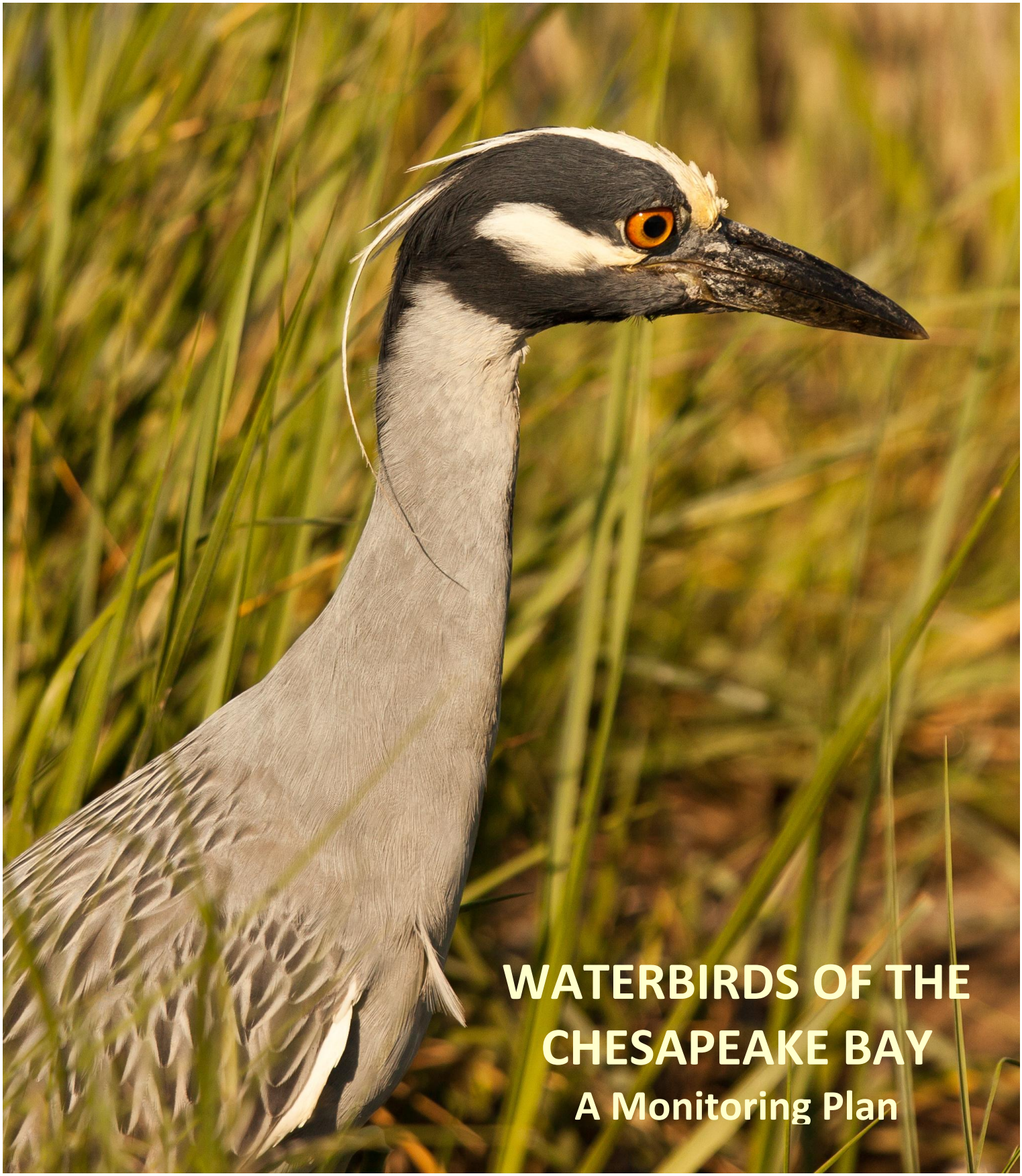

WATERBIRDS OF THE CHESAPEAKE BAY

A Monitoring Plan

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On the cover: Yellow-crowned night-heron foraging in salt marsh. Photo by Bryan Watts.

Partnership organizations

This monitoring plan is a partnership effort of state and federal agencies, non-governmental organizations, academic institutions, and individuals committed to the conservation of waterbird populations that depend on the Chesapeake Bay.

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This compilation and plan builds on the work of generations of biologists who have conducted thousands of waterbird surveys throughout the Chesapeake Bay for more than half a century. Their dedication and work has given us the grand vista out onto this fascinating community that we enjoy today. It is with gratitude for these contributions and the hope that new generations of biologists will take up the cause that this plan was produced.

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EXECUTIVE SUMMARY

The Chesapeake Bay is one of the most productive aquatic ecosystems in the world and plays an important role in the life cycle of many bird species. Each year, the rich resources of the Bay attract millions of waterbirds of 140 species from throughout the western hemisphere. Dependency on the Bay varies from species that stopover for a few days during migration to species that live out their entire life cycle within a single tributary. Many species that depend on the Bay are of high international, national or regional conservation concern. Monitoring is an essential component of conservation. Local monitoring programs satisfy regulatory mandates, contribute to continental population assessments, and inform adaptive management programs. Because many waterbirds are top consumers and collectively require a broad array of resources they represent sensitive, cost effective indicators of overall ecosystem health.

This plan addresses three fundamental questions including 1) What are the monitoring needs for waterbirds within the Chesapeake Bay?; 2) How much of this need is being addressed by existing programs?;and 3) What programs should be expanded or established to address unmet needs?. All waterbird species were evaluated according to when, where, how, and to what extent they depend on the Bay and whether or not monitoring is central to management decisions. All existing monitoring programs were assessed according to species and seasons of coverage. Unmet monitoring needs were identified by comparing needs and coverage within existing programs. Recommendations were made to fill strategically important gaps in monitoring coverage.

Coverage of identified waterbird monitoring needs within the Chesapeake Bay is currently poor. Of the 163 species-by-season combinations where a monitoring need was identified, less than 35% are being met by existing programs. Strengths include breeding colonial waterbirds, winter waterfowl, and species with high conservation priority including bald eagles, piping plovers and American oystercatchers. Significant gaps include breeding marsh birds, migrating shorebirds, wintering sea ducks and seabirds. Examination of the relationships between coverage and survey rationale suggests relatively high coverage by surveys contributing to range-wide population estimates reflecting continental monitoring programs that include the Chesapeake Bay.

Recommendations to expand existing programs and establish new monitoring programs would increase coverage of identified monitoring needs from 34% to 78%. Recommendations include the expansion of the Tidal Marsh Bird Survey and the Program for Regional and International Shorebird Monitoring programs into the Chesapeake Bay and the re-establishment of the Atlantic Coast Sea Duck Survey. In addition to these broad platform surveys, targeted surveys should be established for the state endangered black rail and the threatened *susurrans* form of the Henslow's sparrow.

INTRODUCTION

Why Monitor Waterbirds

Waterbirds (see Appendix 1 for definitions) are one of the most visible and diverse components of the Chesapeake Bay ecosystem. They are effective sentinels for both acute environmental insults such as chemical or oil spills or diseases such as West Nile Virus or Avian Influenza and long-term changes in the environment such as wetland degradation, loss of fish stocks, and climate change. Waterbirds are of recreational and aesthetic interest to the public such that information on their status is of general interest to society and a driver of local economies. Within the conservation community, information on status and distribution is the basis for management decisions and often the primary measure of success.

From a conservation perspective, there are three broad classes of rationales or needs for local monitoring including 1) regulatory mandates, 2) contributions to range-wide population objectives, and 3) informing local management. For many species that have formal legal protection under either federal or state statute, monitoring may be a legal requirement to be met by regulatory agencies. This rationale typically applies to species with high conservation priority but may also apply to species with nuisance or hunting status. Species that occupy large geographic ranges cover numerous local and several regional jurisdictions. For many of these species, progress toward continental monitoring or conservation objectives requires the participation by and coordination of local monitoring programs. Such collective participation is often justification for local monitoring. Finally, monitoring information is often an essential element of local planning and management and typically supplies the metric of success for adaptive management programs.

A large number of government agencies, universities, nongovernmental organizations, corporations, and private citizens participate in waterbird counts annually within the Chesapeake Bay. Count objectives, time horizons, methodologies, geographic coverage, and species involved often vary from project to project producing a patchwork of information. With some notable and important exceptions there is little coordination between efforts making it difficult to use this information to address Bay-wide questions. With the emergence of regional and national bird conservation plans and the completion of state comprehensive wildlife conservation strategies it has become increasingly important to seek opportunities to integrate efforts such that information collected may contribute to identified information targets for priority species. It is hoped that integration will ultimately lead to economies of scale and higher quality information. This plan is intended to provide a basis for establishing common monitoring goals.

The Chesapeake Bay

Physical Characteristics

The Chesapeake Bay is the largest estuary in the United States. The Bay's drainage basin covers 1.92 million square kilometers (742,000 square miles) an area larger than all of New England (Pritchard and Schubel 2001). More than 50 large tributaries empty into the Bay with headwaters in 6 states and the District of Columbia. A large estuary is formed by the interaction of these tributaries with the Atlantic Ocean. The estuary is bounded to the east by the Atlantic Ocean and to the west by the fall line. The fall line is where the metamorphic rocks of the Piedmont meet the sedimentary rocks of the Coastal Plain. The geologic formations along this boundary frequently determine the landward extent of tidal influence. The estuary is 320 kilometers (199 miles) long with more than 9,000 kilometers (5,592 miles) of tidal shoreline and 11,600 square kilometers (4,479 square miles) of water surface. The configuration of the Chesapeake Bay is unusual in having by far the highest drainage basin to water volume ratio of any of the world's major estuaries. This translates into a very shallow average depth of less than 7 meters (22 feet). An estimated 20% of the Bay is less than 2 meters (6.5 feet) deep. This shallow depth including more than 240,000 hectares (600,000 acres) of bottom that receives direct sunlight is one of the keys to the Bay's tremendous productivity.

Salinity varies widely throughout the Chesapeake Bay estuary and is one of the dominant drivers of species distribution. Annual discharge of freshwater into the Bay averages 71 cubic kilometers (17 cubic miles) or nearly the standing volume of the estuary. However, inputs vary dramatically with annual values of 50% below or above the average during drought or rainy years respectively and single large storms may contribute a great deal to the annual total. Both the seasonality and distribution of discharge have an influence on the spatial pattern of salinity. More than 80% of freshwater inputs come from just 3 tributaries including the Susquehanna, Potomac, and James Rivers. All of the Eastern Shore tributaries combined account for less than 4% of the total. Like most of the mid-Atlantic rivers, average flows are highest in the spring and lowest in late summer and early fall. Throughout the Bay, salinity is highest near the mouth and along the bay side of the Delmarva Peninsula. Relatively higher salinities along the Eastern Shore reflect the Coriolis force and the lower fresh water inputs. Heavier, high-saline waters extend further up the tributaries during times of low flow. Variation in several factors (e.g., winds, tides, water temperature, fresh water discharge) influence salinity patterns over short time scales leading to dynamic shifts in salinity. Mobile aquatic species that have narrow salinity tolerances (and their consumers) move to maintain favorable conditions. However, the distribution of fixed species such as marsh plants or less mobile bivalves reflect longer term salinity conditions.

Climate of the Chesapeake Bay is considered temperate humid and is controlled by proximity to warm Gulf Stream waters and the wind circulation over the North Atlantic (Kutzbach and Webb

2001). The Gulf Stream conveys warm tropical waters north along the coast and serves to moderate nearshore water temperatures between 15 and 25° C (60-75° F). Although the Labrador Current deflects the Gulf Stream offshore just south of the entrance to the Bay, its proximity has an influence on water temperatures. The subtropical high-pressure system centered over the North Atlantic circulates clockwise drawing tropical moisture up to the Bay from the south Atlantic and the Gulf of Mexico from April through September. Later in the fall this high-pressure system is positioned further south and its strength is diminished. From October through March the forces controlling the weather are the westerly winds of the mid-latitudes. These air masses are cooler and drier. The southern frontal boundary of polar air masses typically remains well to the north of the Bay such that the area experiences mild winters. Of additional interest is a steep gradient in the average number of days below freezing across the Bay. Just north of the Bay the average number of days below freezing is 50% higher compared to in the southern reaches of the Bay. This sharp change has implications for range boundaries of many species.

The tidal Bay's wide salinity gradient, shallow water, and climate have made it one of the most productive aquatic ecosystems in North America with a mean primary productivity of 1,500 g/m^2/year. This compares to 125 g/m^2/year for the open ocean, 400 g/m^2/year for lakes and streams, and 650 g/m^2/year for cultivated lands. This extreme productivity is the basis of a complex food web that includes some 2,700 species.

Human Aspect

The Chesapeake Bay was the site of the first successful European settlement in North America and the natural landscape has been altered by European culture for more than four centuries. The human population within counties adjacent to the tidal reach of the Bay has increased from 1.63 million people in 1900 to 3.81 million people in 1950 to 8.06 million people in 2000 (http://www.census.gov). The human population within the broader watershed is predicted to swell to 17.4 million by the year 2020. The Chesapeake Bay landscape lies within the second largest mega-region (BoWash) in the world accounting for 2.2 trillion dollars in economic activity or 20% of the gross domestic product of the United States (Florida et al. 2008). This economic engine is spilling out across the landscape and consuming natural habitats at rates well beyond historical levels. Consumption of open land to fuel residential and industrial development across the Bay landscape has increased dramatically in recent decades (Gray et al. 1988) and is expected to reach 110 km^2/yr (42 mi^2/yr) over the next 30 years (Goetz

et al. 2004) resulting in a 60% increase in urban sprawl (Boesch and Greer 2003). Over the past decade the Bay appears to have reached a tipping point where moderate-sized population centers are gaining momentum and beginning to coalesce along major shorelines.

Habitats Important to Waterbirds

Upland Habitats

Bay Islands - The Chesapeake Bay supports more than 100 offshore islands that vary in size, geologic origin, isolation from the mainland and habitat composition (Wray 1992, Leatherman et al. 1995, Cronin 2005). The largest land masses including the approximately 30 islands surrounding Tangier Sound are vestiges of an earlier era in the geological history of the Bay that were isolated when the Bay was "drowned" by rising seas. Many smaller islands exist closer to the western or eastern shores of the Bay and are of different origin. Small sandy islands are common around the mouths of large tributaries and have been formed by sediment transport by storms or the interaction between tributary outflow and long shore sediment transport. Human-made islands are a growing presence within the Chesapeake Bay system and include islands that serve as dredge material deposition sites and those created to support bridges and tunnels.

Nearshore Uplands – The natural state of near-shore uplands surrounding the tidal reach of the Chesapeake Bay is forest composed of a mixture of pine and hardwood species (Brush 2001). The relative contribution of these forest components shifts from the coast to the fall line such that pine-dominated forests are primarily on the outer Coastal Plain and hardwood-dominated forests are on the inner Coastal Plain. However, this natural gradient has been highly modified by the conversion of hardwoods to pine plantations and the suppression of fire within the outer Coastal Plain. Currently, near-shore habitats are highly dissected and include a mix of forest, agricultural fields, and an expanding footprint of residential and industrial development.

Exposed Banks – Shear, exposed banks occur throughout the Chesapeake Bay where flood waters erode the shoreline or in areas with exposure to long fetches. These banks vary in

length from meters to kilometers and are disturbance-prone habitats that require regular erosion to prevent occlusion from succession. Concentrations of exposed banks occur where bluffs intersect with meanders on the upper reaches of tributaries or along high-energy shorelines. They are particularly common within topographic highs along the main stem of the Bay and along the Potomac, Rappahannock, and James rivers. A survey of all tidal tributaries of the Bay in the mid-1990s identified more than 1,400 open, shear banks greater than 2 meters (6.5 feet) in height (Watts et al, unpublished data).

Marshes

Emergent tidal marshes are one of the most characteristic features of the Chesapeake Bay region. These habitats form along low to medium energy shorelines where sediment deposits provide substrate for the colonization of water-tolerant vegetation (Cowardin et al. 1979). Marshes provide a boundary between uplands and open water, export energy to the broader Bay and provide habitat for many species. Three intertidal marsh types occur within the Chesapeake Bay including salt marsh, brackish marsh, and tidal fresh marsh.

Salt Marsh - Salt marshes are characterized by the presence of plant communities tolerant of salinity values of 18-30 parts per thousand (ppt). Salt marsh is the most abundant marsh type in the lower Chesapeake Bay and covers approximately 7,163 ha (Stevenson *et al*. 2000). This marsh type is distributed along the main stem of the Bay but also extends up the lower reaches of major tributaries but ultimately gives way to brackish and tidal-fresh wetlands within lower salinity waters. Elevation within the salt marsh determines inundation frequency and the associated vegetation. The low marsh is inundated daily by normal high tides and within the mid-Atlantic is dominated by smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus roemerianus*). The high marsh is inundated irregularly by spring tides and has a savannah-like structure. The high marsh zone is dominated by salt grass (*Distichlis spicata*) and salt meadow hay (*Spartina patens*) but also contains scattered shrubs (typically *Iva frutescens* or *Baccharis hamilifolia*) and is often fringed by maritime pine savanna.

Brackish Marsh - Brackish marsh occurs primarily within tidal tributaries where salinity ranges from 5.0 to 18.0 ppt. Stevenson *et al.* (2000) estimates that brackish marshes cover approximately 43,953 ha in the Chesapeake Bay. Brackish marsh occurs throughout the upper

Bay's main stem in Maryland and along all major tributaries of the lower Bay within appropriate salinity zones. This marsh type is dominated by dense stands of tall cordgrass (*S. cynosuroides*) with salt meadow hay, Olney's three-square (*Schoenoplectus americanus*), and salt grass in the high marsh zone and may have a narrow fringe of saltmarsh cordgrass depending on salinity.

Tidal-fresh Marsh – Tidal-fresh marshes occur within the upper reaches of tributaries where freshwater inputs maintain salinities below 5 ppt. These marshes cover approximately 26,245 ha (Stevenson et al. 2000). Lower saline marshes support the highest diversity of plant species of all the marshes within the Chesapeake Bay (Odum *et al.* 1984). These marshes are often dominated by broad-leaved plants such as arrow-arum (*Peltandra virginica*) and pickerelweed (*Pontederia cordata*). Other common plants include marsh hibiscus (*Hibiscus spp.*), marsh mallow (*Kosteletzkya virginica*), shoreline sedge (*Carex hyalinolepis*), narrow-leaved cattail (*Typha angustifolia*), wild rice (*Ziania aquatica*), southern wild rice (*Zizaniopsis miliacea*), rice cutgrass (*Leersia oryzoides*), and various other sedges (*Carex spp*.) rushes (*Juncus spp*.) and cattails (*Typha spp*.). Spatterdock (*Nuphar advenum*) and yellow pond lily (*N. luteum*) can form extensive mats in areas that are inundated for long periods.

Unvegetated Intertidal

Mud and sand flats – Mud and sand flats are intertidal areas with unconsolidated bottoms that do not support root systems of vascular plants. These areas often support a diverse community of aquatic invertebrates that include marine worms, bivalves, crustaceans, and other important prey for waterbirds. Mud and sand flats are similar in structure but vary in sediment type from soft silt to sand. Unlike some of the outer coastal bays or other locations within the hemisphere that experience extreme tidal ranges, the Chesapeake Bay does not support extensive concentrations of flats. Tidal flats within the Chesapeake Bay have not been mapped or quantified. Thin ribbons of mud flats occur along most tide guts and marsh shorelines and collectively these patches are significant. Larger patches occur in silted bays and in the interior of some of the larger Bay islands. Concentrations of sand flats are distributed along high energy shorelines with beaches and adequate sand sources. Examples include the areas around Smith and Tangier Islands, the arc of shoreline between Mathews and Hampton, Virginia, and the Susquehanna Flats around Havre de Grace, Maryland.

Beaches - Beaches represent intertidal zones with adequate sand sources where wave action occurs with enough energy to prevent vegetative growth. Active beach zones extend from low tide up to the level of spring tides and depending on the position may or may not include developed dune systems. Within the Chesapeake Bay, concentrated beaches occur around isolated Bay islands, along barriers within the lower Western Shore, around the mouths of large tributaries where the long-shore transport of sand is disrupted, and along the outer edges of extensive marshes. Although not as extensive as along the outer Atlantic Coast, dune systems do occur within the Chesapeake where historic or current wave and wind energies are high.

Rocky shorelines – The tidal reach of the Chesapeake Bay is wholly within the Coastal Plain physiographic province and does not have exposed rocky substrates. However, the establishment of artificial substrates such as groins, jetties, rock islands and seawalls is increasingly providing intertidal substrates that mimic those found along the North Atlantic. Some of these larger structures such as the islands of the Chesapeake Bay Bridge Tunnel have been colonized by marine communities and provide habitat for waterbirds. Rocky intertidal substrates are expanding within the Chesapeake Bay as more of the shoreline is developed and more infrastructure is needed for bridges, shoreline stabilization, and the maintenance of navigational channels. No current estimates are available on the amount of this habitat that is available to waterbirds or for trend analysis

<u>Aquatic Habitats</u>

Shallow-water Zone - The shallow-water zone is located adjacent to the shoreline of the Chesapeake Bay and extends out to water depths of approximately 3 meters (10 feet). This depth represents the approximate limit of the level of light penetration needed for the growth of submerged aquatic vegetation (SAV). SAV that are commonly used by waterbirds include wild celery (*Vallisneria americana*) found in freshwater areas; sago pondweed (*Potamogeton pectinatus*) in freshwater and brackish areas; widgeon grass (*Rupia maritima*) in brackish areas; and eel grass (*Zostera marina*) and sea lettuce (*Ulva lactuca*), found in brackish to salty areas. Fish, bivalves, crustaceans and other aquatic invertebrates that are important for waterbirds are abundant within these vegetated zones and within the shallow water generally.

Deep-water Zone - The deep-water zone includes areas with water depths of greater than 3 meters (10 feet). This includes a great deal of the main stem of the Bay and major tributaries, as well as, channels along many minor tributaries. Deep-water portions of the Bay support the truly pelagic schooling fish such as Atlantic Menhaden (*Brevoortia tyrannus*) and Bay Anchovy (*Anchoa mitchilli*) that are key to the open-water food chain.

Waterbirds and the Chesapeake Bay

The tremendous productivity, geographic position, and diversity of habitats within the Chesapeake Bay have led to the formation of a broad waterbird community (Appendix 2). The Bay supports large populations of summer or winter resident waterbirds and is a convergence area for migratory birds throughout the Western Hemisphere. More than 140 species of birds including migratory shorebirds, seabirds, waterfowl, marsh birds, colonial waterbirds, and raptors are regular users of the Bay's aquatic resources. Due to its unique geographic position relative to latitudinal shifts in climate, the Bay is a location of great faunal interchange where 42 waterbird species reach their breeding or winter range limits.
The Bay supports 67 species of breeding waterbirds, 87 species of wintering waterbirds, and 138 species that stopover during migratory periods (see details in Appendix 3). In addition, several species utilize the Bay as a post-nesting nursery or as a congregation area for nonbreeding subadults during the summer months. Dependency on the Bay varies from species that stopover for a few days during migration to species that live out their entire life cycle within a single tributary. On a continental scale, the ecological role of the Bay also varies dramatically between species and seasons. The Bay is believed to support a moderate to very high (greater than 10%) portion of the continental population for 5 breeding species, 14 wintering species, 34 fall migrant species and 33 spring migrant species (Table 1, see details in Appendix 3).

Table 1. Relative importance (responsibility) of the Chesapeake Bay to North American (NA) waterbird populations during different periods of their life cycle. Numbers indicate the number of waterbird species. Total waterbirds considered in plan is 140. Importance terms include "Very High" - >50% of NA population, "High" - >20% of NA population, "Moderate" – 10-20% of NA population, "Low" – 1-10% of NA population, "Lowest" - <1% of NA population, and "Peripheral" – on extreme edge of normal geographic range.

Responsibility	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Very High				1	1	1
High	1			2	8	8
Moderate	4			11	25	24
Low	28	2	8	33	57	58
Lowest	32	3	7	36	43	42

Responsibility	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Peripheral			1	4	4	4

Many species that depend on the Bay are of high international, national or regional conservation concern (see details in Appendix 2). Nearly 30% of the waterbird species using the Bay are believed to be declining on a continental scale. More than 65% were assigned moderate to high conservation scores within Bird Conservation Region 30. Other species are of conservation concern at the state level or within smaller jurisdictions that host them during the summer or winter months. More than 40% of the bird species are listed as having the highest conservation concern by both Virginia (47 of 96) and Maryland (61 of 140) in their respective wildlife conservation action plans depend on the Chesapeake Bay. A large portion of the waterbirds that have high regional concern depend on the Bay during migratory periods or during the winter months (Table 2).

Table 2. Relationship between dependency of species during different periods of their life cycle and Conservation Concern Scores for Bird Conservation Region 30. Conservation scores were taken from the Atlantic Coast Joint Venture Waterfowl Implementation Plan (Atlantic Coast Joint Venture 2005) and from the New England/Mid-Atlantic Coast Bird Conservation Region (BCR 30) implementation plan (Atlantic Coast Joint Venture 2008). Numbers indicate the number of waterbird species (See Appendix 2 and 3 for details).

Concern Scores	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Highest	7		1	13	18	18
High	12		3	20	33	33
Moderate	17	4	3	21	33	33
Low	29	1	8	33	54	53

The highest priority waterbird species within the Chesapeake Bay are those for which the Bay both plays a significant role in their life cycle (high responsibility) and have a high concern score within the region. Such species include 3 breeding species, 7 overwintering species, and 16 species that depend on the Bay during the migratory periods. All breeding species within this category nest in marshes including the king rail, black rail, and seaside sparrow. Overwintering species include 3 seabirds (red-throated loon, horned grebe, northern gannet), 3 waterfowl (canvasback, ruddy duck, Atlantic brant), and 1 marsh bird (saltmarsh sparrow). Species staging during migration include 5 waterfowl (tundra swan, ruddy duck, canvasback, Atlantic brant, American black duck), 5 marsh birds (saltmarsh sparrow, seaside sparrow, king rail, black rail, sora), 4 seabirds (horned grebe, northern gannet, red-throated loon, least tern), and 2 shorebirds (greater yellowlegs, short-billed dowitcher).

The full range of water-associated habitats found within the Chesapeake Bay are used by waterbirds for some activity (Table 3, see details in Appendix 3). Primary activities include breeding, foraging, loafing, and roosting. Some general patterns are evident in how species utilize these habitats. Near-shore uplands provide breeding habitat for species like bald eagles that forage primarily over open water but also provide alternate foraging, loafing and roosting habitat for species that depend on other substrates. Bay islands support a high diversity of species conducting all activities because these unique places contain most of the other habitats of significance to waterbirds and are largely devoid of ground predators. High salinity marshes support a greater diversity of waterbirds compared to lower salinity marshes. Shallow water areas support a higher diversity of foragers compared to deep water zones. It should be noted that broad patterns in diversity mask the distribution of specialized species that occur in each of these habitats.

Table 3 Waterbird activities within habitats found in the Chesapeake Bay. Numbers represent species (See Appendix 4 for details).

Habitat	Breeding	Foraging	Loafing	Roosting
Upland	21	50	52	54
Bank	3	-----	3	3
Bay Island	52	64	74	75
Beach	11	36	46	23
Mudflat	-----	59	61	21
Rocky Intertidal	1	12	25	4
Salt Marsh	32	74	76	59
Brackish Marsh	17	60	55	40
Tidal-fresh Marsh	11	43	39	24
Shallow Water	-----	72	57	24
Deep Water	-----	48	54	52

THE NEED FOR WATERBIRD MONITORING

Rationale

The underlying rationale or purpose of a monitoring program informs or at times dictates design. There are three broad rationales for monitoring waterbirds within the Chesapeake Bay including 1) to satisfy regulatory mandates, 2) to contribute to range-wide conservation objectives, and 3) to inform local management. All, some, or none of these rationales may pertain to individual waterbird species that utilize the Chesapeake Bay.

Regulatory Mandate

For many species that have formal legal protection under either federal or state statute, monitoring is a legal requirement. This requirement may involve regular assessment or reviews of status relative to some predetermined recovery threshold that once attained may lead to a change in legal status. For some species such as the bald eagle that was recently removed from the federal list of threatened and endangered species, there is a legal mandate for post-delisting population assessment. For other species, management and protection of critical areas is predicated on knowing the location of such sites. Documentation of such locations for use in management activities, permit review, and other regulatory programs requires regular monitoring conducted with adequate frequency.

Contribute to Range-wide Objectives

Many species of conservation concern or significance occupy large geographic ranges that encompass many local to regional jurisdictions. Although objectives may be set on a continental scale for these species, meeting these objectives often requires coordination of many local programs. In some circumstances, the actual objective of these local programs may be continental rather than local in scale.

Population status, distribution and trends

For many species our ability to determine status and to track distribution and trends would not be possible without the efforts of many local monitoring programs working in concert. Contribution to such continental efforts is often the overriding objective on a local level. In some circumstances, the local information may provide little conservation value unto itself.

Local role in national objectives

For some species where the Chesapeake Bay plays a particularly vital role in their annual cycle, local monitoring efforts may transcend local objectives. In some cases, efforts within the Bay may represent the best strategic opportunity to monitor population status on a continental scale or may be used to formulate national policy or management objectives. Species that fall within this category include those such as the red-throated loon where a large portion of the continental population depends on the Bay during at least one phase of the annual cycle.

Inform Local Management

Wildlife managers are in constant need of information on which to base management decisions. This information may include the distribution and health of populations of concern, relationships between a population and threats, or how a population is responding to management activities. Timely information on a local scale is often critical to the success of local management programs.

Population status, distribution and trends

Successful conservation of species of concern typically requires that managers have a working knowledge of the distribution of critical areas and population trends. Such information allows managers to prioritize and design appropriate management actions. On a local scale, monitoring programs are used as a population “checkup” and frequently provide the first signs of problems that require further attention.

Environmental Indicators

Some waterbird species are considered to be effective sentinels of the environment and so have value as indicators of ecosystem health. Objectives of monitoring programs for these species are often beyond the focal species to issues such as environmental contaminants, overfishing or climate change. Monitoring these species may represent the most cost-effective

approach to tracking environmental threats. Species that represent good candidates for environmental monitoring are those that are broadly distributed, high on the food chain, sensitive to threats of interest, and can be effectively studied.

Adaptive Management

Effective population management is an iterative process where actions are taken, population response is measured, and depending on the nature of that response, future actions may be modified. Metrics of success are essential elements of this process. Monitoring programs provide the feedback necessary to inform management and should be matched to the scale of management actions.

Monitoring needs

There is justification to implement a monitoring program within the Chesapeake Bay for a large number of waterbird species (see Appendix 5 for details). Of the 140 species and 448 waterbird by season combinations, there is reasonable justification to establish monitoring programs for 103 (73%) species and 163 (36%) species-season combinations. These species include, but are not limited to, species for which the Bay plays a significant role in their life cycle (high responsibility) and/or have a high concern score within the region. Rationale for monitoring includes regulatory mandates (58 species), range-wide objectives (87 species), and local management (100 species) with 46 species having justification in all three categories.

The role of the Chesapeake Bay in the life cycle of waterbird species and its strategic importance in contributing to estimates of continental populations may be seen in the rationale of monitoring waterbirds with season (Table 4). Many of the species that are of concern to state or federal agencies are breeding species, reflecting a historic bias in how the estuary is viewed in terms of its importance to species. Species of interest during the winter period are primarily waterfowl even though monitoring could contribute to the local management of many species. A large number of species utilize the Bay during migratory periods and strategic monitoring of some species such as shorebirds may contribute to estimates of continental trends. Monitoring of these species would also inform management since many shorebirds are vulnerable to disturbance within staging sites.

Table 4. Relationship between rationale for monitoring within the Chesapeake Bay and season. Numbers indicate the number of waterbird species (See Appendix 5 for details).

Rationale	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Regulatory Mandate	37	----	1	13	16	16
Range-wide Contribution	37	----	----	33	20	20
Local Management	50	----	2	44	28	27

EXISTING WATERBIRD MONITORING PROGRAMS

Over the decades, thousands of surveys have been conducted for waterbirds within the Chesapeake Bay. Surveys vary from one-time efforts to determine local status, to project-based investigations, to annual efforts that are part of long-standing, continental monitoring programs. A number of monitoring programs currently exist or have been proposed that have the potential to meet monitoring needs for waterbirds within the Chesapeake Bay. These include broad, multi-species, platform surveys and single-species targeted surveys.

Broad Platform Surveys

The North American Breeding Bird Survey (BBS)

The North American Breeding Bird Survey (BBS) is a continent-wide, volunteer-based program that uses roadside point counts to survey breeding birds (Bystrak 1981). Initiated in 1966, the program includes a network of more than 4,100, 50-point survey routes across the United States and Canada and has become the dominant tool for evaluating population trends and distribution for a large number of breeding species (Peterjohn et al. 1995, Dunn et al. 2000). The program has the distinct advantages of having a standard survey protocol that has been used consistently over a long period of time and having very broad geographic coverage.

The objectives of the BBS program are to estimate distribution and trends for breeding populations over large spatial scales. Data from the program have been used to assess trends in breeding on smaller spatial scales (e.g. Sauer et al. 2003) the lower limit of which is dictated by survey coverage. The data are not useful in assessing area use by birds during passage or winter. The program is most effective for common, widespread species. Targeted surveys are a better fit to many breeding waterbird species that are rare to uncommon and have few breeding locations. Of the list of waterbirds using the Chesapeake, the best fit for a BBS approach to population monitoring is for marsh-nesting birds. Even for this community, there

are several concerns about the use of the BBS network to assess populations within the Bay. BBS survey routes are road-based and right-of-ways for roads are generally positioned disproportionately within the upland portions of the landscape. As a result, wetland or water-associated habitats and species are often underrepresented by the survey (Herkert 1995). In addition, placement of elevated roadways within wetlands alters the habitat such that the breeding bird community sampled along the roadway is also impacted. The primary period of breeding activity and associated detectability for several of the dominant marsh-nesting species such as rails is a full month earlier than the BBS survey window for the region (Watts 1992). The implication of this temporal mismatch is that even for point locations that occur near wetlands, rails may be underrepresented due to low detectability.

Chesapeake Bay

The tidal reach of the Chesapeake Bay and its immediate watershed contains 41 BBS routes completely with an additional 25 routes that are partially contained. Although the BBS program is a powerful monitoring tool for many bird species breeding across North America, the program is not suited to monitoring waterbird populations within the Chesapeake Bay. Other monitoring techniques should be employed that are more capable of achieving objectives.

Christmas Bird Count (CBC)

The Audubon Society's Christmas Bird Count (CBC) is a volunteer-based survey that uses fixed plot searches to survey winter bird populations (Butcher 1990). Initiated in 1900 the survey is continent wide and the technique is now used throughout the world. Surveys are conducted within a few weeks of 25 December and the sampling unit is a 24.13-km (15 mile) diameter circle. Plot coverage, counting effort and recording protocols vary through space and time. Survey results have been used to estimate geographic distribution (Root 1988), range shifts (Sorte and Thompson 2007), and population change (Dunn and Sauer 1997). However, analyses are limited by the non-random selection of plot locations and the lack of standardization in counting effort and methods. To overcome these obstacles investigators have attempted to control for survey effort and have confined analyses to physiographic strata to reduce the influence of nonrandom plot selection. However, regional comparisons of CCB data are problematic because of differences in effort and the unbalanced representation of strata.

Chesapeake Bay

Twenty-nine CBC survey plots include some portion of the tidal reach of the Chesapeake Bay. Each year, thousands of volunteers participate in CBC surveys. This network of surveys is the primary information available on the occurrence of most waterbird species within the region. Although the quality of coverage likely varies between species groups depending on detectability (e.g., secretive marsh birds vs. large gulls), some species groups appear to be well represented. In addition, a core group of plots have been included in the survey for 40 years or more.

Tidal Marsh Breeding Survey (TMBS)

Point count methodologies have been used for decades to estimate bird densities and to evaluate a host of parameters that influence density such as distribution, habitat use, phenology, etc. (e.g. Hutto et al. 1985, Ralph et al. 1995). The approach is attractive because it includes a sampling unit that is easily repeatable through space and time. Several advances in point count techniques including the use of double-observer techniques to quantify detection probabilities (Kissling and Garton 2006), distance sampling to correct for effective survey area (Thomas et al. 2010) and stratification of detection mode to refine distance estimates (Allredge et al. 2007) have been made in recent years to measure biases and errors in density estimation. The point-count approach is most suited for species that are widespread requiring subsampling techniques to estimate population characteristics and during seasons when detection probabilities are adequate. Of the waterbird groups addressed in this plan, point-count techniques are most suited to marsh-nesting birds. Standardized, off-road, point-count techniques have been developed for secretive marsh-nesting birds for North America (Conway and Nadeau 2006, Conway 2011). The approach uses distance estimation to improve effective sample area, a series of play-back calls to improve detection probabilities, and stratification of count data by time. Variations on this general approach are being used throughout eastern North America including the Chesapeake Bay.

Although there has been considerable discussion about both the need and potential design elements, no national monitoring program has been established for marsh birds. A program has been designed for the coastal area of the mid-Atlantic and southern New England (BCR 30) (Shriver et al. 2008). This program uses a generalized random tessellated stratification approach to select survey sites and a modified Conway (2011) approach to sample birds. Researchers are currently testing the program in salt marshes including portions of the Chesapeake Bay.

<u>Chesapeake Bay</u>

Off-road, point-count techniques have been used to investigate marsh-bird communities throughout the Chesapeake Bay since at least the early 1990s. Virtually all of these surveys have used a sampling approach conceptually similar to but different in details from the Conway (2011) approach. Most investigations have focused on short-term objectives rather than in the context of long-term monitoring frameworks. For example, for salt marshes large networks of survey plots have been established to investigate the influence of marsh area on both migrant and breeding birds (Watts 1992, 1993, Watts and Paxton, unpublished data), the influence of landscape context on the integrity of the breeding community (DeLuca et al. 2004), the effect of open-marsh management on rail populations (Brinker and Therres 1992), the influence of fire management (Kern et al. 2012) and the benefits of marsh restoration (Haven et al. 2001). Similarly, point-count networks have been established within lower saline marshes to investigate the implications of shifts in vegetation related to sea-level rise (Paxton and Watts 2003) and to examine community composition and distribution (Wilson et al., unpublished,

VDGIF, unpublished). Comparatively few point-count networks have been established within the Chesapeake Bay with the intent of monitoring status, distribution and trends of breeding marsh birds. Some notable exceptions include the network of surveys established throughout the Maryland portion of the Bay (Tango et al. 1997, Brinker et al. 2002) and the network of survey plots established to assess the black rail population within the Virginia portion of the Bay (Wilson et al. 2009).

Colonial Waterbird Survey (CWS)

The North American Waterbird Conservation Plan (Kushlan et al. 2002) calls for the establishment of a coordinated monitoring program throughout the Americas that is capable of detecting a 50% population change in 10 years. Although colonial waterbirds are surveyed by most jurisdictions throughout North America, no multijurisdictional coordinated monitoring program exists. The U.S. Fish and Wildlife Service has provided guidance in developing monitoring programs (Steinkamp et al. 2003) and a portal for the submission and storage of data. However, survey design and methodologies continue to vary widely limiting the usefulness of efforts on broader scales. Several attempts since the 1970s have been made to move toward coordinated surveys throughout the Northeast region or along the western Atlantic Flyway. Since the 1990s surveys have been synchronized but methodologies continue to vary from state to state. In 2013 a number of states from Maine – Virginia are scheduled to conduct statewide colonial waterbird breeding surveys. To take full advantage of this circumstance, participating states will attempt to identify key parameters that are common across the northeast and mid-Atlantic region, minimize differences in methodologies to the greatest extent possible, and enter results into a single database. The overarching objective of this effort is to provide guidance and a basis for future coordinated regional surveys.

Annual Atlantic coast least tern breeding surveys from Maine to Virginia have been on-going since 2006. Several survey windows have been established based on latitudinal differences in breeding phenology. Thus far, survey data indicate that least tern breeding populations have a wide variance over both space and time largely due to their ephemeral breeding habits. Therefore, range-wide inferences made from these surveys are limited to tracking population trends over the long term.

<u>Chesapeake Bay</u>

Within the Chesapeake Bay surveys of selected colonial waterbird colonies began in the 1940s and 1950s (Stewart and Robbins 1947, 1958, Abbott 1955). During the 1975 and 1976 breeding seasons the first systematic survey of wading bird colonies was completed in association with a broad-based survey covering the Atlantic Coast (Custer and Osborn 1977). In 1977, the first systematic survey of all colonial waterbird species was conducted in association with the "Maine to Virginia" project (Erwin and Korschgen 1979). Both of these efforts focused on the outer coastal fringe and more saline reaches of the Bay. The entire tidal reach of the Bay was surveyed for all colonial waterbird species in 1993 (Brinker et al. 1993, Watts and Byrd 1998) 2003 (Watts and Byrd 2006, MD DNR unpublished) and 2008 (Watts and Paxton 2009, MD DNR

unpublished). Initially, the project attempted to provide a complete enumeration of colonies and breeding pairs every 10 years using a combination of aerial and ground surveys (Williams et al. 2007, Brinker et al. 2007). Following the 2003 survey, a decision was made by participating partners to conduct surveys every five years to detect changes in populations in a more timely fashion, especially given the rapid loss of some breeding islands in the Chesapeake Bay (Erwin et al. 2011). The objectives of the survey are 1) to determine the status, distribution, and trends for all colonial waterbirds in the Chesapeake Bay, 2) to contribute to range-wide population estimates, 3) to provide locations that may be used by regulatory agencies during environmental reviews, 4) to provide baseline information that may be used to evaluate local management actions.

One of Virginia's oldest and most well established least tern colonies is located at Grandview Beach Nature Preserve on the western shore of the lower Chesapeake Bay. This colony has been active since the late 1800's and has been surveyed annually since 1975 (Beck et al., 1990). Additional colonies in Virginia's portion of the Bay have been surveyed yearly since 2006 as part of the Atlantic coast breeding survey. The objectives of the survey are 1) to contribute to an index to long-term trends in regional breeding populations, 2) to provide least tern colony locations that may be used by regulatory agencies during environmental reviews, 3) to provide baseline information that may be used to evaluate local management actions.

Program for Regional and International Shorebird Monitoring (PRISM)

Shorebirds have been surveyed throughout North America during migration since the mid-1970s by the International Shorebird Survey (ISS) and the Maritimes Shorebird Survey (MSS). Both of these programs are volunteer-based efforts that have proven useful in evaluating population trends (Howe et al. 1989, Morrison et al. 1994) and describing movement phenology and distribution. Sites are visited every 10 days during the spring and fall migratory periods. In 2003, these programs were consolidated into the Program for Regional and International Shorebird Monitoring (PRISM) that more fully refines monitoring objectives, site selection, and survey methodologies (Skagen et al. 2003). Program objectives are to 1) estimate the size of breeding populations of 74 shorebird taxa in North America, 2) describe the distribution, abundance, and habitat relationships for these taxa, 3) monitor trends in shorebird population size, 4) monitor shorebird numbers at stopover locations, and 5) assist local managers in meeting their shorebird conservation goals.

<u>Chesapeake Bay</u>

No monitoring program has been designed or established within the Chesapeake Bay for migrant shorebirds. Shorebirds have been surveyed at the Craney Island Dredged Material Management Area for many years (Shopland 1975, Williams, unpublished) along several kilometers of open beach within the lower Bay (McLean 1993) within tidal salt marshes (Watts 1992, Beheler and Watts 2012) and within tidal-fresh marshes (Paxton and Watts 2003). In

Maryland, shorebirds have been surveyed twice per month at Poplar Island since 2002. Surveys have also been conducted at Hart-Miller Island in the upper Bay: almost weekly 1996-2002, and on an irregular basis since that time. Both of these locations were formed from dredge spoil material and both have been included in the International Shorebird Survey network (PRISM) (see A Plan for Monitoring Shorebirds During the Non-breeding Season in Bird Monitoring Region Maryland – BCR 30 by Sandy Chan 2008, available from Manomet website).

These project-based surveys give an indication of the distribution and abundance of shorebird species. However, they were not intended to be part of a larger monitoring program. To date, one of the two PRISM sites established within the Chesapeake Bay has been monitored regularly.

Atlantic Coast Wintering Sea Duck Survey (WSDS)

The Atlantic Coast wintering sea duck survey is a multi-species, aerial transect survey covering near-shore coastal waters including large estuaries in fulfillment of monitoring goals of the Sea duck Joint Venture (2012). The survey is intended to fill historic deficiencies in coverage of this waterfowl group in the traditional mid-winter waterfowl survey. The objectives are to 1) characterize winter distribution and habitat use, 2) detect distributional shifts, 3) provide an index of population size and trends, and 4) inform management decisions. Some form of the survey was conducted between 1991 and 2005. An experimental survey has been conducted since 2008 to characterize sea duck winter distribution along the U.S. East Coast and to evaluate potential improvements for future surveys

<u>Chesapeake Bay</u>

Historic information on sea duck abundances within the Chesapeake Bay is poor because the mid-winter waterfowl survey has not covered their primary habitat. Although a number of projects focused on diet, contaminants (DiGiulio and Scanlon 1984), disease (Locke et al. 1970, Montgomery et al. 1979), and other topics have been conducted or are ongoing, these have not been attached to monitoring programs. The Chesapeake Bay has been included in the Atlantic Coast wintering sea duck survey since its inception.

Midwinter Waterfowl Inventory (MWI)

The midwinter waterfowl inventory is an aerial survey of duck, goose, and swan species conducted throughout the lower 48 states (Steiner 1984). Federal and state biologists have conducted the survey in most states since the mid-1950s. The survey was designed to determine numbers and distribution of waterfowl on the wintering grounds and to provide a long-term data base for estimating population trends. Since the late 1950s, waterfowl breeding surveys conducted in mid-continent breeding areas have been the primary source of information on which hunting regulations have been based. Breeding surveys in eastern North America were not initiated until the early 1990's, but are now the primary source of data for

establishing waterfowl hunting regulations along the East Coast (Atlantic Flyway). For this reason, on a continental level the midwinter survey is now considered to provide supplemental population information except for selected species with poor breeding coverage (e.g., Atlantic brant and tundra swans). The survey covers most of the wintering waterfowl habitat in the flyway (nearly 80%) each year. The midwinter survey has been criticized by some for state to state variation in methodology and for the nonrandom selection of waterfowl congregation areas as survey sites (Eggeman and Johnson 1989, Heusmann 1999). These shortcomings limit the usefulness of the information for population estimation and trends on regional to continental scales for some species.

Chesapeake Bay

Due to its tremendous productivity and geographic position, the Chesapeake Bay represents one of the premier sites in North America for waterfowl during migration and winter. Although historic accounts of waterfowl numbers are numerous, systematic surveys were not established until 1948 when the midwinter waterfowl inventory was initiated. The survey covers designated routes that include major tributaries, shallow-water portions of the main stem, and near-shore agricultural fields. Survey information has been used extensively to examine waterfowl within the Chesapeake Bay including evaluation of population trends (Perry and Deller 1995), changes in species composition (Perry et al. 1981), and distribution related to winter food (Perry et al. 2007).

Waterfowl Breeding Survey (WBS)

The Atlantic Flyway Breeding Waterfowl Plot Survey is a multi-species, plot-based survey stratified by physiographic area that covers the northern portion of the Atlantic Flyway from New Hampshire through Virginia (Heusmann and Sauer 1997, 2000). Beginning in the late 1940s the United States Fish and Wildlife Service initiated a waterfowl breeding survey in the prairie pothole region that evolved into a cooperative effort between the United States and Canada. During the late 1950s this survey became the primary source of information used to develop annual waterfowl hunting regulations. Beginning in the 1980s there was a movement to develop flyway-specific regulations and this lead to the establishment of a breeding waterfowl survey in the northeast portion of the Atlantic Flyway in 1989 that was refined and became operational in 1993. The survey covers all species breeding within the region using randomly selected, 1-km^2 plots censused by ground crews. Most plots occurring in tidal salt marsh are surveyed from aircraft. Primary objectives of the survey include 1) to provide population data required to set waterfowl hunting regulations and manage eastern waterfowl stocks, especially eastern mallards, 2) to evaluate breeding distribution, and 3) to examine habitat use by breeding species.

Chesapeake Bay

Work has been conducted with breeding waterfowl within the Chesapeake Bay for a very long time (e.g. Stotts and Davis 1960, Stewart 1962). Extensive breeding work was conducted for

mallard and black duck on several bay islands in the late 1980s (Krementz et al. 1992). In addition, breeding productivity studies have been carried out since the mid-1990's on several of Virginia's bay islands (VDGIF, unpublished data). In recent years, these studies have been confined to only a few locations as breeding pair distribution and numbers continue to decline, largely due to loss of habitat attributed to rising sea levels and erosion. The Chesapeake Bay has been included in the Atlantic Flyway Breeding Waterfowl Plot Survey since its inception in 1989. The breeding survey has been used to evaluate population trends (Costanzo and Hindman 2007) size and habitat use for mallards, black ducks, wood ducks, and resident Canada geese (Costanzo 2002).

Targeted Surveys

International Piping Plover Census (IPPC)

The piping plover population along the Atlantic Coast was formally listed as federally threatened under the Endangered Species Act in 1986 (U.S. Fish and Wildlife Service 1985) resulting in federal and state mandates to both protect and monitor populations. Collaboration between U.S. and Canadian recovery teams designed an international census that included both winter and breeding efforts throughout the entire known range. Census efforts have been conducted every 5 years beginning in 1991 (Haig and Plissner 1993, Elliott-Smith et al. 2009). Biologists from all jurisdictions known to support suitable habitat conduct surveys during narrow 2-week windows in winter and summer to reduce double counting due to movements. All individuals detected are counted. The objectives of the census are 1) to monitor progress toward recovery and 2) to determine the distribution of the species.

Annual Atlantic Coast Piping Plover Breeding Survey

Annual estimates of breeding pairs of Atlantic Coast piping plovers are based on multiple surveys of almost all breeding habitat, including many currently unoccupied sites. Sites that cannot be monitored repeatedly for breeding success (primarily sites with few pairs or inconsistent occupancy) are surveyed at least once during a standard nine-day count period in early June (Hecht and Melvin 2009). Annual population monitoring on the breeding grounds has been a major part of the recovery program for Atlantic Coast piping plovers since 1986 and serves as the primary measure of local and regional progress toward recovery.

Chesapeake Bay

Breeding piping plovers have been surveyed annually in the Chesapeake Bay since 1986 using the protocols adopted by the annual Atlantic coast survey (Watts et al. 1996, Boettcher et al. 2007). The known historic range is limited to the lower western shore of the Bay including Grandview Beach, Craney Island, and below Gwynn's Island. Breeding pairs have not been documented within these locations since 1997. The Chesapeake Bay is peripheral to the piping plover winter range with a considerable population wintering in North Carolina but very few

records in Virginia. The Chesapeake Bay has been included in the winter portion of the international census since the 2006 survey. Outside of the breeding and winter seasons, piping plovers have been detected during the migratory periods in several locations throughout the Bay.

Bald Eagle Breeding Surveys (BEBS)

The regulatory mandates of the Endangered Species Act (ESA) (16 U.S.C. 1531-1543; 87 Stat. 884) and the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d; 54 Stat. 250) on the federal level and various wildlife laws on the state level led to a unified effort to monitor bald eagle breeding populations across North America beginning primarily in the 1970s. Although compiled on a national level and often coordinated on the level of recovery units, level of effort and methodology has varied dramatically across states from intensive aerial surveys or ground-based surveys to volunteer-based monitoring networks. Most survey programs were executed on an annual basis through the 1990s. Survey programs had multiple objectives including 1) contributing to continental population and trend estimates, 2) identifying nest sites for protection, 3) estimating reproductive rates, and 4) evaluation of management actions or adaptive management. Since the federal "downlisting" of the bald eagle in 1995 (Millar 1995) most states have discontinued formal survey programs. Following federal "delisting" in 2007 (72 FR 37346) the USFWS developed a national monitoring plan (72 FR 37373) as mandated by ESA. The plan utilizes lists of known nests and randomly selected survey blocks within a dual-frame approach. The survey is designed to have an 80% probability of detecting a 25% decline in the population over a 20-year period. Due to high turnover rates, the effectiveness of this approach has been questioned for the Chesapeake Bay (Watts and Duerr 2010).

Chesapeake Bay

The Chesapeake Bay is an important recovery unit for bald eagles and monitoring has been a component of both the Bay-wide (Byrd et al. 1990) and Virginia (Watts 2005) conservation plans. The breeding population has been surveyed annually for more than 50 years beginning with a ground survey in 1957 and the establishment of an aerial survey in 1962 (Abbott 1963, Watts 2010). The aerial survey has employed a standard two-flight approach (Fraser et al. 1983) to track the entire population within the tidal reach of the Bay and to estimate reproductive rates. The population has increased dramatically since the late 1970s (Watts et al. 2007, 2008) resulting in the removal of the species from the Maryland list in 2010 and the Virginia list in 2013. Due to recovered status, Maryland and Virginia ended the study-wide, annual, aerial survey in 2004 and 2011 respectively (Watts and Byrd 2011). Annual surveys in Virginia are now confined to the James and Rappahannock watersheds. Annual and periodic surveys are continuing in Maryland in support of specific projects.

Midwinter Bald Eagle Survey (WBES)

A volunteer-based, continent-wide survey was initiated in 1979 for bald eagles during winter (Steenhof et al. 2008). The objectives of the survey were 1) to generate an index of population

size and trends and 2) to identify areas where birds were concentrated during winter. Early surveys lacked consistency in survey methodology, effort, and coverage (Millsap 1986). Initiated by the National Wildlife Federation the survey has been managed by several agencies and is now organized by a partnership between U.S. Geological Survey and the Army Corps of Engineers. The survey has become more standardized in several respects and has been used successfully to evaluate continental and regional population trends (Steenhof et al. 2002).

Chesapeake Bay

Aerial, shoreline surveys for wintering bald eagles were initiated throughout the Chesapeake Bay in 1962 (Larson and Abbott 1962). These surveys continued to cover selected drainages through the early 1990s. Participation in the national survey was initiated in the mid-1980s and continues to the present. There currently are 4 locations surveyed in Virginia including the Caledon and Mason Neck shorelines on the Potomac and the upper James and Rappahannock Rivers and 3 locations surveyed in Maryland including the Conowingo Dam, Aberdeen Proving Ground, and Blackwater National Wildlife Refuge. These 7 locations represent some of the highest-use areas for bald eagles within the Chesapeake Bay. In addition to participation in the national program, selected areas have been covered by air (Cooper and Watts, unpublished) and/or boat (Portlock 1994, Watts 2006, VDGIF, unpublished data, MDNR, unpublished data) to meet objectives of local projects.

Bald Eagle Summer Concentration Area Survey (BECAS)

The Chesapeake Bay is an area of convergence for post-nesting and subadult bald eagles from breeding populations in the southeast and northeast. Eagles migrate north from southeastern states to spend the summer months in the Bay (Broley 1947; Wood *et al*. 1990; Millsap *et al*. 2004). Bald eagle "concentration areas" are locations where eagles congregate in numbers much higher than what may be accounted for by local breeding pairs and their offspring and that support one to several communal roosts. There have been six summer concentration areas delineated throughout the tidal reach of the Bay (Watts et al. 2007, VDGIF unpublished data, Aberdeen Proving Ground unpublished data). The distribution of these areas presumably reflects the availability of food and the sites are believed to host large numbers of individuals and have high conservation significance. Surveys were initiated within concentration areas in the early 1980s (Wallin and Byrd 1984, Watts and Byrd 1999) with the objectives of 1) delineating high-use shorelines and 2) informing management activities. Shoreline surveys have been conducted several times per year although consistency of coverage has varied between locations and over time. Survey protocols and data recording was standardized in the mid-1990s (Watts and Whelan 1997, Watts 1998) and information is now suitable for examination of age structure, site-specific trends, identification of spatial patterns, and eagle-human interactions. Surveys are intended to support local management needs and are not contributing to national monitoring objectives.

Osprey Breeding Survey (OBS)

Due to severe declines during the 1950s and 1960s over much of their breeding range osprey have been monitored extensively. Monitoring information has been used to generate population estimates for the United States (Henny 1983, Houghton and Rymon 1994). However, there is no coordinated, range-wide monitoring program for this species and given their improved status, such a program is unlikely. Most current monitoring programs are tracking recovery within inland locations or are utilizing osprey as environmental indicators (Grove et al. 2009).

Chesapeake Bay

The Chesapeake Bay supports the largest breeding population of osprey in the world. Because the osprey was a species of high conservation concern during the period of greatest decline considerable effort was invested in monitoring the primary breeding areas between the early 1970s and the early 1990s (Kennedy 1977, Reese 1977, Byrd 1990). Monitoring programs were focused on tracking the status, distribution and reproductive rates relative to recovery objectives. There have been only two complete surveys of the population within the tidal reach of the Bay including one in the early 1970s (Henny) and one in the mid-1990s (Watts et al. 2004). Since the early 1990s osprey work in the Bay has been project-focused and has included contaminant monitoring (Rattner et al. 2004), dietary shifts (Glass and Watts 2009), response to habitat restoration (Erwin et al. 2007), etc. Although work is proceeding in several locations throughout the Bay there is no established program for coordinated monitoring. There is a need to 1) establish monitoring objectives Bay-wide, 2) evaluate how ongoing local projects may fit into a coordinated program, and 3) establish new monitoring efforts where needed.

American Oystercatcher Breeding Survey (AOBS)

The American Oystercatcher working group was formed in 2001 and has held annual meetings since that time (http://amoywg.org/amoy-working-group). The group has developed protocols for a coast-wide banding and resight program and successfully conducted a winter survey to estimate population size (Brown et al. 2005). Although most states throughout the Atlantic breeding range have active oystercatcher programs, no coordinated, range-wide monitoring program has been designed or implemented. Discussions are ongoing to design a coordinated, range-wide breeding/resighting survey tentatively planned for 2014 and a second range-wide winter survey has recently been completed in 2013.

Chesapeake Bay

Although there are early accounts of American Oystercatchers in the Chesapeake Bay, work to determine status and distribution was not initiated until the 1980s (Anderson 1988, Brinker 1996). Comprehensive surveys of the breeding population were in 2003 and again in 2008 (Wilke et al. 2005, 2007, Traut et al. 2006). Surveys are an attempt to give a complete assessment of the population every 5 years and have included extensive ground counts of all

known breeding habitat within the Chesapeake Bay. The objectives of the survey are 1) to determine the status, distribution, and trends for breeding American Oystercatchers in the Chesapeake Bay, 2) to contribute to range-wide population estimates, 3) to provide locations that may be used by regulatory agencies during environmental reviews, and 4) to provide baseline information that may be used to evaluate local management actions.

Studies in Maryland and Virginia that compared fledging success of oystercatchers breeding in the Chesapeake Bay to the fledging success of pairs breeding seaward of the Delmarva Peninsula, indicate that productivity estimates in the Bay are equal to or above values reported for seaside marshes, coastal bays and barrier beaches (Traut et al. 2006; VDGIF, unpubl. data). The alarming rate at which Bay islands are eroding (Erwin et al. 2011), however, signifies the need to repeat these studies periodically to measure the response of ground nesting birds to rapid habitat loss.

Mute Swan Survey (MSS)

The Atlantic Flyway Mute Swan Survey is an aerial and ground survey conducted by most Atlantic Flyway states in late summer to estimate total population size and productivity (Allin 2003). The mute swan is an invasive species that has expanded exponentially throughout the region following an accidental release (Hindman and Harvey 2004). The species causes damage to submerged and emergent aquatic vegetation (Tatu et al. 2007) and nesting habitats critical to other waterbird species of conservation concern (Therres and Brinker 2004) and so is the focus of a control and management program. The objectives of the survey are 1) to determine population size and trends, 2) to estimate productivity, 3) to determine distribution and habitat use, 4) to locate swans for population control, and 5) to provide a metric to be used in an adaptive control program. The survey was established in 1986 and has been conducted every three years throughout the flyway. Maryland Department of Natural Resources has also conducted annual surveys of mute swans in late summer between 1972 to 1982 and 2005 to 2013.

<u>Chesapeake Bay</u>

Piecemeal surveys of mute swans have been conducted in various locations in the Chesapeake Bay since the escape of 5 individuals into the estuary in 1962 (e.g. Allin et al. 1987, Reese 1996). The population exceeded 4,000 individuals by 2000 (Costanzo and Hindman 2007). Their consumption and destruction of submerged aquatic vegetation has led to concerns about impacts to ecosystem function and other species ultimately leading to the development of a Chesapeake Bay mute swan management plan and a statewide mute swan management plan in Maryland. The Chesapeake Bay has been included in the flyway-wide survey since its inception and information produced along with other efforts has been used to monitor progress toward conservation targets.

Monitoring coverage and gaps

Existing coverage of waterbird monitoring needs is inadequate within the Chesapeake Bay (see Appendix 5 for details). Approximately 34% of the need identified is being met. Strengths include the breeding (62%) and winter (51%) seasons due to the colonial waterbird survey and the midwinter waterfowl inventory. These broad platform programs include a significant number of species with identified monitoring needs. An additional strength is coverage of individual species with high conservation priority including the bald eagle, piping plover, and American oystercatcher. Large gaps in coverage include breeding marsh birds, migratory shorebirds, and wintering sea ducks. Examination of the relationships between coverage and survey rationale suggests relatively high coverage by surveys contributing to range-wide population estimates reflecting continental monitoring programs that include the Chesapeake Bay (Table 5).

Table 5. Relationship between coverage of monitoring need, survey rationale, and season for waterbird monitoring within the Chesapeake Bay. Numbers indicate the number of waterbird species (see Appendix 5 for details). Parenthetic values indicate the percentage of need met by existing programs.

Rationale	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Regulatory Mandate	20(54)	----	1(100)	6(46)	0(0)	0(0)
Range-wide Contribution	30(81)	----	----	22(67)	0(0)	0(0)
Local Management	29(58)	----	2(100)	24(55)	0(0)	0(0)

TOWARD COMPREHENSIVE WATERBIRD MONITORING

Recommendations

The most efficient means of increasing coverage of identified waterbird monitoring needs is to expand existing survey efforts to include some species that are similar in type, habitat use, and season of occurrence and to establish new surveys in areas that represent significant and high priority gaps. The largest unmet needs identified include breeding marsh birds, migratory shorebirds, and winter sea ducks. The tidal marsh breeding survey initiated within the northeast region should be expanded into the Chesapeake Bay and should include brackish and tidal-fresh marshes in addition to salt marshes. The Program for Regional and International

Shorebird Monitoring that has consolidated the Canadian Maritime Shorebird Survey and the International Shorebird Survey should be continued and expanded within the Chesapeake Bay and should include all habitats known to be important to migratory shorebirds. Plans to re-establish the Atlantic Coast Sea Duck Survey should be brought to completion and this survey should be expanded to include grebes, loons, and other seabirds. In addition to these broad platform surveys, targeted surveys should be established for the state endangered black rail and the threatened *susurrans* form of the Henslow's sparrow. Recommended additions to existing programs are outlined in Table 6.

Table 6. Recommendations for existing surveys, expansions of existing surveys and establishment of new surveys within the Chesapeake Bay. See text below for survey abbreviations.

Survey	Recommendation
TMBS	*Expand marsh bird monitoring program currently being conducted within the Northeast into the Chesapeake Bay. Insure that the program contributes to national, regional, and local estimates of population status, distribution, and trends. Program should contribute to understanding of current constraints/threats and provide a metric for evaluating ongoing adaptive management programs.*
CWS	*Continue to conduct ongoing colonial waterbird surveys to contribute to local, regional, and continental estimates of population size, distribution and trends and to inform local planning and adaptive management programs. Attempt to coordinate monitoring with similar programs in eastern North America. Develop and implement approaches for estimating reproductive rates.*
PRISM	*Extend Program for Regional and International Shorebird Monitoring into the Chesapeake Bay to contribute to national, regional, and local estimates of population status, distribution, and trends. Establish a network of monitoring sites that includes habitats known to be important for migratory shorebirds within the Chesapeake Bay and capable of providing information for local planning and management. Develop a community of capable volunteer observers.*
WSDS	*Establish a robust sea duck monitoring program capable of delivering population and distribution information required on both a continental and local scale. Consider expanding the species list to include non-targets that are not covered by current monitoring programs (e.g. gulls, terns, loons, grebes, pelagic seabirds).*
WBS	*Continue survey in the Chesapeake Bay to support estimates of population size, distribution, and trends on local, regional, and continental scales and to support local adaptive management programs. Consider expanding to include other non-target species (pied-billed grebe, common moorhen).*

Survey	Recommendation
MWI	*Continue survey of key waterfowl species along traditional routes in support of Atlantic Flyway adaptive management programs focused on species population management, habitat conservation and restoration. Consider stratifying data collected according to habitat types to inform local planning and management.*
BRBS	*Build on recent survey efforts to establish a formal monitoring program for the black rail to contribute to regional population estimates and trends and to inform local planning and adaptive management. Utilize point-count methodologies and playback regimes that include non-target species that breed within high-marsh habitat. Design field effort to coincide with tidal marsh bird surveys and surveys for Henslow's sparrows.*
HSBS	*Establish targeted survey for threatened susurrans form of Henslow's sparrow that includes all potential breeding habitat to inform local management plan and actions. Utilize point-count methodologies and include non-target species that breed within high-marsh habitat. Design field effort to coincide with tidal marsh bird surveys*
IPPC	*Continue survey historic sites throughout the Chesapeake Bay in support of local, regional, and continental estimates of population size, distribution, and trends and in fulfillment of regulatory mandates.*
AOBS	*Build on recent survey efforts to establish a formal monitoring program for American Oystercatchers within the Chesapeake Bay to contribute to regional population estimates and trends and to inform local planning and adaptive management. Design field effort to coincide with colonial waterbird survey, migratory shorebird surveys, and international piping plover census.*
BEBS	*Adopt the national monitoring plan as the primary contribution made by the Chesapeake Bay toward population trends on a national scale. Consolidate project-based monitoring efforts into a central data repository to inform local management and bay-wide assessments. Transition conservation approach away from nest-level management.*
WBES	*Continue mid-winter bald eagle surveys to contribute to assessments of continental population trends and local management actions. Conduct a bay-wide surveillance survey to determine if other high-use locations should be included as survey sites. Use historic data to evaluate the level of confidence in estimating local trends.*
BECAS	*Continue surveys of summer bald eagle concentration areas to inform local planning and ongoing adaptive management programs focused on human disturbance. Establish thresholds in changes in use that should trigger management actions. Use historic survey data to determine the number of surveys needed to detect such thresholds with acceptable levels of confidence.*
OBS	*Consolidate and expand ongoing osprey monitoring projects throughout the Chesapeake Bay to form a cost-effective, early-warning network for*

Survey	Recommendation
	environmental health. Focus efforts on easily measured reproductive metrics that are recognized indicators of contaminants and fish stocks.
MSS	*Continue survey within the Chesapeake Bay in support of state adaptive population control programs and to contribute to regional and flyway estimates of population size, distribution, and trends.*

Survey plans

Detailed survey plans including 1) issues faced by targeted taxa, 2) information needs, 3) strata, 4) focal species, 5) quantitative objectives, 6) survey methods, 7) sample size requirements, 8) associated variables, 9) sampling plans, and 10) recommendations for implementation are presented below.

Broad Platform Surveys

Tidal Marsh Bird Survey (TMBS)

Issues

The Chesapeake Bay supports one of the most significant concentrations of tidal wetlands and associated bird communities within North America. Community subtypes include salt marsh, brackish marsh, and tidal-fresh marsh. BBS data provide inadequate coverage and for most species very little is known about population status and trends. Species are threatened by sea-level rise, marsh subsidence, habitat loss, habitat degradation related to urban expansion, invasion by invasive plants, increases in mammalian predator populations, and human disturbance. Very little is currently known about population trends or their potential relationship to stressors.

Objectives

To establish a monitoring program capable of delivering needed status, distribution, and trend information for most species breeding within tidal marshes of the Chesapeake Bay. To identify significant stressors to populations that may be included in planning and management programs.

Information needed –Survey information is needed to establish population status, distribution, and trends with an adequate level of confidence. Although no national marsh bird monitoring program currently exists, information from the Chesapeake Bay should contribute to such a program in the future. Information will contribute to population estimates and trends for the mid-Atlantic and Northeast regions. Information is needed to identify principal stressors

on marsh-bird populations, to inform local management, and as a component of ongoing adaptive management programs.

Strata – It is not possible to survey the entire populations within the Chesapeake Bay. Subsampling effort should be stratified according to known factors contributing to marsh-bird community structure including salinity-based marsh type (salt, brackish, tidal-fresh) and marsh size (<5 ha, 5-50 ha, >50ha), as well as, potential stressors including mammalian predator activity and inundation rates.

Focal Species – Survey will focus on all species breeding within tidal marshes with an emphasis on obligate species (Table 7).

Table 7. List of waterbird species that will be included in surveys within tidal marshes of the Chesapeake Bay. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Pied-billed grebe	**Black rail**	**Henslow's sparrow**
American black duck	**Common gallinule**	**Saltmarsh sparrow**
American bittern	**Willet**	**Seaside sparrow**
Least bittern	**Northern harrier**	**Coastal swamp sparrow**
King rail	**Short-eared owl**	**Sedge wren**
Clapper rail	Red-winged blackbird	**Marsh wren**
Virginia rail	**Boat-tailed grackle**	

Quantitative Objectives –The survey will adopt quantitative objectives outlined within Shriver et al. (2008) including 1) to produce density estimates with coefficients of variation $\leq$ 0.40 and 2) to achieve 80% power to detect 5% annual change in abundance over 10 years at a significance level of 0.1. It should be noted that these objectives will never be achievable for some species and that effort or levels may have to be adjusted as habitat-specific information is available and based on reduced survey interval (5 vs 1 year).

Methods

Survey methods – Field methods will generally follow recommendations from Shriver et al. (2008). Surveys will utilize standard point-count methodologies with distance estimation to improve effective sample area and time stratification. A modified playback regime will be used for call-responsive species to improve detection rates (Conway and Gibbs 2005).

Sample size requirements – Sample requirements to meet quantitative objectives are not known for habitats within the Chesapeake Bay. Following general recommendations from Shriver et al. (2008) samples in the range of 10-20 patches for each strata should be adequate.

Associated variables – Variables to be included in models are 1) number of birds detected, 2) detection type (aural or visual), 3) detection distance, 4) time period of detection,

5) marsh type, 6) patch size 7) extent of invasion by common reed, 8) presence of ground predators, 9) tide stage and 10) inundation frequency of ecotone during breeding season.

Sampling plans – Breeding chronology should be taken into account when designing fieldwork. Within the Chesapeake Bay, peak detectability of rails occurs in May while some passerine populations continue to migrate until early June. A minimum of 3 surveys should be conducted during the first 4 hours after sunrise between 1 May and 15 July. To accommodate both nocturnal calling species (e.g., black rails) and diurnal calling species (e.g., Henslow's sparrows) each route should be run twice per survey. The first should be conducted 2-4 hours before sunrise to sunrise and then repeated in a reverse direction from sunrise to 2-4 after sunrise. A minimum of 10 days should separate consecutive surveys. Early data should be used to further refine sampling regime. Patch network should be surveyed every 5 years.

Recommendations for implementation

-Compile patch coverage for marshes according to type and size for the Chesapeake Bay.
-Develop modified Generalized Random Tessellated Stratification patch selection procedure.
-Explore options for quantifying marsh inundation frequency.
-Survey effort should be designed to coincide with targeted surveys for Henslow's sparrows and black rails.

<u>Colonial Waterbird Survey (CWS)</u>

Issues

The Chesapeake Bay supports a diverse community of breeding colonial waterbirds. Some of these species have recently expanded their range into the Chesapeake (e.g., great black-backed gull, double-crested cormorants, brown pelican, Anhinga), others are recovering from population declines (e.g., great blue heron, great egret), while still others are experiencing rapid declines (e.g. snowy egret, little blue heron, common tern, black skimmer). There has been very little demographic data collected for most species and the causes of declines remain unclear. For some colonies habitat loss or degradation, nest predation, and human disturbance are known to be factors. Some species that are expanding are considered to be nuisance species. Due to their substrate use or impact to other species, some of these species (e.g., double-crested cormorants, herring gull, and great black-backed gull) have been the focus of control programs within the region.

Objectives

To conduct a monitoring program capable of delivering needed status, distribution, and trend information for most species breeding within tidal marshes of the Chesapeake Bay. To identify significant stressors to populations that may be included in planning and management programs.

Information needed – Information is needed on the location, species composition, and size of all waterbird colonies within the Chesapeake Bay. The Bay is an important breeding area for many colonial waterbirds and information collected in the Bay contributes to continental, regional and local assessments of status, distribution, and trends. Because many species are state listed or species of conservation concern and because most species breed in few concentrated locations, breeding sites are protected. Survey information is used in the permit review process and to determine areas that are of high conservation value for acquisition or other protection. For species with ongoing management programs (conservation or control), survey data serves as a response metric for adaptive management. Information on reproductive rates, adult and young survival, site fidelity, prey populations, impact of predators, and impact of human disturbance would be desirable.

Strata – Objective is to enumerate all colonies and pairs. All habitats that support breeding colonies should be surveyed including bay islands, dredge spoil islands, beaches, marshes, near-shore forests, and urban neighborhoods with habitat suitable for urban-nesting species.

Focal Species – Survey will focus on colonial waterbirds that breed within the Chesapeake Bay (Table 8).

Table 8. List of colonial waterbird species that will be included in surveys. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Great black-backed gull	**Least tern**	**Snowy egret**
Herring gull	**Black skimmer**	**Tricolored heron**
Laughing gull	Anhinga	**Little blue heron**
Gull-billed tern	Double-crested cormorant	Cattle egret
Caspian tern	**Brown pelican**	Green heron
Royal tern	White ibis	**Black-crowned night heron**
Sandwich tern	**Glossy ibis**	**Yellow-crowned night heron**
Forster's tern	**Great blue heron**	
Common tern	**Great egret**	

Quantitative Objectives – Objective is to locate and count >95% of all colonies and breeding pairs.

Methods

Survey methods – Colonies will be located and surveyed using a combination of aerial and ground surveys. Aerial surveys will be used to locate, map, and estimate all colonies visible from the air. Follow-up ground surveys will be conducted except for colonies covering tens of hectares where colony disturbance is a concern and remote colonies where access is not feasible. Subcanopy urban colonies will be located by systematically driving through potential

habitat. Paired ground and aerial surveys will be compared to calculate estimation errors for colonies with aerial surveys only. Whenever possible and feasible, multiple surveys should be conducted to cover the peak in colony size.

Sample size requirements – Objective is to survey all colonies and pairs.

Associated variables – Variables to be included in surveys are 1) number and location of colonies, 2) number of breeding pairs, 3) stage of nesting, 2) habitat type, 3) nesting substrate type, 4) human presence within colonies, and 5) evidence of ground or aerial predators.

Sampling plans – Breeding chronology should be taken into account when designing fieldwork. Ideally, all surveys should be conducted during peak incubation (i.e., when first laid nests are just starting to hatch). As a general rule, coastal marshes and islands supporting gulls, terns, and allies should be surveyed between mid-May and mid-June. Ground counts of urban areas should be conducted during April, May, and June. Ground counts of bay islands and marshes should be conducted during June and July. A complete survey of colonies should be conducted every 5 years.

Recommendations for implementation

-Adopt 5-year regional survey schedule.

-Survey selected geographic areas twice to estimate colony detection rates.

-Use recent GPS technology to more efficiently map colonies and deliver digital coverage.

-Work with Maryland partners to develop bay-wide survey methods to achieve consistency in counting techniques.

-Work with regional partners (ME – MD) to minimize differences in survey methods to improve the accuracy of region-wide population estimates.

-Survey effort should be designed to coincide with American Oystercatcher surveys.

<u>Program for Regional and International Shorebird Monitoring (PRISM)</u>

Issues

More than half of the shorebird populations migrating along the Atlantic Flyway are believed to be declining. For many of these species, migratory surveys represent the best and most cost-effective option for estimating trends. The Chesapeake Bay supports a wide range of habitats used by migratory shorebirds and these habitats are subject to threats (e.g. loss, degradation, human disturbance) that have the potential to impact staging shorebirds. No program has been established within the Chesapeake Bay to monitor migratory shorebirds.

Objectives

To collect information on migratory shorebirds that is capable of contributing to continental estimates of population status and trends and to provide information needed to identify significant local staging areas, to inform local plans and adaptive management programs.

Information needed –Information is needed on the abundance and distribution of migrant shorebirds within the Chesapeake Bay. Information will contribute to continental estimates of shorebird population size and trends. Information is needed within the Chesapeake Bay to establish habitat associations and to identify important staging areas that may inform local management plans. Information is needed as a metric for ongoing adaptive management programs (e.g., impoundment management, marsh restoration, bleach closure). Collecting information on stopover duration, foraging rates, prey populations, and weight changes is desirable and such information has the potential to drive management decisions within specific staging sites. Information on non-target species (e.g., gulls, terns) should be collected when possible.

Strata – Effort should be stratified according to distinct habitat types known to support migrant shorebirds within the Chesapeake Bay including salt marsh, brackish marsh, tidal-fresh marsh, high-energy beaches, and impoundments.

Focal Species – Survey will include all migratory shorebirds using the Chesapeake Bay with particular emphasis on those species that are recorded annually (Table 9).

Table 9. List of migratory shorebirds that use the Chesapeake Bay annually and will be included in surveys. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Wilson's phalarope	Least sandpiper	**Willet**
American avocet	**Dunlin**	Spotted sandpiper
Black-necked stilt	**Semipalmated sandpiper**	**Whimbrel**
Wilson's snipe	Western sandpiper	**Black-bellied plover**
Short-billed dowitcher	**Sanderling**	Killdeer
Long-billed dowitcher	Marbled godwit	Semipalmated plover
Stilt sandpiper	Hudsonian godwit	**Piping plover**
Red knot	**Greater yellowlegs**	**Ruddy turnstone**
Purple sandpiper	Lesser yellowlegs	**American oystercatcher**
White-rumped sandpiper	**Solitary sandpiper**	

Quantitative Objectives – The broad, continental objective is to achieve 80% power to detect a 50% decline occurring during 20 years with the significance level set at 0.15.

Methods

Survey methods – Area searches conducted by foot, boat, or air as appropriate should be used to estimate species and numbers within site boundaries. Volunteers should be used

for ground surveys when possible. Due to the difficulty of identifying some shorebird species, adequate training of observers should be required.

Sample size requirements – Target sample sizes for continental objectives have not been specified such that the role of the Chesapeake Bay toward this effort is unclear at present. Information to establish sample sizes for local objectives is not available. Initial efforts should attempt to establish 4-6 sites per habitat type and encourage volunteers to establish additional sites within the same framework.

Associated variables – Primary variables to be included are 1) number of individuals, 2) species composition, 3) habitat type, 2) date, and 3) human activity. Secondary variables to include as available are 1) prey levels, foraging rates, weight changes, inundation frequency (marsh), and water levels (impoundments).

Sampling plans – Movement phenology should be taken into account when designing fieldwork. Survey effort is targeted for spring, fall, and winter. Surveys should be conducted every 10 days during spring (15 March through 15 June), fall (15 July through 25 October), and winter (5 November though 25 February). For tidal sites, surveys should be conducted within 2 hours of low tide.

Recommendations for implementation

-Compile list and map of sites that meet habitat types included and conditions for volunteer.

-Identify initial, core set of sites to include in survey network.

-Recruit volunteers to conduct surveys.

-Produce and conduct training course for volunteer observers.

-Adopt an online data entry and management process.

-Use initial information to inform sample needs for local objectives.

<u>Atlantic Coast Wintering Sea Duck Survey (WSDS)</u>

Issues

The Chesapeake Bay is a critical winter location for sea ducks. Although several threats have been identified within the sea duck strategic plan (e.g. habitat degradation, contaminants, climate change, disease), unlike other waterfowl there is no monitoring program in place to inform management on either a local or continental scale. Our understanding of population size, distribution, and trends remains poor.

Objectives

To collect sea duck abundance and distribution information to contribute to continental population estimates and to support local plans and adaptive management programs.

Information needed –Information on the abundance and distribution of sea ducks is needed across primary habitats primarily within the main stem of the Chesapeake Bay to identify important wintering areas, to examine dynamics of use of significant areas, and to support local planning and adaptive management programs focused on hunting, prey populations, and human disturbance. Information on survivorship, site fidelity, and connectivity with breeding grounds to delineate stocks is desirable.

Strata – Preliminary surveys are being conducted in preparation of a comprehensive sea duck monitoring plan for the Atlantic Flyway. Among others, likely strata include 1) water depth, 2) habitat type, and 3) latitude.

Focal Species – Survey will include all sea duck species that use the Chesapeake Bay (Table 10).

Table 10. List of wintering waterfowl that should be covered by the sea duck survey in the Chesapeake Bay. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Red-breasted merganser	King eider	Surf scoter
Harlequin duck	Black scoter	Long-tailed duck
Common eider	White-winged scoter	

Quantitative Objectives –Objectives with regard to precision of population estimates, trends, habitat use and proportion of winter habitat covered are under development by the Monitoring Subcommittee of the Sea Duck Joint Venture.

Methods

Survey methods – Primary habitats along the outer coast and within estuaries such as the Chesapeake Bay will be systematically covered using aerial, band transects. Specific methods are under development to incorporate environmental effects.

Sample size requirements – Preliminary surveys are being conducted to be used in the development of a comprehensive monitoring plan that will include an adequate sampling regime to meet quantitative objectives.

Associated variables – Primary variables to be included are 1) number of individuals, 2) species, 3) flock size, 4) depth, and 5) habitat type.

Sampling plans – Surveys should be conducted annually within the first 2 weeks of January. Survey transects will be positioned perpendicular to the shoreline to cover the available depth gradient.

Recommendations for implementation

-Use GPS technology to map the location of sea duck concentrations to enable more precise habitat associations.

-Consider the expansion of the species covered to include comparable non-target species (e.g. gulls, terns, loons, grebes, pelagic seabirds).

Waterfowl Breeding Survey (WBS)

Issues

The Chesapeake Bay supports a limited community of breeding waterfowl dominated by mallard, Canada goose, mute swan, wood duck, and black duck but also including blue-winged teal and hooded merganser. Canada geese, mute swans, and mallards have colonized the Bay in recent decades, are year-round residents and adaptable to urban environments. In some settings, resident Canada geese and mute swans are considered to be nuisance species. There is some concern about a declining trend in wood duck numbers over the past several years. Additional surveys may be needed to further evaluate this trend. Black ducks have experienced dramatic declines that have been related to erosion of critical bay-island breeding areas, development of Bay shorelines, increases in populations of ground predators, and increases in inundation rates due to sea-level rise.

Objectives

To collect information to inform hunting regulations and adaptive management programs and to estimate habitat-specific breeding densities.

Information needed – Information is needed on the size and trajectory of breeding waterfowl species for the purpose of setting hunting regulations and planning management activities. Information collected in the Chesapeake Bay contributes to the broader regional survey and is used to estimate population size and trends. The information is also used to estimate habitat-specific densities and reproductive rates. For all species, population information is used as a response metric for ongoing adaptive management programs focused on hunting, control, and habitats. Because black ducks are listed as species of greatest conservation need in both Maryland and Virginia, information on this species is used for conservation planning and permit review. Information on reproductive rates, adult and young survival, connectivity to winter sites, the occurrence of ground predators, human activity, and inundation frequency would be desirable.

Strata – The broader survey has delineated a large number of physiographic strata. However, the tidal reach of the Chesapeake Bay is included within the upper coastal plain strata. The survey is further stratified by habitat type.

Focal Species – Survey will focus on waterfowl species that breed within the Chesapeake Bay (Table 11).

Table 11. List of waterfowl species that are included in breeding surveys within the Chesapeake Bay. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Mallard	Blue-winged teal	Canada goose
American black duck	Wood duck	Mute swan

Quantitative Objectives –Objective is to survey 1,500 plots per year.

Methods

Survey methods – Area searches of sample plots are made by foot or air during the peak period (April and May) of waterfowl breeding activity. All waterfowl activity is recorded and post-survey protocols are used to compile total numbers and breeding pairs. Surveys are conducted during both dawn/dusk and daylight periods and correction procedures are used to average counts.

Sample size requirements – The number of plots surveyed within habitat strata for the Chesapeake Bay is set by the regional design and is increased as needed based on regular review of results.

Associated variables – Variables to be included in surveys are 1) number and activity of waterfowl, 2) habitat type, 3) human presence, and 4) evidence of ground or aerial predators.

Sampling plans – Sample plots should be covered by ground or air during April and May. Survey should be conducted during the time period (dawn/dusk vs. daylight) specified for sample plot. Plots are fixed and surveyed annually.

Recommendations for implementation

-Consider expanding list to include non-target but comparable species (e.g. pied-billed grebe, common moorhen).

-Consider collecting data on inundation rates within breeding areas.

-Consider collecting data on evidence of ground predators and human activity.

<u>Midwinter Waterfowl Inventory (MWI)</u>

Issues

On a continental scale, the Chesapeake Bay is an important location for waterfowl in winter. While in the Bay, waterfowl are subjected to and in the future will experience several threats including reductions in water quality, declines in food resources such as SAV and shellfish, increases in human activity and disturbance, contaminants, and habitat loss. Understanding the influence of these threats on waterfowl numbers and distribution and planning for the mitigation of such threats requires survey information.

Objectives

To collect waterfowl abundance and distribution information in support of local plans and adaptive management programs.

Information needed –Information on the abundance and distribution of waterfowl is needed within the Chesapeake Bay to identify important wintering areas, to examine dynamics of use of significant areas, and to support local planning and adaptive management programs (e.g. impoundment management, SAV restoration, oyster reef and other bivalve projects). Waterfowl are also good sentinel species for habitat degradation and human disturbance.

Strata – Waterfowl are surveyed and summed within designated routes without regard for relevant strata.

Focal Species – Survey will include all waterfowl species within designated survey routes (Table 12).

Table 12. List of wintering waterfowl that are typically covered by the midwinter waterfowl inventory in the Chesapeake Bay. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Common merganser	Northern shoveler	Bufflehead
Red-breasted merganser	Northern pintail	**Ruddy duck**
Hooded merganser	Wood duck	Snow goose
Mallard	Redhead	Canada goose
American black duck	**Canvasback**	**Atlantic brant**
Gadwall	Greater scaup	Mute swan
American Wigeon	Lesser scaup	Tundra swan
Blue-winged teal	Ring-necked duck	
Green-winged teal	Common goldeneye	

Quantitative Objectives –Objectives with regard to target percentage of populations covered or likelihood of detecting differences between strata or magnitude of trends over time have not been formulate.

Methods

Survey methods – Area searches conducted by air should be used to estimate species and numbers along designated routes. Surveys should be conducted annually within the first two weeks of January. Species that are difficult to distinguish from the air (e.g. scoters, scaup) should be lumped into the lowest taxonomic class possible.

Sample size requirements – Survey routes have been established since the mid-1950s without consideration of sample sizes. Objective is to provide summary information for traditional routes.

Associated variables – Primary variables to be included are 1) species, 2) number of individuals, and 3) route.

Sampling plans – Surveys should be conducted annually within the first 2 weeks of January. Efforts should be made to cover all traditional routes.

Recommendations for implementation

-Information should be stratified according to salinity and habitat types important to waterfowl.

-Consider the use of GPS technology to map the location of waterfowl to enable more precise habitat associations.

-Consider the expansion of the species covered to include comparable non-target species (e.g., gulls, loons, grebes).

Targeted Surveys

<u>Black Rail Breeding Survey (BRBS)</u>

Issues

The population of black rails in eastern North America is believed to have declined by more than 75% over the past 2 decades. The Chesapeake Bay population is believed to have declined by more than 90%. Causes for declines are poorly known but likely include marsh loss and degradation, elevated inundation rates during the breeding season related to sea-level rise, increases in ground predator populations, and human disturbance. Black rails are listed as endangered in Maryland and as threatened in Virginia. Location information is needed for inclusion in permit review and management plans. No estimates of population size or trends are available in eastern North America. Survey and monitoring programs are needed to fill information gaps on habitat use and threats to inform conservation plans.

Objectives

To collect information needed to estimate population size and trends and to inform local planning and adaptive management programs.

Information needed – Black rails are listed as endangered in Maryland and as threatened in Virginia. Information on the abundance and distribution of breeding pairs is needed throughout the potential breeding range within the Chesapeake Bay to formulate management plans and to identify primary causal factors for declines. Definitive information is

needed on habitat use. Information on nesting success, young and adult survival, diet, location of wintering areas, phenology of residency, and site fidelity is desirable.

Strata – All high-marsh patches greater than 50 ha in area should be considered potential breeding sites and should be included for consideration. Patches should be stratified according to known history of use.

Focal Species – Survey will focus on breeding black rails but will include other non-target, high-marsh, breeding species that are detectable during survey window (Table 13).

Table 13. List of species that breed in high-marsh habitats and that would be effectively surveyed during survey window for black rails. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Black rail	Clapper rail	Virginia rail

Quantitative Objectives – To locate >90% of active breeding sites with a 95% confidence level.

Methods

Survey methods – Surveys will utilize standard point-count methodologies with time stratification. A playback regime will be used to improve detection rates. Work in the Chesapeake Bay has shown that both time of day, playback regime, and point-count duration influence detection rates with this species. A modification of the standard national recommendation (Conway 2011) will be used.

Sample size requirements – All patches with a known history of use will be included in surveys. A random subset of high-marsh patches meeting current understanding of requirements (>50 ha in area) will be selected for inclusion.

Associated variables – Primary variables to be included in models are 1) presence or absence of black rails, 2) number of calling individuals, 3) history of known use, 4) size of high-marsh patch, 5) presence of ground predators, and 6) inundation frequency.

Sampling plans – Marsh patches should be surveyed 3 times between 1 May and 1 July to capture the most active period of the breeding season. Calling rates within the Chesapeake Bay appear to be best during the night hours. Broad survey for occupation should be conducted every 5 years. Active sites should be surveyed annually within the context of an adaptive management program.

Recommendations for implementation

-Compile historic breeding locations to form a core breeding distribution and to inform site selection for surveys.

-Use remote sensing techniques to identify suitable high-marsh patches for inclusion.

-Explore options for quantifying marsh inundation frequency.

-Survey effort should be designed to coincide with marsh-bird and Henslow's sparrow surveys.

Henslow's Sparrow Breeding Survey (HSBS)

Issues

The unique Atlantic Henslow's sparrow (*Ammodramus henslowii susurrans*) that is a specialist of salt-marsh habitats has disappeared over most of its former breeding range and may have gone extinct in the Chesapeake Bay. The form was last known from Maryland and Virginia marshes along the eastern shore of the Chesapeake in the early 1990s and late 1990s respectively. The form utilizes the highest portion of the high marsh within the marsh/upland ecotone. This habitat is often linear and is characterized by stands of salt meadow hay interspersed with shrubs that grade into a band of switch grass (*Panicum virgatum*). The underlying cause of the population decline is not fully known. One likely contributing factor is the rapid expansion of the invasive common reed (*Phragmites spp*.). Because this species invades along the marsh-upland ecotone, Henslow's sparrows may be particularly vulnerable. Other possible causes include ground predators and sea-level rise.

Objectives

Information needed – Abundance and distribution of breeding pairs is needed throughout the potential breeding range within the Chesapeake Bay. This form is listed as threatened in both Maryland and Virginia and distribution information is needed to formulate management plans designed to reverse population decline and to protect active or potential sites from further loss. If a remnant breeding population is discovered demographic data would be desirable to aid in identifying possible causes for declines.

Strata – All high-marsh patches greater than 50 ha in area are potentially suitable breeding habitat and should be included in survey. Marshes should be categorized according to both the extent of common reed invasion and whether or not marshes are accessible to ground predators (mainland vs island marshes).

Focal Species – Survey will focus on breeding Henslow's sparrow but will include other non-target, high-marsh, breeding species (Table 14).

Table 14. List of species that breed in high-marsh habitats that will be included in surveys. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

American black duck	**Northern harrier**	**Saltmarsh sparrow**
Black rail	**Short-eared owl**	**Seaside sparrow**
Clapper rail	**Henslow's sparrow**	**Sedge wren**
Willet		

Quantitative Objectives – To locate >90% of active breeding sites with a 95% confidence level.

Methods

Survey methods – Survey should utilize standard point-count methodologies with distance estimation to improve effective sample area and time stratification. Point counts should be positioned along the marsh-upland ecotone with a minimum of 200-m separation.

Sample size requirements – All potential breeding sites should be included in initial survey year. Subsequent years should include all occupied sites and 1/3 (randomly chosen without replacement) of all unoccupied sites to estimate reoccupation rates.

Associated variables – Initial variables to be included in models are 1) size of high-marsh patch, 2) length of marsh-upland ecotone, 3) extent of invasion by common reed, 4) presence of ground predators, and 5) inundation frequency of ecotone during breeding season.

Sampling plans – Marsh patches should be surveyed once every 2 weeks from 1 June through mid-July to capture the most active period of the breeding season. Broad survey for occupation should be conducted every 5 years. Active sites should be surveyed annually within the context of an adaptive management program.

Recommendations for implementation

-Compile historic breeding locations to form a core breeding distribution.
-Use remote sensing techniques to identify suitable high-marsh patches for inclusion.
-Explore options for quantifying marsh inundation frequency.
-Survey effort should be designed to coincide with marsh-bird and black rail surveys.

<u>International Piping Plover Census (IPPC)</u>

Issues

Following dramatic range-wide population declines the piping plover was federally listed as threatened along the Atlantic Coast. On the state level the species is listed as endangered and threatened by Maryland and Virginia respectively. The primary causes of endangerment include widespread loss of habitat due to beach development, and reduced productivity due to human disturbance and nest predators. Other factors of concern include changes in storm frequency or magnitude related to climate change and the availability of prey for rearing young.

Objectives

To survey all suitable nesting and winter habitat within the known historic range in the Chesapeake Bay.

Information needed – Abundance and distribution of breeding pairs is needed throughout the potential breeding and winter range within the Chesapeake Bay. On a continental scale surveys are used to monitor progress toward recovery goals and to document distribution. Within the Chesapeake Bay information is needed to protect active sites from loss or disturbance to meet state and federal regulatory responsibilities. Information on reproductive rates, habitat use, evidence of mammalian predators, and evidence of human disturbance is desirable.

Strata – All suitable habitats within the historic range within the Chesapeake Bay will be surveyed. Piping plovers are habitat specialists that utilize high-energy beaches throughout their life cycle. High-energy beaches within the historic Chesapeake Bay range include Craney Island, Grandview Beach, Plumtree Island, Newpoint Comfort, Bethel Beach, and Rigby Island.

Focal Species – Survey will focus on piping plovers during the breeding and winter seasons but will include other non-target shorebirds that utilize high-energy beaches (Table 15).

Table 15. List of species that breed in or utilize high-energy beach habitats that will be included in surveys for piping plovers. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Red knot	**Sanderling**	**Piping plover**
Dunlin	**Willet**	**Ruddy turnstone**
Semipalmated sandpiper	**Black-bellied plover**	**American oystercatcher**
Western sandpiper	Semipalmated plover	

Quantitative Objectives – To locate all breeding and wintering piping plovers using the Chesapeake Bay with a high (>90%) level of confidence.

Methods

Survey methods – Area searches should be made of all beaches within the historic Chesapeake range including systematic coverage of active beach zones and appropriate back dune areas. Pairs detected should be monitored to document breeding attempts and chicks surviving to fledging age.

Sample size requirements – All high-energy beaches between Gwynn's Island and Craney Island should be surveyed.

Associated variables – Variables to be included in surveys are 1) the number of piping plovers detected, 2) the number of people, vehicles, and dogs on each beach segment and 2) any evidence of mammalian predators within beach segments.

Sampling plans – All suitable beaches within the historic Chesapeake breeding range should be walked during the window established for the annual survey window (1-9 June) and wintering birds (23 January-6 February). Breeding surveys are conducted annually in Virginia and winter surveys are conducted every 5 years according to the timetable of the international census.

Recommendations for implementation

-Train volunteers to cover sites within the Chesapeake Bay.

-Establish survey sites for migratory shorebirds (PRISM) within focal areas for plovers and conduct surveys simultaneously.

<u>American Oystercatcher Breeding Survey (AOBS)</u>

Issues

The mid-Atlantic region supports the largest breeding population of American oystercatchers throughout their range and a significant winter population. The Chesapeake Bay supports significant breeding habitat for the species and a minor winter population. Oystercatchers are listed as a species of greatest conservation need in both Maryland and Virginia recognizing their very limited range and vulnerability to habitat loss, ground predators, and human disturbance. Oystercatchers require habitats that are valued for recreational activity during the breeding season. Other factors of concern include changes in storm frequency or magnitude related to climate change and the health of bivalve populations on which they specialize.

Objectives

To collect information needed to estimate population size and trends and to inform local planning and adaptive management programs.

Information needed – Abundance and distribution of breeding pairs and wintering individuals is needed throughout the Chesapeake Bay to contribute to local, regional and continental estimates of population size and trends. This information is also needed to identify threats, inform local planning and as a metric for adaptive management programs. Information on habitat use, human disturbance, reproductive rates, prey populations, adult and young survival, and connectivity to winter grounds is desirable.

Strata – Objective is to enumerate all breeding pairs and wintering individuals. Survey effort should be stratified according to breeding habitat type (beach and marsh).

Focal Species – Survey will focus on American oystercatchers during the breeding and winter seasons but will include other non-target shorebirds that utilize similar habitats (Table 16).

Table 16. List of species that breed in or utilize high-energy beach habitats that will be included in surveys. Species that are listed as having high conservation need in Maryland or Virginia are highlighted in bold.

Red knot	**Sanderling**	**Piping plover**
Dunlin	**Willet**	**Ruddy turnstone**
Semipalmated sandpiper	**Black-bellied plover**	**American oystercatcher**
Western sandpiper	Semipalmated plover	

Quantitative Objectives – To locate all breeding and wintering American oystercatchers using the Chesapeake Bay with a high (>90%) level of confidence.

Methods

Survey methods – The range of American oystercatchers within the Chesapeake Bay is well known. Area searches should be made of all beaches, primary marsh edges, and bay islands within this range by foot, boat, or air as appropriate. All individuals detected should be mapped and monitored to determine breeding status.

Sample size requirements – Objective is to enumerate all breeding pairs and wintering individuals. All suitable habitat should be surveyed. Information should be stratified according to habitat type and other associated variables.

Associated variables – Variables to be included in surveys are 1) the number and location of American oystercatchers, 2) evidence of nests or young, 3) habitat type, 4) evidence of human activity, 5) evidence of mammalian predators.

Sampling plans – All suitable habitat within the historic Chesapeake breeding range should be surveyed for the presence of American oystercatchers from late May through June. Surveys should be conducted every 5 years and made to coincide with the colonial waterbird survey, the migratory shorebird survey (PRISM), and the international piping plover census.

Recommendations for implementation

-Coordinate survey with colonial waterbird survey, migratory shorebird survey, and piping plover census.

-Scan all individuals detected for alpha-numeric color bands in collaboration with the American Oystercatcher Working Group.

-Establish protocol for reporting on associated variables (e.g. human activity, mammalian activity, habitat type).

<u>Bald eagle breeding surveys (BEBS)</u>

Issues

The Chesapeake Bay now supports the largest breeding population of bald eagles in eastern North America estimated to be approaching 1,500 pairs. Despite federal and state delisting the population continues to face threats due to urban development, human disturbance, contaminants, and others. Following federal delisting the U.S. Fish and Wildlife Service was legally mandated to produce a post-delisting monitoring plan. The plan developed utilizes a dual-frame approach to estimate the number of occupied nests by combining a "list frame" (list of known nests, each with its respective status information for a given time period) with an "area frame" (group of randomly selected survey plots). The number of occupied nests within the list frame is estimated during a survey of the list frame. Area-frame surveys provide an estimate of the proportion of eagle nests that overlap with the list frame. The plan focuses on the requirement to detect a decline that would trigger relisting but does not address information needs for local management or ongoing adaptive management projects. Following more than 50 years of monitoring to inform nest-level management, surveys for this purpose have ended on a bay-wide scale requiring a transition in management approach.

Objectives

To collect survey data needed to support national monitoring plan and local management.

Information needed – The information needed for the national monitoring program is a sample of occupied nests with an estimate of detection rates and the level of overlap between the list and survey frames. Survey efforts in the Chesapeake Bay are in support of trend estimation on a national scale. Several properties within the Chesapeake Bay have ongoing adaptive management programs that require nest surveys to determine nest occupation and success.

Strata – Although strata are delineated within the national monitoring plan according to density of use, all areas within the tidal reach of the Bay are contained within a single strata. Project-based surveys are focused on local management and cover entire properties of interest.

Focal Species – Monitoring program will only include breeding bald eagles.

Quantitative Objectives – The quantitative objective outlined in the national monitoring plan is to achieve an 80% probability of detecting a 25% or greater change in the number of occupied bald eagle nests between 5-year intervals over a 20-year period. This is a national objective. There is no stated objective for the Chesapeake Bay. Project-based surveys are focused on minimizing local disturbance and as such have no quantitative objective.

Methods

Survey methods – The national monitoring plan uses aerial surveys to check nests within the list frame and systematically covers the area frame with transects. Double-observer techniques are used to estimate detection rates. Project-based surveys use a standard two-

flight approach where the first flight is used to check the status of known nests and to locate new nests and the second flight is used to count young for productivity estimates.

Sample size requirements – The geographic blocks indicated within the national monitoring plan do not conform to the tidal Chesapeake Bay. There is no sample size specified for the Bay. The objective of project-based surveys is to survey all nests within a specified property so there is no sample size required.

Associated variables – The primary variables included in the national monitoring program are 1) nest status (occupied vs unoccupied), 2) observer detections, and 3) previous status of nest (known vs unknown).

Sampling plans – Survey flights for the national monitoring plan and for local projects should be conducted during March to maximize the likelihood of documenting breeding attempts. Productivity flights for local projects should be conducted between 15 April and 15 May to document young before leaf-on conditions. The survey interval for the national monitoring plan is 5 years. Most local survey projects are conducted annually.

Recommendations for implementation

-Consolidate results of project-based surveys into a central data repository to inform local management, bay-wide assessments and the national monitoring program.

-Make transition away from nest-based management.

<u>Midwinter Bald Eagle Survey (WBES)</u>

Issues

From mid-November through March the Chesapeake Bay supports a large (several thousand) number of bald eagles that include migrants from Northeastern North America and non-breeding residents. Eagles congregate in relatively few locations throughout the Bay and these locations have high conservation significance. Surveys of winter concentration areas have been incorporated in a national survey to estimate continental population trends. Survey results inform local planning efforts and ongoing adaptive management programs.

Objectives

To survey eagles within selected winter sites to be used for assessment of continental trends and for local management plans.

Information needed – The information needed for the national monitoring program is a count of birds within designated site boundaries.

Strata – Areas included in current surveys were selected based on prior knowledge of eagle distribution and because they had a history of high use. The Chesapeake Bay was not stratified according to any land use or biological strata and site locations are nonrandom.

Focal Species – Monitoring program will only include bald eagles during the winter period.

Quantitative Objectives – Surveys within the Chesapeake Bay are conducted in support of the national program. There has been no attempt to establish population estimation or trend objectives for the Bay itself or to evaluate the power of local surveys to reach such objectives.

Methods

Survey methods – Area searches for bald eagles should be conducted within determined site boundaries by boat or air as appropriate. Location of all birds detected should be identified to age class and mapped.

Sample size requirements – Target sample sizes for continental objectives have not been specified such that the role of the Chesapeake Bay toward this effort is unclear at present. Although management programs that utilize information for planning are concerned about trends, no attempt has been made to estimate the power needed to assess such trends.

Associated variables – The primary variable included in the national monitoring program is the number of birds detected. An additional parameter of interest is age composition.

Sampling plans – A minimum of 1 survey should be conducted during the first 2 weeks of January for consistency with national protocol. Sites should be surveyed annually.

Recommendations for implementation

-Establish threshold changes in use that should trigger management actions.

-Use historic survey data to evaluate the number of surveys needed per year to detect threshold changes in use with an acceptable level of confidence.

-Conduct a surveillance survey to determine if other high-use sites exist that should be added to the survey network within the Bay.

<u>Bald Eagle Summer Concentration Area Survey (BECAS)</u>

Issues

During the summer months, the Chesapeake Bay supports large numbers of non-breeding resident and migrant eagles from the Southeast. Several locations that are believed to support large prey populations host concentrations of eagles. These sites are vulnerable to urban development, human disturbance, changes in prey populations and contaminants. Because these same sites support the highest breeding densities within the Bay they are considered to have the highest conservation value within eastern North America and are included within local conservation plans and adaptive management programs focused on disturbance.

Objectives

To survey eagles within summer concentration areas to inform local planning and ongoing adaptive management programs.

Information needed – The information needed for local planning and adaptive management programs is a count of birds within designated site boundaries. Information on flushing distances, age composition, presence and activity of humans along shorelines, boat activity, and feeding rates is desirable.

Strata – The current network of summer concentration areas includes shorelines with a history of high eagle use during the summer months. Site delineation is the result of broad surveys over more than a 20-year period. All sites occur within low saline waters.

Focal Species – Monitoring program will only include bald eagles.

Quantitative Objectives – Survey information has been used primarily to inform planning as to where management activities should take place. There has been no attempt to establish population thresholds for management action or to evaluate the power of surveys to detect such thresholds.

Methods

Survey methods – Area searches for bald eagles are conducted within the boundaries of delineated concentration areas. Shoreline surveys are conducted by boat since visibility during the period of leaf on reduces detection rates from the air. Locations of birds detected are mapped.

Sample size requirements – All known summer concentration areas should be surveyed to determine level and distribution of use. Although management programs that utilize information for planning are concerned about trends related to shoreline development or disturbance, no attempt has been made to establish management thresholds or to estimate the power needed to detect such thresholds.

Associated variables – The primary variables of interest in shoreline surveys are the number of birds detected and their locations. Secondary variables include 1) age composition, 2) flushing distances, 3) human presence along the shoreline, and 4) boat activity.

Sampling plans – A minimum of 2 surveys should be conducted during the peak (15 June to 15 July) of summer use. Morning surveys are preferred but close access to shorelines is often dependent on high tide. Surveys should be conducted annually to evaluate changes in overall use and distribution.

Recommendations for implementation

-Establish thresholds for changes in use that should trigger management actions.

-Use historic survey data to evaluate the number of surveys needed per year to detect such changes with acceptable level of confidence.

Osprey Breeding Survey (OBS)

Issues

The Chesapeake Bay supports the largest breeding population of osprey in the world now estimated between 6,000 and 8,000 breeding pairs. Osprey have been recognized globally as effective sentinels of environmental health particularly with regard to contaminants and overfishing. Contaminants of concern have been detected in the Chesapeake Bay and continue to represent a threat that requires monitoring. Menhaden is a keystone fish within the Bay food web and the reduction fishery has reduced stocks to historic lows. Osprey now extend throughout the tidal reach of the Chesapeake and reproductive rates have been associated with contaminants and have also been suggested to respond to reductions in menhaden stocks. Osprey may represent the most cost-effective monitoring tool for some environmental stressors in the Bay.

Objectives

To collect reproductive rate information on osprey on a spatial scale that is useful as an indicator of environmental health.

Information needed – Information on reproductive rates (young fledged per pair) is needed on a large spatial scale in order for osprey to serve as effective sentinels. Reproductive rate is a relatively easy metric to measure in osprey and is the focus of a volunteer-based, global monitoring program that includes the Chesapeake Bay (http://www.osprey-watch.org). Information on territory occupancy, hatching rate, feeding rates, adult survival, and young survival would be desirable and would help to interpret spatio-temporal patterns in reproduction. Periodic collection of tissues (e.g. eggs, blood, feathers) to determine contaminant levels would provide a more precise metric for contaminant reduction.

Strata – Nests included should be stratified according to salinity (<1ppt, 1-18 ppt, >18 ppt) to isolate different fish communities and contaminant sources. Nests should also be stratified according to historic centers of environmental contamination (e.g. Baltimore Harbor, Anacostia River, Elizabeth River)

Focal Species – Monitoring program will only include breeding osprey.

Quantitative Objectives –To achieve 80% power to detect 10% difference in reproductive rates among strata and within strata over 5 years at a significance level of 0.1.

Methods

Survey methods – Nests will be monitored bimonthly from the time of pair arrival until the nest has failed or young have fledged to document nesting attempts and reproductive rates.

Sample size requirements – Target sample sizes have not been established. Historic data should be used for this purpose.

Associated variables – Primary variables to be included are 1) salinity zone (salt, brackish, tidal fresh), and 2) historic contaminant status (high or low). Secondary variables include 1) provisioning rates, 2) contaminant levels in tissues, 3) adult return rates (marked birds).

Sampling plans – Individual nests should be monitored bimonthly from late March when most pairs arrive until late June to mid-July when most young fledge.

Recommendations for implementation

-Consolidate current osprey monitoring projects within the Chesapeake Bay.

-Recruit volunteers to fill gaps in coverage targeting designated strata.

-Encourage online data reporting and archiving within project OspreyWatch.

-Utilize banding techniques that will maximize benefits from monitoring to estimate demographic parameters.

<u>Mute Swan Survey (MSS)</u>

Issues

The Chesapeake Bay supports a large population of mute swans. The population has caused measurable damage to aquatic resources that are important to ecosystem function and critical to the occurrence of other species. To protect habitat and other species, mute swans have been the focus of a managed control program designed to reduce population size and associated impacts to Bay living resources.

Objectives

To collect information needed to inform adaptive management programs

Information needed – Information is needed on the size, distribution, and productivity of the mute swan population throughout the Chesapeake Bay to inform ongoing adaptive control programs. Information collected within the Chesapeake Bay contributes to the larger Atlantic Flyway effort that is used to estimate flyway and regional population size and trends.

Strata – The effort is an attempt to conduct a complete census of the population and all primary habitats known to support breeding are covered.

Focal Species – Survey will focus on post-breeding mute swans.

Quantitative Objectives – Objective is to enumerate a large percentage of the population for the purpose of tracking population size and trends.

Methods

Survey methods – Aerial and ground counts are made throughout primary habitats known to support mute swans. Individuals detected are counted and aged based on plumage classes to estimate productivity.

Sample size requirements – Survey is an effort to deliver full area coverage. A three-year survey interval has been determined to provide acceptable trend estimates.

Associated variables – Variables to be included in surveys are 1) number of individuals detected, 2) age class of individuals, 3) group size, 4) habitat type, and 5) location.

Sampling plans – Surveys are conducted in the post-breeding period (August-September) to allow for estimates of productivity based on age classes.

Meeting monitoring needs

Recommendations to expand existing programs and establish new monitoring programs would increase coverage of identified monitoring needs from 34% to 78% (Table 16). These advances come primarily during migration (52% of seasonal need) due to the coverage of shorebirds, in winter (34%) due to the coverage of sea ducks and other seabirds, and during the breeding season (34%) due to coverage of breeding marsh birds.

Table 17. Improvements in coverage of monitoring need through expanding existing surveys and establishing new surveys (see Appendix 5 for details). Numbers indicate species by season combinations. Existing refers to existing programs, expand refers to expanding existing surveys, establish refers to establishing new programs, not covered indicates the number of monitoring needs left unmet, and coverage indicates the percentage of needs met.

Season	Need	Existing	Expand	Establish	Not Covered	coverage
Breeding	50	31	2	17	0	100%
Nursery	1	0	0	0	1	0
Summer	3	1	0	0	2	33%
Winter	47	24	1	16	6	87%
Fall Migration	32	0	0	18	14	56%
Spring Migration	30	0	0	18	12	60%

Season	Need	Existing	Expand	Establish	Not Covered	coverage
Total	163	56	3	68	35	78%

Even with recommendations 22% of the identified monitoring need within the Chesapeake Bay remains unmet primarily during migration (74%) and in winter (17%) (see Appendix 5 for details). The largest portion of this unmet need is concentrated with passerines that use marshes during migration and winter. Efforts to understand the winter marsh community have been initiated in recent years (Smith et al., unpublished) but no plans are in place to quantify use of the Bay by this group during migration. The use of tidal-fresh marshes by significant numbers of staging swallows in late summer has been noted (Watts, VDGIF unpublished) but requires adequate investigation. The mid-Atlantic coast is known to represent the primary wintering grounds for the unique Ipswich form of the savannah sparrow. A recent survey has covered a small portion of habitat within the Bay (Smith et al., unpublished) but a broader survey is needed to identify significant sites. Similarly, the use of the Bay during fall migration by the mid-continent population of common loons has been identified (Spitzer, unpublished) but there has been no systematic treatment.

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APPENDICES

APPENDIX 1. Definitions of terms used in this document and methods for assessing monitoring needs.

Terms used in this document

Waterbird – The term "waterbird" is defined in many ways throughout the literature and often refers to restrictive taxonomic groups. The term is used more loosely in this plan to refer to the group of species that are dependent on the Chesapeake Bay estuary to complete portions of their life cycle and that are specifically dependent on water or water-associated resources within this region.

Chesapeake Bay – The Chesapeake Bay is a vast watershed covering thousands of square kilometers and portions of 6 states. The portion of the watershed that is covered within this plan is restricted to the Chesapeake Bay estuary. The estuary is the portion of the Bay that is under tidal influence. This area is bounded to the east by the Atlantic Ocean at the Bay mouth and the fall line that separates the Coastal Plain province from the Piedmont province.

Fall line - The fall line is an erosional scarp where the metamorphic rocks of the Piedmont meet the sedimentary rocks of the Coastal Plain. The geologic formations along this boundary frequently determine the landward extent of tidal influence.

Breeding season – The breeding season is defined here as the time period between courtship and post-fledging dispersal. This time window varies widely between waterbird species within the Chesapeake Bay and may range from January through November.

Nursery – The term "nursery" is used here to refer to those individuals that were not produced by breeding pairs within the Chesapeake Bay but move to the Bay after fledging. An example of this phenomenon is the movement of brown pelican young from the Carolinas to the Bay in late summer. We know relatively little about this role of the Chesapeake but indications suggest that it is likely more common than currently known.

Summering – The term "summering" refers to residency of non-breeding individuals during the summer months. Examples of this within the Chesapeake Bay include subadult double-crested cormorants from New England populations spending the summer months or subadult osprey flying up from South American winter ranges to spend the summer.

Winter season – For migratory birds, the winter season is the period of residency within the wintering grounds. This period varies widely between waterbirds in the Chesapeake Bay and may range from August through May.

Fall migration – Fall migration refers to the period of autumn passage through the Chesapeake Bay. Schedules of movement and stopover duration vary widely between waterbirds that use the Chesapeake Bay and may range from mid-July through mid-December.

Spring migration - Spring migration refers to the period of spring passage through the Chesapeake Bay. Schedules of movement and stopover duration vary widely between waterbirds that use the Chesapeake Bay and may range from mid-February through mid-June.

Importance of the Chesapeake Bay to waterbird populations

As one dimension of assessing the need for monitoring waterbird species that utilize the Chesapeake Bay a gross estimate was made of the portion of the continental population that depends on the Bay during all periods of the annual cycle. Continental population estimates were taken from Rich et al. (2004) for landbirds, Kushlan et al. (2002) for some waterbirds, and Brown et al. (2001) and Morrison et al. (2006) for shorebirds. With the exception of a few select species that have received considerable survey attention, estimates of populations using the Bay during the various seasons are poor. Estimates for the Bay were compiled from Duerr and Watts (2012), from unpublished sources, from anecdotal information, from the Christmas Bird Count, and from the position of the Bay relative to migration pathways. Because no definitive information exists for many species by season combinations, broad categories of use were considered here. An indication of confidence level was also included with each value to warn the reader about the lack of certainty.

Categories of importance

Very High - >50% of North American population utilizes the Chesapeake Bay.

High - >20% of North American population utilizes the Chesapeake Bay.

Moderate – 10-20% of North American population utilizes the Chesapeake Bay.

Low – 1-10% of North American population utilizes the Chesapeake Bay.

Lowest - <1% of North American population utilizes the Chesapeake Bay.

Levels of confidence

4 – Good – estimates based on targeted species-specific surveys of entire population or general lack of occurrence relative to continental population.

3 – Fair – estimate based on sub-sampling but limitations in methods or coverage. Estimates expected to be within range specified.

2 – Poor – estimates based on limited data and/or the distribution of ranges relative to the Chesapeake Bay. Estimate expected to be within range most of the time.

1 – Guestimate – Order of magnitude judgment made by author because few data available on relative abundance and range distributions not helpful.

APPENDIX 2. Population estimates for waterbird species that regularly use the Chesapeake Bay. Units include total individuals (t) and breeding individuals (b). Subspecific populations are indicated where appropriate.

Species/Subspecies	Common Name	AOU	Global Population[1]	N. A . Population[2]	Trend[2]	BCR 30 Concern[3]
Podiceps grisegena holboellii	Red-necked Grebe	20	150,000-370,000t	45,000t	Stable/unknown	Moderate
Podiceps auritus cornutus	Horned Grebe	30	160,000-2,100,000t	>100,000t	Declining	High
Podilymbus podiceps podiceps	Pied-billed Grebe	60	110,000-130,000t	125,000t	Declining	High
Gavia immer	Common Loon	70	580,000t	575,000t	Declining	Moderate
Gavia stellata	Red-throated Loon	110	490,000-1,500,000t	375,000t	Declining	Highest
Stercorarius pomarinus	Pomarine Jaeger	360	50,000-100,000t	20,000-40,000b	Stable/unknown	Low
Stercorarius parasiticus	Parasitic Jaeger	370	500,000-1,000,000t	unknown	Stable/unknown	Low
Rissa tridactyla tridactyla	Black-legged Kittiwake	400	17,000,000-18,000,000t	3,126,000b	Declining	Low
Larus marinus	Great Black-backed Gull	470	630,000-720,000t	160,430b	Increasing	Low
Larus fuscus fraellsii	Lesser Black-backed Gull	500	680,000-750,000t	unknown	Stable/unknown	Low
Larus argentatus smithsoniaunus	Herring Gull	510	2,600,000-3,000,000t	>246,000b	Stable/unknown	Low
Larus delawarensis	Ring-billed Gull	540	2,600,000t	1,700,000t	Increasing	Low
Larus atricilla megalopterus	Laughing Gull	580	810,000-840,000t	528,000-538,000b	Increasing	Low
Larus philadelphia	Bonaparte's Gull	600	260,000-530,000t	260,000-530,000t	Stable/unknown	Moderate
Gelochelidon nilotica aranea	Gull-billed Tern	630	79,000-310,000t	6,000-8,000b	Declining	Highest
Hydroprogne caspia	Caspian Tern	640	180,000-320,000t	66,000-70,000b	Increasing	Low
Thalasseus maximus maxima	Royal Tern	650	280,000-310,000t	100,000-150,000b	Stable/unknown	Moderate
Thalasseus sandvicensis acuflavidus	Sandwich Tern	670	460,000-500,000t	75,000-100,000b	Increasing	Low
Sterna forsteri litoricola	Forster's Tern	690	120,000t	120,000t	Declining	High
Sterna hirundo hirundo	Common Tern	700	1,100,000-4,500,000t	300,000b	Increasing	Moderate
Sternula antillarum antillarum	Least Tern	740	65,000-70,000t	60,000-100,000b	Declining	High

Species/Subspecies	Common Name	AOU	Global Population[1]	N. A . Population[2]	Trend[2]	BCR 30 Concern[3]
Chlidonias niger surinamensis	Black Tern	770	45,000-1,300,000t	100,000-500,000b	Stable/unknown	Moderate
Rynchops niger niger	Black Skimmer	800	120,000-210,000t	65,000-70,000b	Declining	Moderate
Oceanites oceanicus oceanicus	Wilson's Storm Petrel	1090	6,000,000t	unknown	Stable/unknown	Low
Morus bassanus	Northern Gannet	1170	530,000t	155,456b	Increasing	High
Anhinga anhinga	Anhinga	1180	20,000-34,000b	20,000-34,000b	Stable/unknown	Low
Phalacrocorax carbo carbo	Great Cormorant	1190	1,000,000-1,600,000t	12,300b	Stable/unknown	Moderate
Phalacrocorax auritus auritus	Double-crested Cormorant	1200	1,100,000-2,200,000t	>740,000b	Increasing	Low
Pelecanus erythrorhynchos	American White Pelican	1250	>120,000b	>120,000b	Stable/Declining	Low
Pelecanus occidentalis carolinensis	Brown Pelican	1260	unknown	191,600-193,700b	Increasing	Moderate
Mergus merganser americanus	Common Merganser	1290	1,352,500t	1,000,000t	Increasing	Low
Mergus serrator	Red-breasted Merganser	1300	545,000t	250,000t	Increasing	Moderate
Lophodytes cucullatus	Hooded Merganser	1310	350,000t	350,000t	Increasing	Moderate
Anas Platyrhynchos platyrhynchos	Mallard	1320	22,930,000t	13,000,000t	Stable/unknown	High
Anas rubripes	American Black Duck	1330	910,000t	910,000t	Declining	Highest
Anas strepera	Gadwall	1350	4,965,000t	3,900,000t	Increasing	Moderate
Anas Americana	American Wigeon	1370	3,100,000t	3,100,000t	Increasing	Moderate
Anas discors	Blue-winged Teal	1390	7,240,000t	7,240,000t	Stable/unknown	Low
Anas crecca carolinensis	Green-winged Teal	1400	3,900,000t	3,900,000t	Increasing	Moderate
Anas clypeata	Northern Shoveler	1420	5,690,000t	3,800,000t	Increasing	Low
Anas acuta acuta	Northern Pintail	1430	5,900,000t	3,600,000t	Declining	Moderate
Aix sponsa	Wood Duck	1440	4,600,000t	4,600,000t	Increasing	Moderate
Aythya americana	Redhead	1460	1,200,000t	1,200,000t	Stable/unknown	Low
Aythya valisineria	Canvasback	1470	740,000t	740,000t	Stable/unknown	High

Species/Subspecies	Common Name	AOU	Global Population[1]	N. A . Population[2]	Trend[2]	BCR 30 Concern[3]
Aythya marila mariloides	Greater Scaup	1480	1,410,000t	800,000t	Stable/unknown	High
Aythya affinis	Lesser Scaup	1490	4,400,000t	4,400,000t	Declining	High
Aythya collaris	Ring-necked Duck	1500	2,000,000t	2,000,000t	Increasing	Low
Bucephala clangula americana	Common Goldeneye	1510	4,600,000t	1,345,000t	Stable/unknown	Moderate
Bucephala albeola	Bufflehead	1530	1,400,000t	1,400,000t	Increasing	High
Clangula hyemalis	Long-tailed Duck	1540	6,200,000t	1,000,000t	Declining	High
Histrionicus histrionicus	Harlequin Duck	1550	271,250t	254,000t	Stable/unknown	Moderate
Somateria mollissima dresseri	Common Eider	1590	2,900,000t	1,050,000t	Stable/unknown	High
Somateria spectabilis	King Eider	1620	1,215,000t	575,000t	Declining	Low
Melanitta nigra americana	Black Scoter	1630	2,300,000t	400,000t	Declining	High
Melanitta fusca deglandi	White-winged Scoter	1650	2,200,000t	600,000t	Declining	High
Melanitta perspicillata	Surf Scoter	1660	600,000t	600,000t	Declining	High
Oxyura jamaicensis jamaicensis	Ruddy Duck	1670	1,110,000t	1,100,000t	Increasing	Moderate
Chen caerulescens atlanticus	Snow Goose (Greater)	1699	4,045,200t	4,045,200t	Increasing	Low
Chen rossii	Ross's Goose	1700	619,000t	619,000t	Increasing	Low
Anser albifrons frontalis	Greater White-fronted Goose	1710	1,212,500t	1,212,500t	Stable/unknown	Low
Branta canadensis canadensis	Canada Goose	1720	5,200,000t	5,200,000t	Increasing	Highest
Branta bernicla hrota	Atlantic Brant	1730	518,500t	306,500t	Stable/unknown	Highest
Cygnus olor	Mute Swan	1782	587,700t	20,000t	Increasing	Low
Cygnus columbianus	Tundra Swan	1800	300,000t	186,300t	Increasing	High
Eudocimus albus	White Ibis	1840	>200,000b	>200,000b	Increasing	Moderate
Plegadis falcinellus falcinellus	Glossy Ibis	1860	1,100,000-3,300,000t	13,000-15,000b	Increasing	High
Botaurus lentiginosus	American Bittern	1900	3,000,000t	3,000,000t	Declining	Moderate

Species/Subspecies	Common Name	AOU	Global Population[1]	N. A . Population[2]	Trend[2]	BCR 30 Concern[3]
Ixobrychus exilis exilis	Least Bittern	1910	>130,000t	128,000t	Declining	Moderate
Ardea herodias herodias	Great Blue Heron	1940	unknown	83,000b	Increasing	Low
Ardea alba egretta	Great Egret	1960	550,000-1,900,000t	180,000b	Increasing	Low
Egretta thula thula	Snowy Egret	1970	unknown	143,555b	Declining	High
Egretta tricolor ruficolis	Tricolored Heron	1990	unknown	<194,000b	Declining	High
Egretta caerulea	Little Blue Heron	2000	unknown	200,000-300,000b	Declining	High
Bubulcus ibis ibis	Cattle Egret	2001	3,800,000-6,700,000t	>750,000-1,500,000t	Increasing	Low
Butorides virescens virescens	Green Heron	2010	unknown	unknown	Increasing	Low
Nycticorax nycticorax hoactii	Black-crowned Night Heron	2020	430,000-3,600,000t	>50,000b	Declining	Moderate
Nyctanassa violacea violacea	Yellow-crowned Night Heron	2030	85,000-160,000t	50,000-100,000b	Stable/unknown	Moderate
Grus canadensis	Sandhill Crane	2060	652,500t	652,500t	Stable/unknown	Low
Rallus elegans	King Rail	2080	unknown	unknown	Declining	High
Rallus longirostris	Clapper Rail	2110	unknown	unknown	Stable/unknown	High
Rallus limicola	Virginia Rail	2120	unknown	unknown	Declining	Moderate
Porzana carolina	Sora	2140	unknown	unknown	Declining	High
Coturnicops noveboracensis	Yellow Rail	2150	unknown	unknown	Stable/unknown	Low
Laterallus jamaicensis	Black Rail	2160	unknown	unknown	Declining	Highest
Gallinula chloropus cachinnans	Common Moorhen	2190	1,700,000-3,300,000t	unknown	Increasing	Moderate
Fulica americana americana	American Coot	2210	3,000,000t	3,000,000t	Increasing	Low
Phalaropus tricolor	Wilson's Phalarope	2240	1,500,000t	1,500,000t	Declining	High
Recurvirostra americana	American Avocet	2250	450,000t	450,000t	Stable/Unknown	Moderate
Himantopus mexicanus	Black-necked Stilt	2260	175,000t	175,000t	Stable/Unknown	Low

Species/Subspecies	Common Name	AOU	Global Population[1]	N. A . Population[2]	Trend[2]	BCR 30 Concern[3]
Gallinago delicata	Wilson's Snipe	2300	2,000,000t	2,000,000t	Declining	Moderate
Limnodromus griseus griseus	Short-billed Dowitcher	2310	153,000t	153,000t	Declining	High
Limnodromus scolopaceus	Long-billed Dowitcher	2320	400,000t	400,000t	Stable/Unknown	Low
Calidrisa himantopus	Stilt Sandpiper	2330	820,000t	820,000t	Stable/Unknown	Low
Calidris canutus rufa	Red Knot	2340	120,000t	120,000t	Declining	Highest
Calidris maritima belcheri	Purple Sandpiper	2350	95,000t	15,000t	Stable/Unknown	High
Calidris fuscicollis	White-rumped Sandpiper	2400	1,120,000t	1,120,000t	Declining	High
Calidris minutilla	Least Sandpiper	2420	700,000t	700,000t	Declining	Moderate
Calidris alpina hudsonia	Dunlin	2430	6,400,000t	750,000t	Declining	High
Calidris pusilla	Semipalmated Sandpiper	2460	2,000,000t	2,000,000t	Declining	High
Calidris mauri	Western Sandpiper	2470	3,500,000t	3,500,000t	Stable/unknown	Moderate
Calidris alba	Sanderling	2480	600,000t	300,000t	Declining	Highest
Limosa fedoa fedoa	Marbled Godwit	2490	175,000t	175,000t	Declining	High
Limosa Haemastica	Hudsonian Godwit	2510	70,000t	70,000t	Declining	High
Tringa melanoleuca	Greater Yellowlegs	2540	100,000t	100,000t	Stable/Unknown	High
Tringa flavipes	Lesser Yellowlegs	2550	400,000t	400,000t	Declining	Moderate
Tringa solitaria solitaria	Solitary Sandpiper	2560	150,000t	150,000t	Declining	High
Tringa semipalmata semipalmatus	Willet	2580	250,000t	250,000t	Stable/Unknown	High
Actitis macularius	Spotted Sandpiper	2630	150,000t	150,000t	Stable/Unknown	Moderate
Numenius phaeopus	Whimbrel	2650	2,000,000t	66,000t	Declining	Highest
Pluvialis squatarola cynosurae	Black-bellied Plover	2700	692,000t	200,000t	Stable/Unknown	High
Charadrius vociferus	Killdeer	2730	1,000,000t	1,000,000t	Declining	Moderate
Charadrius semipalmatus	Semipalmated Plover	2740	150,000t	150,000t	Stable/Unknown	Moderate

Species/Subspecies	Common Name	AOU	Global Population[1]	N. A . Population[2]	Trend[2]	BCR 30 Concern[3]
Charadrius melodus melodus	Piping Plover	2770	5,945t	5,945t	Increasing	Highest
Arenaria interpres interpres	Ruddy Turnstone	2830	500,000t	105,000t	Declining	Highest
Haematopus palliatus	American Oystercatcher	2860	11,650t	11,000t	Stable/unknown	Highest
Circus cyaneus hudsonius	Northern Harrier	3310	1,300,000t	455,000t	Declining	Low
Haliaeetus leucocephalus	Bald Eagle	3520	330,000t	330,000t	Increasing	Moderate
Falco peregrinus	Peregrine Falcon	3560	1,200,000t	280,000t	Increasing	Low
Pandion haliaetus	Osprey	3640	460,000t	210,000t	Increasing	Low
Asio flammeus flammeus	Short-eared Owl	3670	2,400,000t	700,000t	Declining	Moderate
Ceryle alcyon alcyon	Belted Kingfisher	3900	2,200,000t	2,200,000t	Declining	Low
Dolichonyx oryzivorus	Bobolink	4940	11,000,000t	11,000,000t	Stable/Declining	Low
Agelaius phoeniceus phoneniceus	Red-winged Blackbird	4980	210,000,000t	190,000,000t	Stable/Declining	Low
Euphagus carolinus	Rusty Blackbird	5090	2,000,000t	2,000,000t	Declining	High
Quiscalus major torreyi	Boat-tailed Grackle	5130	3,700,000t	3,700,000t	Increasing	Low
Plectrophenax nivalis	Snow Bunting	5340	39,000,000t	19,500,000t	Stable	Low
Passerculus sandwichensis princeps	Ipswich Sparrow	5420	5,000-7,000b	5,000-7,000b	Stable	Moderate
Ammodramus henslowii susurrans	Henslow's Sparrow	5470	79,000t	79,000t	Declining	Moderate
Ammodramus caudacutus	Saltmarsh Sparrow	5490	250,000t	250,000t	Declining	Highest
Ammodramus nelson	Nelson's Sparrow	5491	510,000t	510,000t	Stable	Moderate
Ammodramus maritimus	Seaside Sparrow	5500	110,000t	110,000t	Stable	Highest
Melospiza georgiana	Swamp Sparrow	5840	9,000,000t	9,000,000t	Increasing	Low
Melospiza georgiana nigrescens	Coastal Swamp Sparrow	5840	50,000b	50,000b	Declining	Moderate
Progne subis	Purple Martin	6110	11,000,000t	9,900,000t	Stable	Low
Petrochelidon pyrrhonata	Cliff Swallow	6120	89,000,000t	81,000,000t	Stable	Low

Species/Subspecies	Common Name	AOU	Global Population[1]	N. A . Population[2]	Trend[2]	BCR 30 Concern[3]
Tachycineta bicolor	Tree Swallow	6140	20,000,000t	20,000,000t	Stable	Low
Reparia riparia	Bank Swallow	6160	46,000,000t	13,800,000t	Stable	Low
Stelgidopteryx serripennis	Northern Rough-winged Swallow	6170	15,000,000t	5,100,000t	Stable	Low
Cistothorus platensis	Sedge Wren	7240	6,500,000t	6,500,000t	Increasing	Moderate
Cistothorus palustris	Marsh Wren	7250	7,700,000t	7,700,000t	Increasing	High

[1]Global population estimates taken from Waterbird Population Estimates, Fourth Edition (Delany and Scott 2006) for waterbird species and the North American Landbird Conservation Plan (Rich et al. 2004) for land birds.
[2]North American population estimates and trends were taken from Rich et al. 2004 for land birds, Kushlan et al. 2002 for waterbirds, and Brown et al. 2001 and Morrison et al. 2006 for shorebirds.
[3]Conservation concern categories for Bird Conservation Region 30 were taken from Atlantic Coast Joint Venture 2008/

APPENDIX 3. Relative importance of the Chesapeake Bay to North American waterbird populations during different periods of their life cycle. Importance terms include "Very High" - >50% of NA population, "High" - >20% of NA population, "Moderate" – 10-20% of NA population, "Low" – 1-10% of NA population, and "Lowest" - <1% of NA population. Parenthetic values indicate the confidence level of importance terms with 4 as the highest value. See Appendix 1 for definitions of periods and process for estimating relative importance and confidence. Colors red through yellow highlight periods of high responsibility. Green highlights species listed as having the "greatest conservation need" on either Maryland or Virginia wildlife action plans.

Common Name	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Red-necked Grebe				Peripheral	Peripheral	Peripheral
Horned Grebe				Moderate(2)	High(2)	High(2)
Pied-billed Grebe	Lowest(4)			Low(2)	Low(2)	Low(2)
Common Loon			Lowest(4)	Low(2)	Low(2)	Low(2)
Red-throated Loon				High(2)	High(2)	High(2)
Pomarine Jaeger					Lowest(3)	Lowest(3)
Parasitic Jaeger					Lowest(3)	Lowest(3)
Black-legged Kittiwake					Lowest(2)	Lowest(2)
Great Black-backed Gull	Low(4)		Low(1)	Moderate(2)	Moderate(2)	Moderate(2)
Lesser Black-backed Gull				Moderate(1)	Moderate(1)	Moderate(1)
Herring Gull	Low(4)		Low(1)	Moderate(2)	Moderate(2)	Moderate(2)
Ring-billed Gull			Lowest(3)	Moderate(2)	Moderate(2)	Moderate(2)
Laughing Gull	Low(4)				High(2)	High(2)
Bonaparte's Gull				Low(2)	Moderate(2)	Moderate(2)
Gull-billed Tern	Low(4)				Low(2)	Low(2)
Caspian Tern	Lowest(4)				Low(2)	Low(2)
Royal Tern	Low(4)	Low(1)			Moderate(1)	Moderate(1)
Sandwich Tern	Lowest(4)				Lowest(2)	Lowest(2)
Forster's Tern	Low(4)			Lowest(2)	Lowest(2)	Lowest(2)
Common Tern	Low(4)				Low(2)	Low(2)
Least Tern	Low(4)				Moderate(1)	Moderate(1)

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Common Name	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Black Tern					Lowest(2)	Lowest(2)
Black Skimmer	Low(4)				Moderate(2)	Moderate(2)
Wilson's Storm Petrel			Peripheral		Lowest(2)	Lowest(2)
Northern Gannet				Moderate(2)	High(2)	High(2)
Anhinga	Lowest(4)					
Great Cormorant				Lowest(3)	Low(2)	Low(2)
Double-crested Cormorant	Low(4)		Low(1)	Moderate(2)	High(2)	High(2)
American White Pelican					Lowest(4)	Lowest(4)
Brown Pelican	Low(4)	Low(1)	Low(1)	Lowest(2)	Lowest(2)	Lowest(2)
Common Merganser				Lowest(3)	Lowest(2)	Lowest(2)
Red-breasted Merganser				Low(3)	Low(2)	Low(2)
Hooded Merganser	Lowest(3)			Low(3)	Low(2)	Low(2)
Mallard	Lowest(3)			Low(3)	Low(2)	Low(2)
American Black Duck	Lowest(3)			Low(3)	Moderate(2)	Low(2)
Gadwall	Lowest(3)			Lowest(3)	Low(2)	Low(2)
American Wigeon				Lowest(3)	Lowest(2)	Lowest(2)
Blue-winged Teal	Lowest(4)			Lowest(3)	Lowest(2)	Lowest(2)
Green-winged Teal				Lowest(3)	Lowest(2)	Lowest(2)
Northern Shoveler				Lowest(3)	Lowest(2)	Lowest(2)
Northern Pintail				Lowest(3)	Lowest(2)	Lowest(2)
Wood Duck	Low(3)			Low(2)	Low(2)	Low(2)
Redhead	Lowest(4)			Low(3)	Low(2)	Low(2)
Canvasback				Moderate(3)	Moderate(2)	Moderate(2)
Greater Scaup				Low(3)	Low(2)	Low(2)
Lesser Scaup				Low(3)	Low(2)	Low(2)
Ring-necked Duck				Lowest(3)	Lowest(2)	Lowest(2)

Common Name	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Common Goldeneye				Low(3)	Low(2)	Low(2)
Bufflehead				Low(3)	Low(2)	Low(2)
Long-tailed Duck				Moderate(3)	Moderate(2)	Moderate(2)
Harlequin Duck				Lowest(2)	Lowest(2)	Lowest(2)
Common Eider				Lowest(3)	Lowest(3)	Lowest(3)
King Eider				Lowest(3)	Lowest(3)	Lowest(3)
Black Scoter				Low(2)	Low(2)	Low(2)
White-winged Scoter				Low(2)	Low(2)	Low(2)
Surf Scoter				Low(2)	Low(2)	Low(2)
Ruddy Duck				Moderate(2)	Moderate(2)	Moderate(2)
Snow Goose (Greater)				Low(3)	Moderate(2)	Moderate(2)
Ross's Goose				Peripheral	Peripheral	Peripheral
Greater White-fronted Goose				Peripheral	Peripheral	Peripheral
Canada Goose	Low(3)			Low(3)	Low(2)	Low(2)
Atlantic Brant				Very High(3)	Very High (3)	Very High (3)
Mute Swan	High(3)			High(3)		
Tundra Swan				Low(3)	High(2)	High(2)
White Ibis		Lowest(2)			Lowest(2)	Lowest(2)
Glossy Ibis	Low(4)				Low(3)	Low(3)
American Bittern	Lowest(1)			Lowest(1)	Lowest(1)	Lowest(1)
Least Bittern	Low(1)				Low(1)	Low(1)
Great Blue Heron	Moderate(4)		Low(1)	Moderate(2)	Moderate(2)	Moderate(2)
Great Egret	Low(4)			Lowest(2)	Low(2)	Low(2)
Snowy Egret	Low(4)				Low(2)	Low(2)
Tricolored Heron	Low(4)				Low(2)	Low(2)
Little Blue Heron	lowest(4)				Low(2)	Low(2)

Common Name	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Cattle Egret	Lowest(4)				Lowest(2)	Lowest(2)
Green Heron	Lowest(2)			Lowest(2)	Lowest(2)	Lowest(2)
Black-crowned Night Heron	Low(4)			Lowest(2)	Low(2)	Low(2)
Yellow-crowned Night Heron	Low(4)				Low(2)	Low(2)
Sandhill Crane					Lowest(2)	Lowest(2)
King Rail	Moderate(1)				Moderate(1)	Moderate(1)
Clapper Rail	Low(1)			Low(1)	Low(1)	Low(1)
Virginia Rail	Low(1)			Lowest(1)	Low(1)	Low(1)
Sora					Moderate(1)	Moderate(1)
Yellow Rail				Lowest(2)	Moderate(2)	Moderate(2)
Black Rail	Moderate(1)				Moderate(1)	Moderate(1)
Common Moorhen	Lowest(3)				Lowest(2)	Lowest(2)
American Coot				Low(2)	Low(2)	Low(2)
Wilson's Phalarope					Peripheral	Peripheral
American Avocet	Lowest(4)				Lowest(2)	Lowest(2)
Black-necked Stilt	Lowest(4)				Lowest(2)	Lowest(2)
Wilson's Snipe				Lowest(2)	Lowe(2)	Low(2)
Short-billed Dowitcher				Lowest(2)	Moderate(2)	Moderate(2)
Long-billed Dowitcher					Lowest(2)	Lowest(2)
Stilt Sandpiper					Lowest(2)	Lowest(2)
Red Knot					Low(2)	Low(2)
Purple Sandpiper				Low(2)	Low(2)	Low(2)
White-rumped Sandpiper					Lowest(2)	Lowest(2)
Least Sandpiper				Low(2)	Moderate(2)	Moderate(2)
Dunlin			Lowest(3)	Low(2)	Low(2)	Low(2)
Semipalmated Sandpiper					Low(2)	Low(2)

Common Name	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Western Sandpiper				Lowest(3)	Lowest(2)	Lowest(2)
Sanderling				Low(3)	Low(2)	Low(2)
Marbled Godwit			Lowest(3)	Lowest(2)	Lowest(2)	Lowest(2)
Hudsonian Godwit					Lowest(2)	Lowest(2)
Greater Yellowlegs				Low(2)	Moderate(2)	Moderate(2)
Lesser Yellowlegs				Low(2)	Moderate(2)	Moderate(2)
Solitary Sandpiper					Low(2)	Low(2)
Willet	Low(3)				Low(2)	Low(2)
Spotted Sandpiper	Lowest(2)				Low(2)	Low(2)
Whimbrel					Low(2)	Low(2)
Black-bellied Plover			Lowest(3)	Lowest(2)	Low (2)	Low(2)
Killdeer	Lowest(2)			Lowest(2)	Low(2)	Low(2)
Semipalmated Plover					Low(2)	Low(2)
Piping Plover	Lowest(4)				Low(2)	Low(2)
Ruddy Turnstone			Lowest(2)	Lowest(2)	Low(2)	Low(2)
American Oystercatcher	Low(4)		Low(2)	Lowest(2)	Low(2)	Low(2)
Northern Harrier	Lowest(4)			Lowest(2)	Lowest(2)	Lowest(2)
Bald Eagle	Low(4)	Lowest(2)	Low(3)	Low(3)	Low(2)	Low(2)
Peregrine Falcon	Lowest(4)		Lowest(2)	Lowest(2)	Low(2)	Low(2)
Osprey	Low (3)	Low(2)	Low(2)		Moderate(2)	Moderate(2)
Short-eared Owl	Lowest(4)			Lowest(2)	Lowest(1)	Lowest(1)
Belted Kingfisher	Lowest(3)			Lowest(2)	Lowest(1)	Lowest(1)
Bobolink					Low(1)	
Red-winged Blackbird	Lowest(3)			Lowest(2)	Low(1)	Low(1)
Rusty Blackbird				Lowest(2)	Lowest(2)	Lowest(2)
Boat-tailed Grackle	Lowest(2)				Lowest(2)	Lowest(2)

Common Name	Breeding	Nursery	Summering	Winter	Fall Migration	Spring Migration
Snow Bunting				Lowest(3)	Lowest(2)	Lowest(2)
Ipswich Sparrow				Low(3)	Low(2)	Low(2)
Henslow's Sparrow	Lowest(3)				Lowest(2)	Lowest(2)
Saltmarsh Sparrow	Low(3)			Low(2)	High(2)	High(2)
Nelson's Sparrow				Low(2)	Moderate(2)	Moderate(2)
Seaside Sparrow	Moderate(3)			Low(2)	Moderate(2)	Moderate(2)
Swamp Sparrow				Low(2)	Low(2)	Low(2)
Coastal Swamp Sparrow	Moderate(3)				High(2)	High(2)
Purple Martin	Lowest(2)				Low(2)	Low(2)
Cliff Swallow	Lowest(4)				Lowest(2)	Lowest(2)
Tree Swallow	Lowest(2)				Low(2)	Low(2)
Bank Swallow	Lowest(4)				Low(2)	Low(2)
Northern Rough-winged Swallow	Lowest(4)				Low(2)	Low(2)
Sedge Wren	Lowest(3)			Peripheral	Lowest(2)	Lowest(2)
Marsh Wren	Low(3)			Lowest(2)	Low(2)	Low(2)

APPENDIX 4. Habitat use and activities for waterbird species that regularly use the Chesapeake Bay. Codes include breeding (B), foraging (F), loafing (L), and roosting (R). Character size indicates relative use. Best available information was compiled from Duerr and Watts (2012) and from the first-hand experience of the author.

Common Name	Upland	Bank	Bay Island	Beach	Mudflat	Rocky Intertidal	Salt Marsh	Brackish Marsh	Tidal-fresh Marsh	Shallow Water	Deep Water
Red-necked Grebe											F,L,R
Horned Grebe										F,L,R	F,L,R
Pied-billed Grebe			B				B	B	B	F,L,R	F,L,R
Common Loon										F	F,L,R
Red-throated Loon											F,L,R
Pomarine Jaeger											F,L,R
Parasitic Jaeger											F,L,R
Black-legged Kittiwake				F						F	F,L,R
Great Black-backed Gull	F,L,R		B,F,L,R	F,L	F,L	F,L	B,F,L,R			F,L	F,L,R
Lesser Black-backed Gull				F,L			F,L			F,L	F,L,R
Herring Gull	F,L,R		B,F,L,R	F,L	F,L	F,L	B,F,L,R			F,L	F,L,R
Ring-billed Gull	F,L,R		F,L,R	F,L	F,L	F,L	F,L	F,L	F,L	F,L,R	F,L,R
Laughing Gull	F,L,R		B,F,L,R	F,L	F,L	F,L	B,F,L,R			F,L,R	F,L,R
Bonaparte's Gull										F,L	F,L,R
Gull-billed Tern	F		B,F,L,R	B,F,L,R		L	F,L				
Caspian Tern			B,L,R	B,L,R	L	L	L			F	F
Royal Tern			B,L,R	B,L,R	L	L	L			F	F
Sandwich Tern			B,L,R	B,L,R	L	L	L			F	F
Forster's Tern			B,L,R	L,R	L	L	B,F,L,R			F	F
Common Tern			B,L,R	B,L,R	L	L	B,L,R			F	F
Least Tern			B,L,R	B,L,R	L	L	L,R			F	F
Black Tern				L	L	L				F	F

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Common Name	Upland	Bank	Bay Island	Beach	Mudflat	Rocky Intertidal	Salt Marsh	Brackish Marsh	Tidal-fresh Marsh	Shallow Water	Deep Water
Black Skimmer			B,L,R	B,L,R	L	L	L,R			F	
Wilson's Storm Petrel											F,L,R
Northern Gannet											F,L,R
Anhinga										F	
Great Cormorant						L					F,L,R
Double-crested Cormorant			B,L,R	L	L	L	L			F,L	F,L
American White Pelican										F,L	F,L,R
Brown Pelican			B,L,R	L		L				F,L	F,L,R
Common Merganser										F,L,R	F,L,R
Red-breasted Merganser											F,L,R
Hooded Merganser										F,L,R	
Mallard	B,F,L		B,F,L,R	L	F,L		B,F,L,R	B,F,L,R	B,F,L,R	F,L,R	L,R
American Black Duck			B,F,L,R	L	F,L		B,F,L,R	B,F,L,R	B,F,L,R	F,L,R	L,R
Gadwall			B,F,L,R		F,L		F,L	F,L	F,L	F,L,R	L,R
American Wigeon			F,L,R				F,L	F,L	F,L	F,L,R	L,R
Blue-winged Teal			B,F,L,R		F,L		F,L	F,L	F,L	F,L,R	L,R
Green-winged Teal					F,L			F,L	F,L	F,L,R	L,R
Northern Shoveler					F,L			F,L	F,L	F,L,R	L,R
Northern Pintail	F,L				F,L			F,L	F,L	F,L,R	L,R
Wood Duck								F,L	F,L	F,L,R	
Redhead										F,L,R	F,L,R
Canvasback										F,L,R	F,L,R
Greater Scaup										F,L,R	F,L,R
Lesser Scaup										F,L,R	F,L,R
Ring-necked Duck										F,L,R	F,L,R

Common Name	Upland	Bank	Bay Island	Beach	Mudflat	Rocky Intertidal	Salt Marsh	Brackish Marsh	Tidal-fresh Marsh	Shallow Water	Deep Water
Common Goldeneye										F,L,R	F,L,R
Bufflehead										F,L,R	F,L,R
Long-tailed Duck											F,L,R
Harlequin Duck											F,L,R
Common Eider											F,L,R
King Eider											F,L,R
Black Scoter										F,L	F,L,R
White-winged Scoter										F,L	F,L,R
Surf Scoter										F,L	F,L,R
Ruddy Duck										F,L	F,L,R
Snow Goose (Greater)	F,L,R				F,L			F,L	F,L	F,L	L,R
Ross's Goose	F,L,R				F,L			F,L	F,L	F,L	L,R
Greater White-fronted Goose	F,L,R				F,L			F,L	F,L	F,L	L,R
Canada Goose	B,F,L,R		B,F,L,R		F,L		B,F,L,R	B,F,L,R	B,F,L,R	F,L	L,R
Atlantic Brant			F,L,R		F,L	F,L	F,L			F,L	L,R
Mute Swan	B,F,L,R		B,F,L,R				B,F,L,R	B,F,L,R		F,L	L,R
Tundra Swan	F,L,R		F,L,R		F,L		F,L	F,L	F,L	F,L	L,R
White Ibis	F,L,R		B,F,L,R		F,L		F,L			F,L	
Glossy Ibis	F,L,R		B,F,L,R				F,L	F,L	F,L	F,L	
American Bittern	F,L,R						F,L,R	B,F,L,R	B,F,L,R	F,L	
Least Bittern								B,F,L,R	B,F,L,R	F,L	
Great Blue Heron	B,F,L,R		B,F,L,R	F,L	F,L		F,L,R	F,L,R	F,L,R	F,L	
Great Egret	B,F,L,R		B,F,L,R	F,L	F,L		F,L,R	F,L,R	F,L,R	F,L	
Snowy Egret	F,L,R		B,F,L,R	F,L	F,L		B,F,L,R	F,L,R		F,L	

Common Name	Upland	Bank	Bay Island	Beach	Mudflat	Rocky Intertidal	Salt Marsh	Brackish Marsh	Tidal-fresh Marsh	Shallow Water	Deep Water
Tricolored Heron	F,L,R		B,F,L,R	F,L	F,L		B,F,L,R	F,L,R		F,L	
Little Blue Heron	F,L,R		B,F,L,R	F,L	F,L		B,F,L,R	F,L,R		F,L	
Cattle Egret	F,L,R		B,F,L,R	F,L	F,L		B,F,L,R	F,L,R		F,L	
Green Heron	B,L,R		B,F,L,R	F,L	F,L	F,L	B,F,L,R	F,L,R	F,L,R	F,L	
Black-crowned Night Heron	B,L,R		B,F,L,R	F,L	F,L	F,L	B,F,L,R	F,L,R	F,L,R	F,L	
Yellow-crowned Night Heron	B,L,R		B,F,L,R	F,L	F,L	F,L	B,F,L,R	F,L,R		F,L	
Sandhill Crane	F,L,R										
King Rail			B,F,L,R		F			B,F,L,R	B,F,L,R		
Clapper Rail			B,F,L,R		F		B,F,L,R	B,F,L,R			
Virginia Rail	B,F,L,R		B,F,L,R		F		B,F,L,R	B,F,L,R			
Sora	F,L,R		F,L,R		F		F,L,R	B,F,L,R	B,F,L,R		
Yellow Rail	F,L,R						F,L,R	F,L,R			
Black Rail			B,F,L,R				B,F,L,R				
Common Moorhen			B,F,L,R				B,F,L,R	B,F,L,R			
American Coot			R		F,L			F,L,R	F,L,R	F,L,R	F,L,R
Wilson's Phalarope								F,L,R		F,L,R	
American Avocet			B,F,L,R								
Black-necked Stilt			B,F,L,R		F,L		F,L,R			F,L	
Wilson's Snipe	F,L,R				F,L,R			F,L,R	F,L,R		
Short-billed Dowitcher	F,L,R				F,L,R		F,L,R	F,L,R			
Long-billed Dowitcher	F,L,R				F,L,R		F,L,R	F,L,R			
Stilt Sandpiper	F,L,R				F,L,R		F,L,R	F,L,R			
Red Knot			F,L,R	F,L,R							
Purple Sandpiper				F		F,L,R					
White-rumped Sandpiper					F,L,R		F,L,R				

Common Name	Upland	Bank	Bay Island	Beach	Mudflat	Rocky Intertidal	Salt Marsh	Brackish Marsh	Tidal-fresh Marsh	Shallow Water	Deep Water
Least Sandpiper	F,L,R				F,L,R		F,L,R	F,L,R	F,L,R		
Dunlin	F,L,R			F,L,R	F,L,R		F,L,R				
Semipalmated Sandpiper				F,L,R	F,L,R		F,L,R				
Western Sandpiper				F,L,R	F,L,R		F,L,R				
Sanderling			F,L,R	F,L,R							
Marbled Godwit			F,L,R		F,L,R		F,L,R				
Hudsonian Godwit			F,L,R	F,L,R	F,L,R		F,L,R				
Greater Yellowlegs	F,L,R		F,L,R		F,L,R		F,L,R	F,L,R	F,L,R		
Lesser Yellowlegs	F,L,R		F,L,R		F,L,R		F,L,R	F,L,R	F,L,R		
Solitary Sandpiper	F,L,R							F,L,R	F,L,R		
Willet	B,F,L,R		B,F,L,R	B,F,L,R	F,L,R		B,F,L,R				
Spotted Sandpiper	F,L,R		F,L,R		F,L,R	B,F,L,R	F,L,R	F,L,R	F,L,R		
Whimbrel			F,L,R	F,L,R	F,L,R		F,L,R				
Black-bellied Plover	F,L,R		F,L,R	F,L,R	F,L,R		F,L,R				
Killdeer	B,F,L,R		B,F,L,R	B,F,L,R	F,L,R						
Semipalmated Plover	F,L,R		F,L,R	F,L,R	F,L,R	F,L,R					
Piping Plover			F,L,R	B,F,L,R							
Ruddy Turnstone			F,L,R	F,L,R	F,L,R	F,L,R	F,L,R				
American Oystercatcher			B,F,L,R	B,F,L,R	F,L,R		B,F,L,R				
Northern Harrier	B,F,L,R		B,F,L,R				B,F,L,R				
Bald Eagle	B,F,L,R		B,F,L,R	F,L		L	F,L	F,L	F,L	F,L	F,L
Peregrine Falcon	B,F,L,R		B,F,L,R	F,L	F,L		F,L				
Osprey	B,L,R		B,L,R							F	F
Short-eared Owl	B,F,L,R						B,F,L,R	B,F,L,R			
Belted Kingfisher		B,L,R								F	F

Common Name	Upland	Bank	Bay Island	Beach	Mudflat	Rocky Intertidal	Salt Marsh	Brackish Marsh	Tidal-fresh Marsh	Shallow Water	Deep Water
Bobolink	B,F,L,R						F	F	F,L,R		
Red-winged Blackbird	B,F,L,R		B,F,L,R				B,F,L,R	B,F,L,R	B,F,L,R		
Rusty Blackbird	F,L,R						F,L	F,L	F,L		
Boat-tailed Grackle			B,F,L,R	F,L	F,L		B,F,L,R				
Snow Bunting			F,L,R	F,L							
Ipswich Sparrow			F,L,R	F,L,R							
Henslow's Sparrow	B,F,L,R						B,F,L,R	F,L,R			
Saltmarsh Sparrow			B,F,L,R		F		B,F,L,R				
Nelson's Sparrow			F,L,R		F		F,L,R				
Seaside Sparrow			B,F,L,R		F		B,F,L,R	B,F,L,R			
Swamp Sparrow	F,L,R		F,L,R				F,L,R	F,L,R	F,L,R		
Coastal Swamp Sparrow			B,F,L,R				F,L,R	B,F,L,R	B,F,L,R		
Purple Martin	F,L,R		F,L,R				F	F	F		
Cliff Swallow	B,F,L,R						F	F	F		
Tree Swallow	B,F,L,R		B,F,L,R				F,L,R	F,L,R	F,L,R		
Bank Swallow	F	B,L,R					F	F	F	F	
Northern Rough-winged Swallow	F	B,L,R					F	F	F	F	
Sedge Wren	B,F,L,R		B,F,L,R				B,F,L,R		B,F,L,R		
Marsh Wren			B,F,L,R				B,F,L,R	B,F,L,R			

APPENDIX 5. Rationale for surveying waterbird species within the Chesapeake Bay, season of most interest for surveys, existing or recommended survey coverage, and seasons of survey coverage. Highlighted seasons indicate those not covered by existing or recommended surveys. Seasons are B – breeding, N – nursery, S – summer, W – winter, FM – fall migration, and SM – spring migration. See text for survey abbreviations.

Common Name	Regulatory Mandate	Range-wide Objectives	Local Management	Season of Interest	Survey Coverage	Season of Coverage
Red-necked Grebe						
Horned Grebe	Yes[4]	Yes[7]	Yes[8]	W	WSDS[11,12]	W
Pied-billed Grebe	Yes[4]		Yes[8,10]	B	WBS[11],TMBS[12]	B
Common Loon	Yes[4]		Yes[8]	W**,FM**	WSDS[11,12]	W
Red-throated Loon	Yes[4]	Yes[7]	Yes[8]	W	WSDS[11,12]	W
Pomarine Jaeger						
Parasitic Jaeger						
Black-legged Kittiwake						
Great Black-backed Gull		Yes[6]	Yes[8,10]	B	CWS	B
Lesser Black-backed Gull						
Herring Gull		Yes[6]	Yes[8,10]	B	CWS	B
Ring-billed Gull						
Laughing Gull	Yes[4]	Yes[6]	Yes[8,10]	B	CWS	B
Bonaparte's Gull						
Gull-billed Tern	Yes[2,3]	Yes[6]	Yes[8]	B	CWS	B
Caspian Tern		Yes[6]	Yes[8]	B	CWS	B
Royal Tern	Yes[2,5]	Yes[6]	Yes[8]	B	CWS	B
Sandwich Tern	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Forster's Tern	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Common Tern	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Least Tern	Yes[4,5]	Yes[6]	Yes[8,10]	B	CWS	B
Black Tern						
Black Skimmer	Yes[2,5]	Yes[6]	Yes[8]	B	CWS	B

Common Name	Regulatory Mandate	Range-wide Objectives	Local Management	Season of Interest	Survey Coverage	Season of Coverage
Wilson's Storm Petrel						
Northern Gannet	Yes[4]		Yes[8]	W	WSDS[11,12]	W
Anhinga						
Great Cormorant						
Double-crested Cormorant		Yes[6]	Yes[8,10]	B	CWS	B
American White Pelican						
Brown Pelican	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Common Merganser						
Red-breasted Merganser		Yes[6]	Yes[8]	W	WSDS[12]	W
Hooded Merganser		Yes[6]	Yes[8]	W	MWI	W
Mallard		Yes[6]	Yes[8]	B,W	WBS, MWI	B,W
American Black Duck	Yes[4]	Yes[6]	Yes[8]	B,W	WBS, MWI	B,W
Gadwall		Yes[6]	Yes[8]	W	MWI	W
American Wigeon		Yes[6]	Yes[8]	W	MWI	W
Blue-winged Teal		Yes[6]	Yes[8]	W	MWI	W
Green-winged Teal		Yes[6]	Yes[8]	W	MWI	W
Northern Shoveler		Yes[6]	Yes[8]	W	MWI	W
Northern Pintail		Yes[6]	Yes[8]	W	MWI	W
Wood Duck		Yes[6]	Yes[8,10]	B,W	WBS, MWI	B,W
Redhead		Yes[6]	Yes[8]	W	MWI	W
Canvasback	Yes[4]	Yes[6]	Yes[8]	W	MWI	W
Greater Scaup		Yes[6]	Yes[8]	W	MWI	W
Lesser Scaup		Yes[6]	Yes[8]	W	MWI	W
Ring-necked Duck		Yes[6]	Yes[8]	W	MWI	W
Common Goldeneye		Yes[6]	Yes[8]	W	MWI	W
Bufflehead		Yes[6]	Yes[8]	W	MWI	W

Common Name	Regulatory Mandate	Range-wide Objectives	Local Management	Season of Interest	Survey Coverage	Season of Coverage
Long-tailed Duck		Yes[6]	Yes[8]	W	WSDS[12]	W
Harlequin Duck						
Common Eider						
King Eider						
Black Scoter		Yes[6]	Yes[8]	W	WSDS[12]	W
White-winged Scoter		Yes[6]	Yes[8]	W	WSDS[12]	W
Surf Scoter		Yes[6]	Yes[8]	W	WSDS[12]	W
Ruddy Duck	Yes[4]	Yes[6]	Yes[8]	W	MWI	W
Snow Goose (Greater)		Yes[6]	Yes[8]	W	MWI	W
Ross's Goose						
Greater White-fronted Goose						
Canada Goose		Yes[6]	Yes[8,10]	B,W	WBS, MWI	B,W
Atlantic Brant	Yes[4]	Yes[6]	Yes[8]	W	MWI	W
Mute Swan		Yes[6]	Yes[8,10]	B	MSS	B
Tundra Swan		Yes[6]	Yes[8]	W	MWI	W
White Ibis						
Glossy Ibis	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
American Bittern	Yes[4,5]		Yes[8]	B	TMBS[12]	B
Least Bittern	Yes[4]	Yes[7]	Yes[8]	B	TMBS[12]	B
Great Blue Heron	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Great Egret	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Snowy Egret	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Tricolored Heron	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Little Blue Heron	Yes[4,5]	Yes[6]	Yes[8]	B	CWS	B
Cattle Egret		Yes[6]	Yes[8]	B	CWS	B

Common Name	Regulatory Mandate	Range-wide Objectives	Local Management	Season of Interest	Survey Coverage	Season of Coverage
Green Heron		Yes[6]	Yes[8]	B	CWS	B
Black-crowned Night Heron	Yes[4]	Yes[6]	Yes[8]	B	CWS	B
Yellow-crowned Night Heron	Yes[4,5]	Yes[6]	Yes[8]	B	CWS	B
Sandhill Crane						
King Rail	Yes[4,5]	Yes[7]	Yes[8]	B	TMBS[12]	B
Clapper Rail		Yes[7]	Yes[8]	B	TMBS[12]	B
Virginia Rail		Yes[7]	Yes[8]	B	TMBS[12]	B
Sora						
Yellow Rail						
Black Rail	Yes[2,5]	Yes[7]	Yes[8]	B	BRBS[12]	B
Common Moorhen	Yes[4]		Yes[8]	B	MBS[11]	B
American Coot		Yes[7]	Yes[8]	W	MWS[11]	W
Wilson's Phalarope						
American Avocet						
Black-necked Stilt						
Wilson's Snipe	Yes[4]	Yes[7]	Yes[8]	W,FM,SM	PRISM[12]	W,FM,SM
Short-billed Dowitcher	Yes[4]	Yes[7]	Yes[8]	FM,SM	PRISM[12]	W,FM,SM
Long-billed Dowitcher						
Stilt Sandpiper						
Red Knot	Yes[4]	Yes[7]	Yes[8]	FM,SM	PRISM[12]	W,FM,SM
Purple Sandpiper	Yes[4]	Yes[7]	Yes[8]	W,FM,SM	PRISM[12]	W,FM,SM
White-rumped Sandpiper						
Least Sandpiper		Yes[7]	Yes[8]	W,FM,SM	PRISM[12]	W,FM,SM
Dunlin	Yes[4]	Yes[7]	Yes[8]	W,FM,SM	PRISM[12]	W,FM,SM
Semipalmated Sandpiper	Yes[4]	Yes[7]	Yes[8]	FM,SM	PRISM[12]	FM,SM
Western Sandpiper						

Common Name	Regulatory Mandate	Range-wide Objectives	Local Management	Season of Interest	Survey Coverage	Season of Coverage
Sanderling	Yes[4]	Yes[7]	Yes[8]	W,FM,SM	PRISM[12]	W,FM,SM
Marbled Godwit						
Hudsonian Godwit						
Greater Yellowlegs	Yes[4]	Yes[7]	Yes[8]	W,FM,SM	PRISM[12]	W,FM,SM
Lesser Yellowlegs		Yes[7]	Yes[8]	W,FM,SM	PRISM[12]	W,FM,SM
Solitary Sandpiper	Yes[4]	Yes[7]	Yes[8]	FM,SM	PRISM[12]	FM,SM
Willet	Yes[4]	Yes[7]	Yes[8]	B,FM,SM	TMBS[12],PRISM[12]	B,FM,SM
Spotted Sandpiper		Yes[7]	Yes[8]	FM,SM	PRISM[12]	FM,SM
Whimbrel	Yes[4]		Yes[8]	FM,SM	PRISM[12]	FM,SM
Black-bellied Plover	Yes[4]		Yes[8]	FM,SM	PRISM[12]	FM,SM
Killdeer		Yes[7]	Yes[8]	FM,SM	PRISM[12]	FM,SM
Semipalmated Plover		Yes[7]	Yes[8]	FM,SM	PRISM[12]	FM,SM
Piping Plover	Yes[1]	Yes[7]	Yes[8]	B,W	IPPC	B,W
Ruddy Turnstone	Yes[4]	Yes[7]	Yes[8]	FM,SM	PRISM[12]	FM,SM
American Oystercatcher	Yes[4,5]	Yes[7]	Yes[8]	B,**S**,W,**FM,SM**	AOBS	B,W
Northern Harrier	Yes[4]		Yes[8]	B	TMBS[12]	B
Bald Eagle	Yes[1,2,3]	Yes[7]	Yes[8,10]	B,S,W,**FM,SM**	BEBS, WBES, BECAS	B,S,W
Osprey		Yes[7]	Yes[8,9]	B,**N,S,FM,SM**	OBS	B
Short-eared Owl	Yes[2]		Yes[8]	B	TMBS[12]	B
Belted Kingfisher						
Bobolink		Yes[7]	Yes[8]	**FM**		
Red-winged Blackbird						
Rusty Blackbird						
Boat-tailed Grackle	Yes[4]		Yes[8]	B	TMBS[12]	B
Snow Bunting						

Common Name	Regulatory Mandate	Range-wide Objectives	Local Management	Season of Interest	Survey Coverage	Season of Coverage
Ipswich Sparrow			Yes[8]	**W**		
Henslow's Sparrow	Yes[2.3]	Yes[7]	Yes[8]	B	HSBS[12]	B
Saltmarsh Sparrow	Yes[4,5]	Yes[7]	Yes[8]	B,**W,FM,SM**	TMBS[12]	B
Nelson's Sparrow		Yes[7]	Yes[8]	**W**		
Seaside Sparrow	Yes[4]	Yes[7]	Yes[8]	B,**W,FM,SM**	TMBS[12]	B
Swamp Sparrow	Yes[4]	Yes[7]	Yes[8]	**W,FM,SM**		
Coastal Swamp Sparrow	Yes[4]	Yes[7]	Yes[8]	B,**FM,SM**	TMBS[12]	B
Purple Martin				**FM,SM**		
Cliff Swallow						
Tree Swallow				**FM,SM**		
Bank Swallow	Yes[4]		Yes[8]	**FM,SM**		
Northern Rough-winged Swallow				**FM,SM**		
Sedge Wren	Yes[2]		Yes[8]	B	TMBS[12]	B
Marsh Wren	Yes[4]	Yes[7]	Yes[8]	B,**FM,SM**	TMBS[12]	B

[1]Current or recent federal listing with monitoring requirement.
[2]Listed as threatened or endangered in Maryland – monitoring needed for management.
[3]Listed as threatened or endangered in Virginia – monitoring needed for management.
[4]Listed as Species of Greatest Conservation Need in Maryland.
[5]Tier I or II status in Virginia.
[6]Chesapeake Bay survey contributes to range-wide estimates of status/distribution/trends.
[7]Survey in Chesapeake Bay could contribute to range-wide estimates of status/distribution/trends.
[8]Determine status/distribution/trends within Chesapeake Bay for local planning.
[9]Monitoring used as indicator of environmental health.
[10]Monitoring is part of adaptive management program.
[11]Expand existing monitoring program to accommodate species.
[12]Establish new monitoring program within Chesapeake Bay.