will require a combination of conservation actions to increase suitable non-tidal habitat to expand the availability and quality (i.e., energetic capacity) of Black Duck habitats throughout their annual cycle.

Strategy Logic



Strategy Description

This strategy includes both natural and managed (i.e., restored) wetlands that have been impacted by drains and ditches, and complements the strategy above focused on intensively managed wetland impoundments. This strategy is intended to help 1) identify and prioritize areas to implement wetland habitat restoration and enhancement activities, 2) synthesize and communicate Best Management Practices, and 3) promote and enable management actions that improve non-tidal wetland habitat quality and quantity to support Black Duck population objectives. We encourage an adaptive management framework, where monitoring is used to evaluate and improve effectiveness. In order to do this, existing BMPs must be collated (A) and communicated to partners in the right format and at the right level to meet their needs (B). We must also identify which watersheds are the highest priority to apply BMPs (C) and the locations of those wetlands that are restorable or enhanceable within the priority watersheds (D). These BMPs will then need to be shared with priority landowners and agencies in a format that is suitable for their needs and which provides the guidance they need to take action (E). Landowners may also need financial support or incentives (F), and a regulatory framework (G) that permits desired management actions to support BMP implementation (H). If landowners implement BMPs, we expect that wetlands will provide suitable habitat for Black Ducks, ultimately leading to maintaining or increasing the overall population of Black Ducks.

Improving Management Actions

Increasing the acreage and quality of non-tidal wetland (hereafter, wetland) habitat can be done via restoration (restoring pre-existing wetlands that have been drained or degraded); enhancement (improving wetland function and value, and water quality); and creation (constructing wetlands in areas that were formerly uplands). Each of these approaches represents a wide range of different techniques which, though they may differ in fundamental ways, all result in increased opportunity for sustaining waterfowl populations. Current wetland restoration and enhancement methods focus on restoring hydrology and hydric vegetation to drained or degraded wetlands. Many freshwater wetlands were drained decades ago by open water ditches and subsurface drains to support agricultural activity. Restoration techniques such as breaking or eliminating underground tile lines and rock drains, constructing low head dikes, creating shallow water potholes, installation of water control structures to help mimic historical wet/dry cycles, and breaching levees or barriers to restore floodplain hydrology are well researched, proven, and effective.

There are several management guidelines already in use to guide wetland habitat management (Fredrickson and Reid 1988, USDA 2008), some of which are tailored to benefit Black Duck or other waterfowl species (Wetland Science Institute 2003). However, clear, regionally-specific guidelines that prioritize the areas and specific habitat types that would provide the greatest benefits to Black Ducks as well as Best Management Practices that detail the most appropriate and effective techniques would be very valuable. Management actions should be implemented in an adaptive management framework, to evaluate and improve the efficacy of methods. The most effective (and cost-effective) approaches should then be promoted and scaled to other areas where they are expected to achieve similar benefits. Any traditional management methods that are no longer considered effective should be discouraged and replaced with alternative recommendations.

Several areas of research are necessary to improve desired management outcomes. For example, pockets of overwintering Black Ducks are known to use open water streams during harsh winters when most open water habitat is frozen. Research on this habitat type, available food resources, and degree of utilization would help determine if protecting and improving habitat conditions in such areas is important for meeting the energetic demands of wintering Black Ducks.

American Black Duck resting. Dave Bowers

The following objectives will be necessary to achieve our goals:

Key Objectives and Activities

Type	Description	Timing
Action	Develop and Test BMPs	
Objective 1a	Implement experimental projects in at least 25% of non-tidal restoration HUCs identified by the DST to identify effective management methods to restore drained wetlands.	2024
Activity 1.1	Define, identify and rank priority HUC12s.	2022
Activity 1.2	Define what is a restoration priority area and what the habitat target(s) should be.	2022
Activity 1.3	Develop restorable wetlands spatial layer that indicates degraded wetlands in Black Duck Priority areas.	2022
Objective 1b	Institute monitoring protocols to evaluate the effectiveness of various management actions and develop BMPs for degraded wetlands.	2023
Activity 1.4	Consolidate standardized monitoring protocols and develop an online site to host them.	2022
Objective 1c	Ensure funding and support is in place to institute monitoring protocols.	2023
Activity 1.5	Develop a list of funders and collaborators (agency partners, consultants, etc) who typically institute monitoring work and host in a centralized location with the goal to identify opportunities for collaboration.	2022
Activity 1.6	Conduct targeted outreach to funders and academic partners to get them on board with the need for monitoring and the need for coastal restoration.	2022
Objective 1d	Conduct workshops every five years, beginning in 2026, to exchange information, promote promising techniques, and recommend regional BMPs for drained wetland restoration.	2026
Action	Facilitate Knowledge, Information, and Equipment Exchange Among Land Managers	
Objective 2	Ensure that 100% of landowners and managers of priority areas can access BMPs in usable format.	2026
Objective 3a	Ensure that landowners of properties within at least 25% of priority HUC 12 watersheds (in restorable wetland areas) have been engaged in outreach efforts on Black Duck conservation.	2028
Activity 3.1	ID priority private/municipal lands for outreach.	2028
Activity 3.2	Develop effective outreach/engagement efforts (e.g. landowner workshops, hire landowner outreach specialists) and provide opportunities for protection and restoration.	2026
Objective 3b	Ensure that landowners of properties covering at least 50% of priority HUC 12 watersheds have the capacity (e.g., incentives, funds, access to technical assistance etc.) to restore drained wetlands.	2028
Activity 3.3	Develop and circulate a list of contractors by state/region who are available to do this kind of work and have the equipment to do it.	2026
Action	Remove Permitting Obstacles	
Objective 4	Begin developing permitting guidelines in partnership with permitting agencies to allow BMP activities for the top two BMPs with permitting challenges.	2028
Activity 4.1	Assess current status of State and Federal permitting for BMPs to determine which are in need of better guidelines.	2026

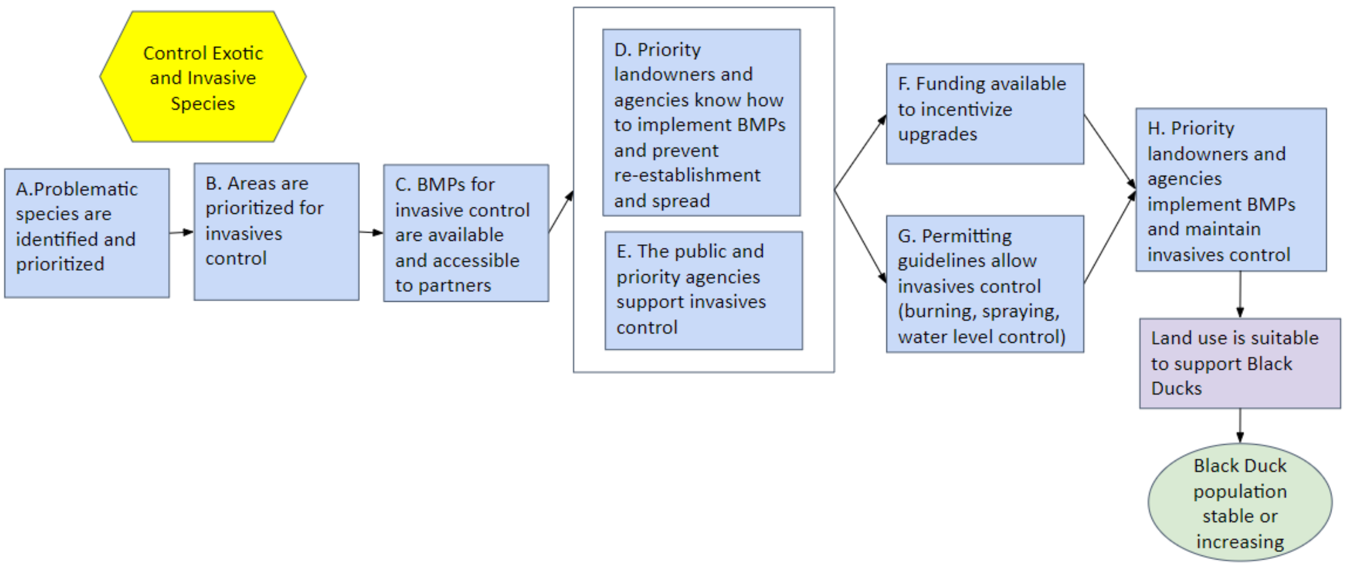
Activity 4.2	Communicate successes from progressive districts to other districts and from successful restoration projects to permitting agencies.	2026
Activity 4.3	Collaborate with Coastal State Organizations (CSOs) with a goal of addressing permitting challenges.	2026
Action	Engage Landowners in Implementing BMPs	
Objective 5	Ensure priority land managers and landowners of public lands are managing their restored wetlands and private landowners have the resources to manage their restored wetlands on at least 25% of HUC 12 priority watersheds.	2033
Activity 5.1	Ensure private landowners have updated land management plans.	2030
Activity 5.2	Assess which states have a wetland assessment requirement and help those states without one to develop one.	2028
Objective 6	Within 10 years of BMP development, assist priority landowners with NRCS sign-ups to implement BMPs on at least 10% of priority HUC 12 watersheds.	2033
Activity 6.1	Identify private lands that are eligible for NRCS programs (e.g. above high tide line, etc.; varies by state) as well as practices that may be eligible in some states and not others (e.g. phrag control, working in salt marsh).	2025
Activity 6.2	Hire landowner outreach positions in at least TBD.	2030

Working with landowners. Ducks Unlimited

CONTROL EXOTIC AND INVASIVE SPECIES

Invasive and exotic species pose the single greatest threat to biodiversity and native species (Richter et al. 1997, Wilcove et al. 1998). These species include both plant and animal species that negatively affect Black Duck habitat and/or access to that habitat. The goal of this strategy is to eliminate or suppress the spread of invasive and exotic plants in wetlands and to eliminate or suppress population growth of invasive animal species through the use of trapping or hunting.

Strategy Logic



Strategy Description

This strategy is designed to help synthesize and apply Best Management Practices (BMPs) to control problematic and invasive species for the benefit of Black Ducks. We expect that by implementing this strategy, we will be able to identify and prioritize problematic species (A) as well as areas to implement control measures (B). BMPs must then be synthesized and made accessible to partners involved in land management (C). If BMPs are accessible, priority landowners and agencies will have the knowledge to implement BMPs (D). Work must also be done to ensure that both the public and the target agencies are supportive of the control efforts (E). If this work is done, sufficient funding is available (F), and permitting guidelines allow appropriate forms of control, then priority landowners should be able to implement and maintain invasives control on priority lands (H). This will result in habitat that is suitable for Black Ducks, ultimately leading to maintaining or increasing the overall population of Black Ducks.

Invasive Species in the Atlantic Flyway that Negatively Impact Black Ducks

A total of eight invasive species were identified by the Black Duck Working Group as particularly impactful to Black Duck populations. These species include four plant and four animal species. Given the number of different species, methods of allowable control, and the geographical extent of the problems these species manifest, prioritization is necessary. An initial prioritization exercise was conducted by members of the Working Group that incorporated both the geographical scale of the threat in each state and the ecological impact of that threat. The latter was weighted twice as much as the geographic scale for this initial prioritization (Table 2).

Table 2: Results of invasive species prioritization process by state. The higher the score, the greater the threat and/or geographic extent. Threat scores were multiplied by two and added to geographic scores for the total score.

State	*Phragmites*	Mute Swan	Purple Loosestrife	Narrow leaf Cattail	Spatterdock	Game farm Mallards	Nutria	Carp
CT	300	150	100	0	0	0	0	0
DE	300	50	0	0	0	150	0	67
MA	300	0	0	0	0	0	0	0
MD	300	100	0	0	0	150	0	0
ME	300	0	150	100	0	0	0	0
NC	200	0	0	0	0	250	100	0
NH	300	100	150	0	0	0	0	0
NJ	300	150	67	0	0	33	0	0
NY	300	100	150	0	0	0	0	0
PA	0	0	100	250	200	0	0	0
RI	300	150	0	0	0	0	0	0
VA	300	150	0	0	0	0	100	0
VT	300	0	117	0	0	0	0	133
Total Score	**3500**	**950**	**833**	**350**	**200**	**583**	**200**	**200**

This list will be further prioritized on a geographic scale that addresses the impact of control actions on overall Black Duck population benefit, the highest priority areas for those control activities and any regulatory hurdles that need to be addressed. The final prioritization will allow for distribution of financial resources through competitive grants and other funding sources to those projects and areas that will provide the most benefit. Individual states will continue to conduct control activities as they always have, however, the prioritization will put everything into a regional scale.

The level of financial resources devoted towards control of invasive species varies across the Black Duck range as does regulatory authority for invasives control. Funding for conservation actions is typically a mix of state and federal funding, although land trusts and other NGOs are also engaged in control of invasive species on very localized scales. The degree to which funds can be expended on invasives control varies by jurisdiction. For instance, control of mute swans, an extremely volatile and politically charged conservation action, has been successfully promulgated in some states, but continues to be prohibited in other jurisdictions. Likewise, aerial spraying of invasive vegetation is an efficient technique used in some jurisdictions, but not allowed in others.

The eight priority species of concern are described briefly below in order of importance across the ACJV Black Duck range.

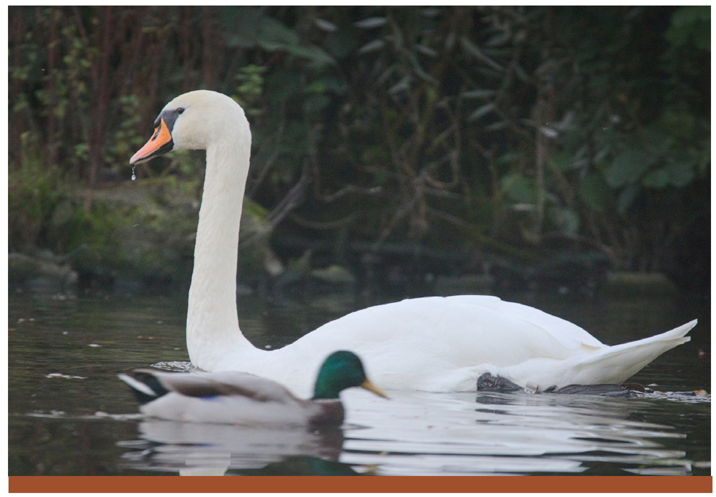
Common Reed

Common reed (*Phragmites australis* or Phragmites), greatly impacts the viability and ecological function of the wetlands that it invades (Chambers et al. 1999; Rice et al. 2000). Monocultures of Phragmites quickly render impacted wetlands useless to most species of wildlife, particularly avian species (Benoit and Askins 1999, Hauber et al. 1991). Numerous State Wildlife Action Plans specifically identify Phragmites as a serious threat to the wetlands and species assemblages in those wetlands. Nearly half of the Greatest Conservation Need (GCN) species in these State Plans are tied in some part of their life cycle to wetlands. The spread and persistence of Phragmites on the landscape is a clear impediment to recovery of these species populations.

Phragmites is most effectively managed by herbiciding one to two times per season followed by mowing the dead stems in the winter and repeated for at least three consecutive years. There is a small window of opportunity for spraying Phragmites when using a systemic herbicide such as those containing the active ingredient glyphosate. When using glyphosate, it's best to spray Phragmites after the seed head forms from late August until the first major frost, however certain other products may offer a larger window (Cross and Fleming 1989). Burning is another, lower impact, way of managing Phragmites stands if herbicides cannot be used.

Mute Swan

Mute Swans are a non-native, invasive species, brought to North America from Eurasia for ornamental purposes in the late 1800s (Atlantic Flyway Council 2015). Free-ranging mute swans became established in the Atlantic Flyway during the early 1900s and expanded rapidly throughout New England, the Mid-Atlantic and into the Great Lakes Region. From 1986-2002, the population in the Atlantic Flyway more than doubled from approximately 6,300 to more than 14,000 swans (Atlantic Flyway Council 2015). Both historical and more recent studies have documented the impacts that mute swans have on the ecological integrity of North American wetlands and the wildlife that depend on these wetlands.



Both Mute Swan and Mallards impact American Black Duck populations. Hedera Baltica, Creative Commons

The biggest impact of mute swans on the continued population growth of Black Ducks is the reduction of submerged aquatic vegetation (SAV) by swans (Allin and Husband 2003; Naylor 2004). Mute swans significantly reduce SAV biomass in those wetlands where swans are present (Allin and Husband 2003, Naylor 2004, Tatu et al. 2006, Swift et al. 2013). Studies (e.g., Krementz 1991) have correlated wintering Black Duck decline with declines in SAV. Other impacts that mute swans have on wintering and, in some areas of the Atlantic Flyway, breeding Black Ducks, is the exclusion of other waterfowl from wetlands. The aggressive nature of mute swans has been repeatedly shown to result in competitive exclusion to resources by other waterfowl species.

Purple Loosestrife

Purple loosestrife is a wetland plant native to Europe and Asia that has become a serious invader of wetlands, roadsides and disturbed areas (Blossey et al. 2001). The plant forms dense stands with thick mats of roots that can extend over vast areas. The stands reduce nutrients and space for native plants and degrade habitat for wildlife. Each plant can grow as many as 30 flowering stems that can produce up to 2.7 million seeds each year. The tiny seeds are easily spread by water, wind, wildlife and humans. The plant forms dense stands with thick mats of roots that can spread over large areas, degrading habitat for many native birds, insects and other species. Dense monocultures, similar to Phragmites invasion, result in a loss of overall biodiversity by crowding out native plants. Large stands of purple loosestrife can clog irrigation canals, degrade farmland and reduce the forage value of pastures (Thompson et al. 1987).

Game Farm Mallards

Continued large, annual releases of captive reared mallards into the Atlantic Flyway increases risks of disease transmission, genetic introgression and hybridization with Black Ducks (USFWS 2013). The threat of disease transmission remains the primary concern among nearly all State wildlife agencies, and there is evidence of possible association between the releases of captive-reared mallards and duck-plague outbreaks. These outbreaks appear to occur most frequently in areas where the largest numbers of captive-reared mallards are being released. Also, there is evidence of duck-plague vaccine virus spreading from captive-reared mallards to migratory waterfowl in Maryland (USFWS 2013).

Narrow-leaf Cattail

Narrow-leaf cattail is a highly invasive plant that invades native plant communities. Leonora Enking

Narrow-leaved cattail is an invasive originally from Asia and Africa that limits biodiversity in many wetland areas (Bansal et al. 2019; Sojda and Solberg 1993). Roots produce dense rhizome mats and clustered leaves produce a thick litter layer that reduces the opportunity for other plants to establish or survive. Many wetland areas that once contained a diverse habitat for wetland wildlife now have solid stands of cattails. Ecologically, this species can be very invasive in disturbed wetlands, where it tends to invade native plant communities when hydrology, salinity, or fertility changes. In this case, they out-compete native species, often becoming monotypic stands of dense cattails. Maintaining water flows into the wetland, reducing nutrient input, and maintaining salinity in tidal marshes will help maintain desirable species composition. In recent decades it has expanded its range in many regions and become much more abundant, especially in roadside ditches and other highly disturbed habitats, as it often out-competes many native marsh species to produce very dense, pure stands.

Carp

Introduced grass carp pose a big threat to wetland habitats throughout North America (Dibble and Kovalenko 2009). Asian carp can consume 5 to 20 percent of their body weight per day. Grass carp feed voraciously on aquatic plants and can consume large quantities in a relatively short time. Food sources within the first two weeks of hatching mainly include rotifers, protozoans, insect larvae, and other zooplankton species. Grass carp transition to filamentous algae before feeding exclusively on macrophytes starting approximately at 1 month of age. These food sources are also sought after by Black Ducks at various life stages.

Carp herbivory quickly leads to a reduction in native non-targeted species of plants is usually seen through selective feeding. An increase in turbidity is a consistent consequence of grass carp establishment; the attributed source of the turbidity, whether from sediment disturbance or increased algae abundance, varies. Grass carp can lead to the decline of plankton, zooplankton, and benthic macroinvertebrates, such as snails and crayfish, thus altering the trophic structure of invaded systems. Grass carp predate on, compete with, and deplete the habitat/shelter of benthic invertebrates. The fish waste left behind by grass carp can fuel excessive algal growth, speeding eutrophication of invaded systems.

Nutria

Nutria damage is evident to varying degrees in every area they are found. Burrowing causes the most noticeable damage. Nutria burrows can also damage flood-control levees that protect low-lying areas; weaken the foundations of reservoir dams, buildings, and roadbeds; and erode the banks of streams, lakes, and ditches. The negative impact this invasive species has on native vegetation and associated wetlands is critically important (Witmer et al. 2012).

Nutria can severely damage coastal marshes by decimating native plants that hold marsh soils together and support the survival of native wildlife species. The impact of nutria on disappearing marshlands along the Chesapeake Bay in Maryland is well documented. Nutria have caused widespread ecosystem changes. In some cases, nutria damage to marsh vegetation and soils is so severe that these resources are permanently lost.

Spatterdock

Although spatterdock is not considered invasive, its extensive rhizome system allows it to grow and reproduce rapidly if not managed. Rapid growth occurs in shallow water bodies when there is an excess of nutrients allowing the plants to completely cover the surface in just a few years, rendering that waterbody useless for waterfowl and other wetland species. Dense growth of spatterdock in shallow water areas can interfere with boating and other forms of recreation, and causes light reduction and oxygen depletion that can kill fish or other plants.

Spatterdock grows in wetlands at Jug Bay Natural Area, seen from Patuxent River Park in Prince George's County, Md. Chesapeake Bay Program

Information Exchange and Landowner Engagement

The most efficient and effective methods for control of exotic and invasive species, whether they be plant or animal, are well understood. A plethora of handbooks and resources exist that outline best management practices for control. However, those BMP's specifically tailored towards those species identified by this Plan, need to be synthesized into an easily accessible and usable form. Similarly, a roadmap for negotiating regulatory changes and hurdles needs to be synthesized by partners who have been successful in implementing various control activities that other partners in other jurisdictions are having trouble implementing.

Regional meetings of habitat managers to share information, successes and failures should be scheduled every five years in order to foster cooperation and to periodically assess progress toward goals. On the local and state level, engaging landowners to control exotic and invasive species will also be critical to long-term success. Key towards achieving this goal is ensuring that adequate funding is available to landowners for implementation as many wetland landowners have the desire to restore wetlands but are not in the position to finance conservation actions out of pocket.

The following actions and underlying objectives will be necessary to achieve our goals:

Key Objectives and Activities

Type	Description	Timing
Action	Identify Priorities for Control	
Objective 1	Black Duck Working Group identifies and prioritizes the invasive species of most concern in the ACJV region.	2022
Objective 2	Prioritize areas by state for invasives control.	2023
Activity 2.1	Create expert-generated state by state maps of control priorities within high priority HUCs identified by the DST.	2023
Action	Facilitate Knowledge and Information Exchange Among Land Managers	
Objective 3	Ensure that 100% of landowners and managers of priority wetlands can access BMPs in usable format.	2023
Objective 4	Hold at least two regional land managers' workshops to share information about current BMPs and implementation priorities for Black Ducks and every five years thereafter.	2024
Objective 5a	Ensure that agency rule-making processes include opportunities for public input on priority invasive animal species control.	2025
Objective 5b	Cultivate agency support for management of invasive species in high priority areas.	2025
Activity 5.1	Develop boilerplate language that helps agencies incorporate invasives management into SOPs.	
Action	Remove Regulatory and Permitting Obstacles	
Objective 6	Within five years of Plan release, begin developing permitting guidelines in partnership with permitting agencies to allow BMP activities.	2026
Activity 6.1	Work with permitting agencies to create state and federal flowcharts that provide step by step guidance on what to expect in regards to permitting requirements when implementing management projects (see Restore Non-tidal Wetland Hydrology chain).	2024
Activity 6.2	Communicate successes from progressive districts to other districts and from successful restoration projects to permitting agencies.	2024
Activity 6.3	Communicate successes from progressive districts to other districts and from successful restoration projects to permitting agencies.	2024
Action	Engage Landowners in Implementing BMPs	
Objective 7	Within five years of Plan release, ensure that landowners of the top 20% of priority wetlands have the funds to carry out invasives control.	2026
Activity 7.1	Work with funders in identified priority areas to ensure that sustainable funding is available for ongoing invasives management.	2023
Objective 8	Within 10 years of Plan release, ensure priority land managers are controlling invasives on at least 30% of prioritized wetlands.	2031

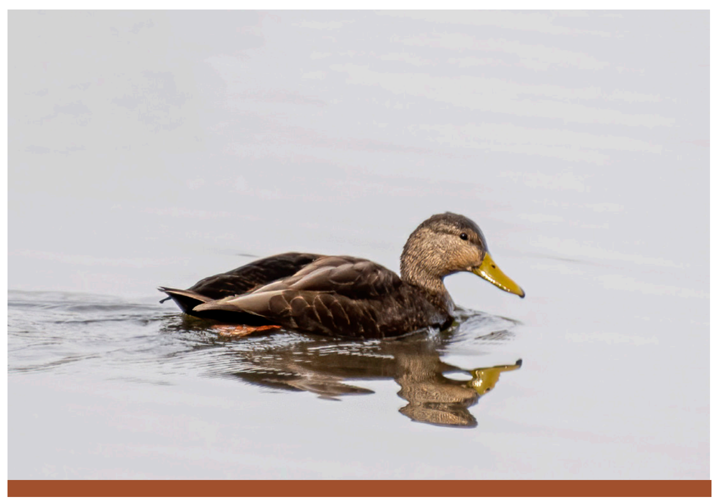
MONITORING & EVALUATING SUCCESS

The success of this plan depends on the ability of partners to track collective progress toward plan objectives and determine whether their efforts are improving or maintaining Black Duck populations. Monitoring and evaluation efforts are central to an adaptive management approach for evaluating management strategies in this plan and should not be considered an optional element (e.g., undertaken only if funding is available). Implementation activities outlined in this plan should be carried out and then the performance of each approach assessed to allow for course corrections. Ultimately, the goal is to understand the effects of various management actions on Black Duck populations. Ongoing investments in research are critical to helping determine whether conservation efforts are increasing suitable habitat for Black Ducks during the non-breeding season to improve the overall population trend. Achieving success will require both large-scale monitoring, to understand population change, and an ability to evaluate management actions at individual sites. If a set of sites is managed specifically to improve Black Duck habitat and Black Duck use of the site increases, similar results would be expected for other sites managed similarly.

MONITORING AND ADAPTIVE MANAGEMENT

Adaptive management and monitoring are critical to helping advance long term management plan goals and objectives. Documenting annual results of management actions can help managers make more informed decisions. Adaptive management will not provide managers with a single answer or a cookbook for management; rather, long-term monitoring will assist with a suite of potential actions that can be evaluated and implemented based on historic trends. Therefore, detailed reporting and documentation of key temporal and spatial variables will ensure desirable results can be achieved long-term. Evaluations and reports on the effectiveness, efficiency, and financial integrity of habitat management actions will ensure the long-term integrity of management programs.

MONITORING BLACK DUCK POPULATIONS


American Black Duck. Dave Bowers

Until recently, Black Duck populations at a landscape level were monitored annually through the Midwinter Waterfowl Inventory conducted in the Atlantic and Mississippi Flyways (Longcore and Clugston 1997). The accuracy of that survey was questioned (Eggman and Johnson 1989, Heusmann 1999) and with the development of new breeding ground surveys implemented in eastern Canada and in Maine (USFWS 2019), Black Duck populations can now be counted on their primary breeding grounds. This survey is a composite survey utilizing fixed wing coverage by the U.S. Fish and Wildlife Service and helicopter plot surveys by the Canadian Wildlife Service, which are published in the annual Waterfowl Population Status Report (https://www.fws.gov/birds/surveys-and-data/reports-and-publications/population-status-php). Breeding Black Ducks are also counted in states from New Hampshire to Virginia during annual breeding waterfowl surveys though they nest in much smaller numbers in this part of the Atlantic Flyway (Heusmann and Sauer 2000). The development and use of breeding ground surveys have reduced the need for winter surveys and allow for a more accurate assessment of how well we are achieving Black Duck population objectives.

EVALUATING MANAGEMENT ACTIONS

This plan emphasizes the need to evaluate promising management actions to determine whether and how they are contributing to Black Duck population stability or growth - particularly in the tidal zones. For each management approach, it is important to determine whether it works as expected and under what conditions it is successful or not. Evaluations of management require performance monitoring, ideally across an array of several managed sites. Conducting evaluations of all restoration or management efforts is strongly recommended. If Black Ducks are not present prior to the management action, occupancy may be a suitable indicator of success. If Black Ducks are present, changes in abundance or density should be evaluated. Ideally, project implementation should be followed with a before-after-control-impact (BACI) monitoring design including baseline monitoring before and after management (primarily vegetation sampling), and comparing treated sites to untreated controls. Monitoring should be conducted for a minimum of at least two to three years. There is also the need for periodic accounting, such as the number of acres treated or protected and spatial data made available to partners.

Performance Monitoring

Monitoring a variety of variables can help detect habitat changes over time, which is critical to understanding the effectiveness of restoration and management actions. In addition to vegetation data, several other variables also provide important insights into the structure and function of salt and freshwater marsh ecosystems. Such variables include unvegetated to vegetated marsh ratio, the nature and degree of historic modifications, sedimentation dynamics, rates of horizontal or vertical erosion, and elevation, all of which drive important processes related to the sustainability or rate of loss of marshes, and which may be affected by management actions.

Protocols

The Saltmarsh Habitat and Avian Research Program (SHARP), which was formed to measure changes to birds and vegetative communities in salt marsh systems, has developed a variety of protocols, including vegetation protocols that provide a simple approach to sampling vegetation in tidal systems. The Integrated Waterbird Management and Monitoring (IWMM) program also provides a variety of avian, habitat, and management action monitoring protocols that can be used across a breadth of wetland habitats. Use of standardized protocols facilitates pooling of data and making comparisons across sites.

Conservation Action Tracking

This plan describes many different objectives and activities among six major conservation strategies. These objectives include science, management, outreach, and engagement activities, and rely upon a diverse partnership working in a coordinated fashion to advance Black Duck conservation throughout the Atlantic Flyway. A centralized and publicly accessible tracking tool is necessary to measure the status of the overarching strategies, the various actions taken, and progress towards agreed-upon objectives. The ACJV has developed a tracking tool that provides current information about the approaches and actions underway in a given area and the stakeholders or landowners involved. The tool will allow managers to search for examples of successful management actions, lands protected, and identify gaps in coverage across the landscape. It also provides a centralized location for partners to track performance and assess overall progress toward specific objectives (e.g., number of acres of a particular management practice put in place on the ground). Partners can view projects that have already been entered here and can input their projects into the tool via the Project Inventory site.

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APPENDIX I

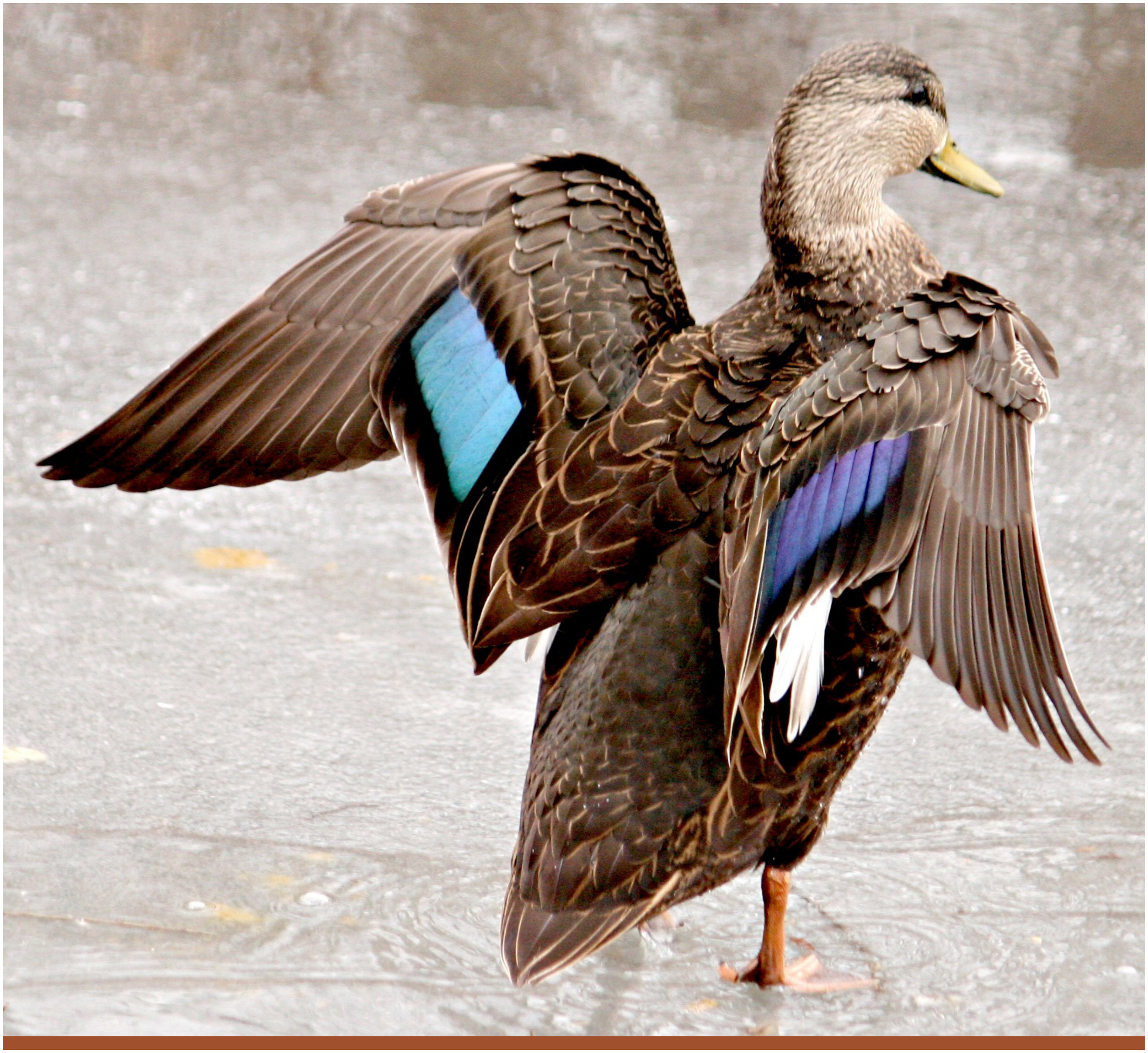
BLACK DUCK OBJECTIVES METHODOLOGY

Population Objectives

The NAWMP (2014) established Black Duck breeding population objectives for the eastern survey area (ESA) based on the long-term average (LTA) between 1990 and 2014. These objectives were later scaled to the continental level, with an LTA of 956,624. Recognizing the inherent fluctuations in populations, and to be aspirational in terms of social and environmental objectives, the NAWMP goals were designed to support a population level equal to that of the best 20% of all years (80th percentile of the LTA), which raised the objective to 1,025,528 (Fleming et al. 2019). These objectives were stepped down, for planning purposes, to the county, degree-block and Joint Venture scale for the autumn (1 Sep–30 Nov) and winter period (1 Dec–31 Jan) to capture temporal differences in the spatial distribution of ducks. For autumn and winter, harvest was calculated for all U.S. counties and Canadian degree blocks from 1999–2013. Brasher et al. (unpublished data) established a method for estimating regional abundance objectives during the non-breeding period using combined autumn and winter abundance objectives from Fleming et al. (2019), multiplied by the corresponding Black Duck LTA and 80th percentile continental population objective, and adjusting for autumn (0.71) or winter survival (0.85). Resulting LTA and 80th percentile objectives for the ACJV were 701,519 and 752,044, respectively. In order to ensure adequate habitat is conserved to meet the LTA, and sufficient habitat for when the population fluctuates above it, the ACJV Black Duck Working Group adopted the 80th percentile of the LTA (Fig. 3) as our goal. This target, if successfully met, is more likely to support the Black Duck population in peak years while providing greater confidence that we will consistently support the population during average years.

Habitat Objectives

Black Duck restoration and protection objectives (Table 1) were estimated using an energetics model consisting of two primary inputs: total energy demand and total food energy supply. Total energy demand was a function of North American Waterfowl Management Plan (NAWMP) goals, migration chronology (to estimate duck use days [DUDs]) and daily energy need (DEN; kcal/bird/day). County-level NAWMP 80th percentile population abundance objectives (Fleming et al. 2019) for nine dabbling duck species including American Black Duck (Anas rubripes), American Wigeon (Mareca americana), Blue-winged Teal (Spatula discors), Gadwall (Mareca Strepera), Green-winged Teal (Anas crecca), Mallard (Anas platyrhynchos), Northern Pintail (Anas acuta), Northern Shoveler (Spatula clypeata), and Wood Duck (Aix sponsa) were stepped down to the 12-digit hydrologic unit code (HUC12) watershed scale. Migration chronology curves were constructed at the Bird Conservation Region (BCR; NABCI 2000) scale using eBird data. DUDs were calculated as the product of the species-specific county level 80th percentile NAWMP population objectives and the daily % of peak summed across the nonbreeding period. In other words, DUDs were the sum of the area under the migration curve. Species-specific energy demand was yielded by multiplying resulting species level DUDs by species-specific DEN calculated from the allometric equation from Miller and Eadie (2006) and then summed to estimate total energy demand for each HUC12 watershed. Total food energy supply was calculated for each HUC12 watershed by estimating the amount (ha) of each wetland type present based on the National Wetlands Inventory and wetland type specific energy density values (kcal/ha) sourced from relevant literature. The energy balance for each HUC12 watershed was estimated by subtracting total energy demand from total energy supply.



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