

2012

Wilderness Character Monitoring Report: Monomoy Wilderness



Photo Credit: David Clapp

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Section 1: Setting of the Refuge

1.1 Geographic

The Monomoy National Wildlife Refuge (NWR) is an ensemble of coastal barrier beaches extending southward from the elbow of Cape Cod, in the Town of Chatham, Barnstable County, Massachusetts. The refuge, managed by the United States Fish and Wildlife Service (USFWS), encompasses 7,604 acres. The eastern boundary of the refuge, which faces the Atlantic Ocean, is at the mean low water line, while the western boundary is a fixed line between points in Nantucket Sound with known latitude and longitude coordinates described in the 1944 Declaration of Taking for the refuge.

Morris Island is the northernmost unit (40 acres) of MNWR; it is connected to the mainland by a constructed causeway. About three quarters of a mile south of Morris Island is North Monomoy Island, a triangular-shaped, mostly intertidal platform. North Monomoy Island is about 1.3 miles long and 0.4 miles wide. Below North Monomoy Island is South Monomoy, a roughly tear-shaped feature, six miles long and about 1.3 miles wide at its bulbous terminus. To the west of the northern tip of South Monomoy is Minimoy Island, a small island, estimated to be 0.25 miles long and 0.36 miles wide.

This coastal barrier complex has a dynamic response to the surrounding wind, tides, and the resulting flow of sediments. South Monomoy is a rare example of an actively accreting coastal landform along the exposed outer shore of Cape Cod. The tides pull sediments from the outer coast of the Cape then deposit these sediments at the tail of South Monomoy as the tides sweep around its “J” shape. A 150 year cycle occurs, in which the islands connect as a peninsula to the outer coast of Cape Cod and then spilt back into islands depending on the rates erosion and accretion. In 2006, the South Beach sand spit (located northeast of South Monomoy) migrated southwest enough to join with what was then South Monomoy Island. As of 2012, this South Beach-South Monomoy peninsula persists although coastal processes may divide it in the future.

Surrounding land uses can influence the island’s geophysical processes as well as the visitor experience. The proximal mainland’s land uses include recreation, resorts, and residential living. In the surrounding waters, recreation and fishing operations, such as shell fishing, occur. The main urban centers, Boston, Massachusetts and Providence, Rhode Island are both about 100 miles away. Visitors to Chatham, however, come from all over the world.

Monomoy NWR is situated in the Cape Cod watershed. It is also a critical stopover point within the Atlantic Flyway of migratory birds. As such, Monomoy NWR is considered an Important Bird Area by Massachusetts Audubon Society and is designated a Western Hemisphere Shorebird Reserve Network site (WHSRN).

Ninety-four percent of MWNR was designated as wilderness in 1970, pursuant to the 1964 Wilderness Act. This area consists of South Monomoy and North Monomoy Island, but excludes Morris Island and two areas within South Monomoy around Powder Hole and Inward Point (including Minimoy Island). These two excluded areas on South Monomoy contained summer cottages, the light station, and other facilities still being used or in private ownership at the time of wilderness designation in 1970. Powder

Hole also included four acres then owned by the Massachusetts Audubon Society. These facilities no longer exist, with exception of the light station, and land titles for all the parcels have transferred to the USFWS.

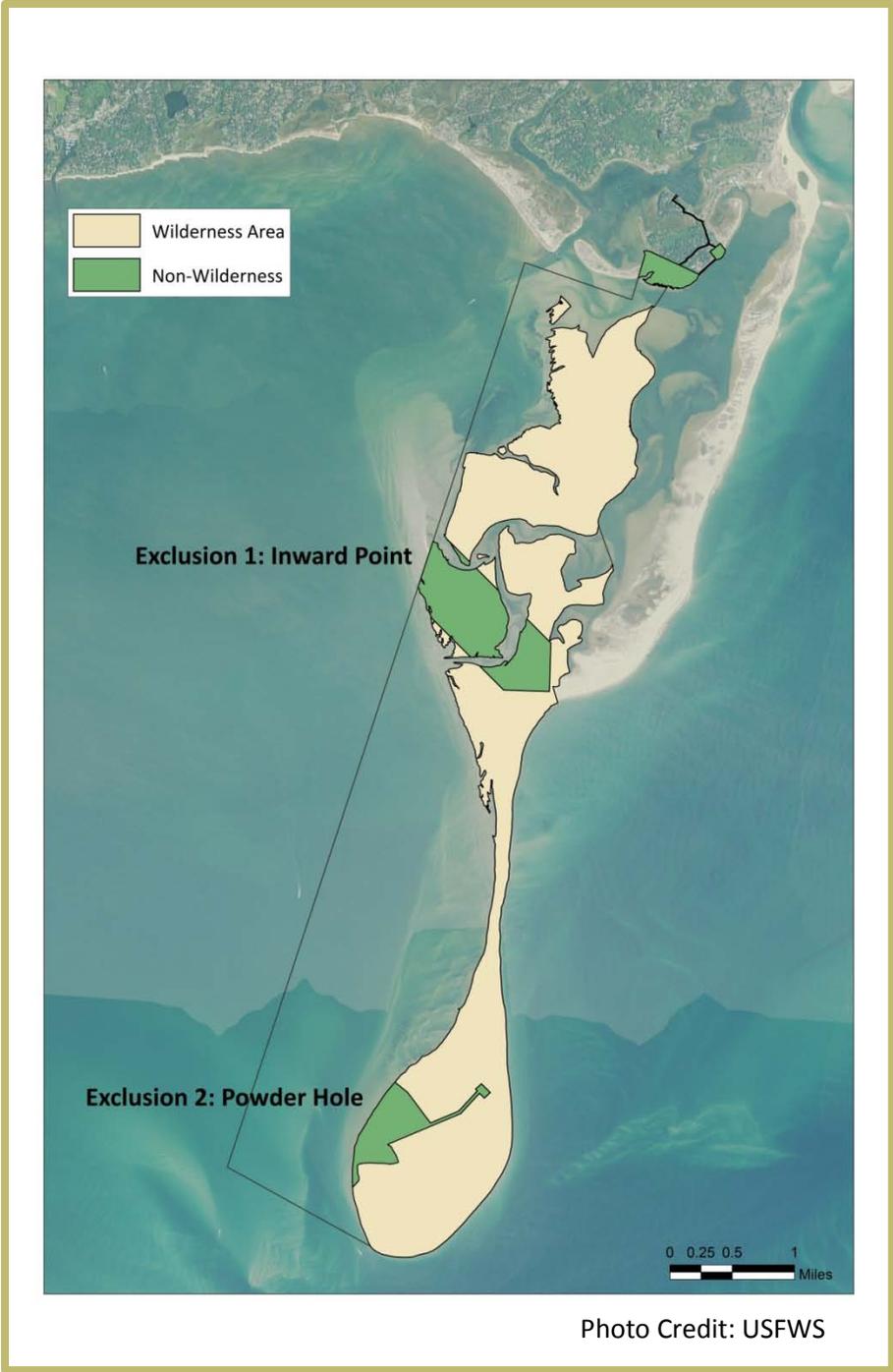
Monomoy National Wildlife Refuge - Comprehensive Conservation Plan



Monomoy National Wildlife Refuge



Photo Credit: USFWS



1.2 Ecologic

The Monomoy Islands rest on a bed of glacial material deposited approximately 18,000 years ago. North Monomoy Island and South Monomoy are estimated to be 6,000 years old.

Tidal process influences the majority of the landscape --60% of the area is intertidal flats, open sand, primary dunes and salt marshes. Upland “back” dunes, shrublands, and freshwater ponds make up the remaining 40% of the wilderness. From east to west, North Monomoy Island is a continuum of narrow

beach, dunes, and intertidal salt marsh, opening onto a wide intertidal sand flat. The northern two-thirds of South Monomoy are flanked by sandy beaches and the southern third supports a dune-ridge system oriented northeast to southwest.

Typical coastal plants, such as American Beach grass and false heather, cover the dunes. Bayberry, beach plum, poison ivy, and short pitch pines fill in the shrublands. Small saltmarsh patches are present on the northwest and southwest sides of South Monomoy and primarily consist of saltmarsh cordgrass, saltmarsh hay, salt grass and black grass. About 150 acres of South Monomoy is freshwater ponds and marshes with cattails, ponds lilies, and common reed (*Phragmites australis*) among the vegetation.



Photo Credit: USFWS

Natural disturbances that shape the islands and limit plant succession include storms, salt spray, and fire. Nor'easters and hurricanes can flood or overwash the coast through heavy rains and high winds, thereby damaging, burying, or flooding coastal vegetation. Historical evidence shows that Native Americans used fire as a tool for hunting and travel. These periodic fires set back woody plant growth, allowing for more persistent grasslands, but did not dramatically alter the landscape. A combination of these disturbances has maintained a shifting mosaic of shrubs within these coastal grasslands.

These coastal islands, with their bands of vegetation, exposed sand, and intertidal flats, supply prime habitat for numerous species of wildlife.

Several species of shorebirds utilize Monomoy NWR during some period of their lifecycle. Since the 1990s, the northern tip of South Monomoy has hosted one of the largest common tern colonies on the Atlantic Seaboard with some 5,000 to 10,000 nesting pairs. Roseate terns (federally endangered) nest within the common tern colony as well, but in lower numbers (less than 100 pairs of roseate terns). These terns have their own preferences of vegetation and sand cover, but will only nest in association with large, productive common tern colonies. Willets also nest within the South Monomoy tern colony and elsewhere on the refuge.

One of largest laughing gull colonies in Massachusetts is also present on Monomoy most years (post-2001) (400-1400 nesting pairs). Great black-backed and herring gulls nest on Monomoy as well. Since these gulls are present in such high population numbers and predate terns, they are subject to lethal and nonlethal control measures.



Photo Credit: Erin Wood

Monomoy NWR and the neighboring South Beach support about 12% of Massachusetts's Piping Plover nesting

population (federally threatened). Least terns, American oystercatchers and black skimmers also nest on the Refuge and benefit from piping plover and shorebird management, which includes area closures to prevent public disturbance and predator control to protect chicks and adults.

Monomoy NWR is an important stopover site for southward migrating shorebirds including the red knot (candidate federal threatened). Migrating waterfowl and landbirds also use the Refuge as a stop-over site during spring and fall migration. Monomoy is an attractive destination because it offers shellfish/invertebrate rich waters and flats, extensive eelgrass and sea lettuce beds, and little human disturbance.

Additionally Monomoy is a site for nesting waterfowl, wading birds and landbird species. The savannah sparrow and salt marsh sparrow nest in the salt marshes, horned larks nest in the beach grass, and yellow-throats nest in woody shrub patches. Several species of waterfowl nest around the fresh water ponds on South Monomoy. Wading birds nest in woody shrubs on North Monomoy.

Several mammals occur on the Monomoy NWR; they are not monitored but some, such as the coyote, are managed as nest predators. The gray seals and harbor seals have a large presence on the island, providing a happy sight to many recreationists and visitors. The gray seals are present year round and pup on the island each winter (Muskeget is the main site in Massachusetts for pups). Harbor seals arrive in early September and will stay until March. While a census has not occurred in recent years, gray seals along with harbor seals number in the thousands. Monomoy is the largest haul out site for gray seals on the US Atlantic Seaboard.



Photo Credit: Fumika Takahashi

Terrestrial mammals consist mostly of small rodents, the most abundant of which are the meadow vole and the white-footed mouse. Raccoons and opossums are periodically observed on the island. If they are a threat to the shorebirds, individuals will be selectively removed.

With the mainland connection via South Beach, the former island became accessible to other terrestrials. The eastern coyote was first observed on the island in the mid-1990s. Its regional population has increased by filling the niche of top carnivore (previous occupied by Northeast populations of wolves, cougar, or black bear). Given their unnatural population rise in Massachusetts and the threat they pose to nesting shorebirds, coyotes are regularly removed from the island.



Photo Credit: USFWS

Monomoy NWR and its intertidal zone host countless invertebrates; of note is the horseshoe crab and northeastern beach tiger beetle. The horseshoe crab uses the Refuge's beaches and salt marsh as a spawning ground and nursery. Horseshoe crabs are harvested as bait and also the biomedical industry uses their blood to test for bacterial contamination. However, horseshoe crabs and their eggs are an important food source for fish and birds. Commercial harvest of the horseshoe crab, including for medical use, is therefore

Photo Credit: USFWS

prohibited at Monomoy NWR in order to maintain the population and be in compliance with the Wilderness Act prohibition on commercial enterprise. The northeastern beach tiger beetle (federally threatened) was reintroduced to South Monomoy beginning in 2000-2003. The tiger beetle population can only persist on undeveloped beaches with no OSV usage. Since reintroduction, the tiger beetle population has increased to well over 1000 individuals.

In sum, Monomoy provides critical habitat for a suite of wildlife.

Monomoy NWR receives approximately 38.9 inches of precipitation annually. Temperatures in winter and summer are more moderate compared to the mainland with average temperatures of 31 degrees Fahrenheit (°F) in January and 71 ° F in July. Changes in climate are a serious concern to the refuge. Scientists predict significant changes in temperature, precipitation, soil moisture, sea level, frequency, and magnitude of storm-surge flooding and coastal erosion –all of which could adversely affect the function of ecological systems and modify vegetation and wildlife distribution. The United States Geology Survey classifies parts of South Monomoy as highly vulnerable to sea level rise. A rise in sea level would result in a loss/shift of coastal land area including the Refuge’s intertidal, salt marsh and drier coastal upland habitat. This would then decrease the feeding, staging, and breeding habitat for many coastal fish and wildlife species, and potentially reduce the size of the Monomoy Wilderness.

1.3 History

On February 10, 1944 the Monomoy NWR was established through a Declaration of Taking by the Secretary of the Interior.

Prior to this establishment, the islands were likely visited by Native Americans and early Europeans. During the late 1700s a settlement known as Whitewash Village was built around Powder Hole near Monomoy Point. This settlement lasted into the mid-1800s, after a storm filled the natural deep water harbor and inlet. Seasonal camps and fishing facilities replaced the year-round fishing village and persisted through the 1900’s around Powder Hole and Inward Point.



The Monomoy Point Light Station was built in 1823 to guide ships, and was replaced in 1849. US Life Saving Stations were built in 1872 to respond to shipwrecks. In 1928, ornithologists, E.H. Forbush and Arthur Cleveland Bent, recognized Monomoy’s importance for birds, and first proposed its protection. By 1932, however, Monomoy was taken over by the US military and used as an aircraft bombing and strafing range through WWII. With the conclusion of the war, Monomoy became a national wildlife refuge. From 1944 to 2000 owners were allowed to keep their summer camps under life estate privileges. When these privileges expired, MNWR gained ownership of the land.

In response to the Wilderness Act of 1964, the national wildlife refuge system was required to review every roadless area of 5,000 acres or more and every roadless island. The provisions of Sections 4(a) and 4(b) in the Act declare that: (1) the Act is to be within and supplemental to the purposes for which National Wildlife Refuges are established; (2) wilderness areas shall be administered so as to meet

purposes of wildlife protection in such a manner as to preserve and protect their wildlife communities; (3) such areas shall also be administered within the wilderness area concept to provide public recreational, scenic, scientific, educational, conservation, and historical enjoyment insofar as wildlife management objectives permit.

In 1970, North and South Monomoy Islands (except for Powder Hole and Inward point areas) were designated as wilderness. Over 90 percent of the statements received at the public hearing favored the wilderness designation.

As part of the MNWR Wilderness Review, the planning team now feels that the excluded Powder Hole and Inward Point qualify for wilderness designation. Should this point of view be passed in the Conservation Comprehensive Plan, staff will treat and manage these areas as wilderness also.

1.4 Refuge Purpose

The Service established Monomoy NWR in 1944 under a Declaration of Taking for the following purposes and under the following authorities:

“... for use as an inviolate sanctuary, or for other management purpose, for migratory birds”
—Migratory Bird Conservation Act (16 U.S.C. §715d)

“... to preserve the wilderness character of the Monomoy Islands” —an Act to Designate Certain Lands as Wilderness (Public Law 91-504, 16U.S.C. §1132(c)).

The 1988 Master Plan for the refuge states:

“... Monomoy’s qualities as wildlife habitat, as a wilderness, and as a place where people can observe and enjoy wildlife and wilderness are interdependent ... that recreationists value the diversity of Monomoy’s wildlife and the wilderness character of the island; that maintaining Monomoy as a wilderness where the imprint of man’s work is substantially unnoticeable requires that off-refuge human activities be prevented from altering the natural diversity of wildlife; and that recreational activity should be managed to avoid deterioration of the wilderness character.”

In 2009, refuge planners determined six goals for the Draft CCP. Goal 4 states:

“Ensure that the spirit and character of the Monomoy Wilderness are maintained.”

Section 2: Wilderness Character Narrative

A wilderness character narrative is a positive and affirming description of what is unique and special about a given wilderness. The narrative describes the five tangible and measurable qualities of wilderness character: 1) Untrammeled, 2) Natural, 3) Undeveloped, 4) Solitude or Primitive and Unconfined Recreation and 5) Other Features. This is a description of values, issues, and threats for the subject wilderness; it is not a critique on the state of wilderness or recommendation for management.

INTRODUCTION



Photo Credit: David Clapp

The single most important clue to understanding the Monomoy Wilderness is to understand the tides. For it is the tides that have shaped this wilderness as it exists today, namely, North Monomoy Island and South Monomoy, and it is the tides that will shape the islands' future.

The sea sculpted the Monomoy Wilderness as it has emerged over the past 6,000 years (on a bed of glacial material which was deposited there approximately 18,000 years ago). Tidal erosion of the coastline, from harsh winter storms, separated the Monomoy peninsula from the mainland at the "elbow" of Cape Cod in the late 1950s and two decades later divided North Monomoy from South Monomoy Island.

In the course of the island's evolution, tidewater raked sand away from the outer rim of Cape Cod and South Monomoy's neck to add sand to South Monomoy's tail. The tides drew sediment from the north to gradually recreate a peninsula which now begins at South Beach and links to South Monomoy. It is anticipated that the waves and winds will eventually rip the peninsula apart again; separating the southern islands once more.

Knowledge of the tides and the associated flow of sediment will influence the islands' shape. The islands' shape, in turn, will influence the islands' flora and fauna. The islands' vegetative landscape begins with exposed east-side beaches and intertidal flats, where few roots can gain a foothold; it extends to high, surfside dunes, caused by shifting sands, where beach grass grows safe from inundation. This resulting sandy-substrate vegetation provides habitat for wildlife. This wildlife includes

invertebrates such as horseshoe crabs which spawn in the intertidal area. Bare ground and a patchwork of grasses provide a breeding and resting region for migratory and resident shorebirds. The tidal shaping of the islands has, at times during the wilderness' history, connected the Monomoy islands to the mainland which provides easier access to terrestrials such as coyote and deer.

Human access to the Monomoy Wilderness has had a large effect on its use. Most visitors reach the wilderness by water, primarily motorboat. The commonly strong, rough currents of Nantucket Sound makes kayaking or sailing to the islands' shores difficult and dangerous. In addition, the weather and water depth, again dependent on the tides, restrict when and where motorboats can land and anchor.

The land form has also impacted the search for fishing spots and how to reach them.

An eleven mile hike from South Beach to South Monomoy lets a dedicated hiker traverse the beaches and dune ridges. Any visit to the Monomoy's wilderness requires effort and knowledge of the tides and the coasts. The incentive for this effort is the reward of interacting with islands designed by nature rather than man.

The North and South Monomoy Islands were designated as a wilderness by Congress in 1970 (Public Law 91-504, 16U.S.C. §1132(c)) pursuant to the Wilderness Act of 1964 and managed by the United States Fish and Wildlife Service. The Service recognized that the preservation of the Monomoy Wilderness offered a special mission: "It is a natural refuge for birds and an ideal retreat for people willing to undertake the journey for the sake of its rewarding seclusion." It is the only wilderness in southern New England.

Thus, the tides give the Monomoy Wilderness a unique imprint, providing natural habitat and checking man's use, thereby creating a rare environment of coastal purity.

[1] UNTRAMMELED

Wilderness is essentially unhindered and free from modern human actions that control or manipulate the community of life.



The natural processes on the Monomoy Wilderness are so dynamic and pronounced that any trammeling at odds with these natural forces would likely require repeated and prolonged maintenance. Fortunately, actions that trammel the environment have been minimal. The picturesque landscape of undulating dunes, wind-swept beach grass, and pockets of shrublands that nestle bright sapphire ponds are not undermined with management.

In the past, the freshwater ponds were stocked with largemouth bass. The pre-wilderness management goal was to make Monomoy an optimal waterfowl nesting and migration habitat, thereby forcing South Monomoy to support foreign flora and fauna. Over time, earthwork and water control structure installation to increase shallow, open freshwater and the planting of millet, rye, winter wheat and other vegetation savored by ducks and geese ceased along with stocking the ponds.

The current management approach is to try to restore or replicate natural processes to reduce threats to indigenous and endangered wildlife. The monitoring of selected species is conducted as unobtrusively as possible to reduce trammeling.

For instance, about every four years the northern tip of South Monomoy is burned to maintain early successional habitat for the exceptional tern colony. Historians speculate that Native Americans used fire as a tool to hunt, to gather food, and to obtain coastal area access, resulting in a favorable shorebird habitat.

Several of the shorebirds are conservation priorities for the wilderness refuge so threats to their populations are minimized. This includes the erection of exclosures to prevent nest predation and the removal of species (such as herring gulls, black back gulls, and coyotes) harmful to the bird populations.

The banding and tagging of certain wildlife, such as American oystercatchers and horseshoe crabs, temporarily trammels the wildlife, but it is done exclusively for research and monitoring purposes.

At present, it seems that nearby developments have not trammled the wilderness' physical processes. The noted coastal ecologist, Grahame Giese, is not aware of any construction which interrupts tidal flow or sediment sources to the Refuge. Because most of the beaches north of Monomoy NWR are part of the Cape Cod National Seashore, the threat of deleterious coastal development appears low. The global danger of climate change may have a series of consequences on Monomoy NWR, the most serious of which is sea level rise and perhaps increased storm event frequency and magnitude. Some habitats may shift, but Giese predicts that the historical coastal processes of accretion and erosion should continue.

In all, current management techniques require little trammeling to restore the wilderness' natural systems and to ensure that the most fragile and endangered wildlife persists; if this management success endures, then even less trammeling will be necessary in the future.

[2] NATURAL

Wilderness maintains ecological systems that are substantially free from the effects of modern civilization.



The Monomoy Wilderness' geophysical elements have lent strategic importance to certain wildlife. Indeed, one of the most prominent features of its ecosystem is its ideal habitat for shorebirds and migratory birds within the Atlantic flyway. As development increases on the mainland, Monomoy's undeveloped, natural beaches become more important as a migration stopover or nesting location.

For thousands of years migratory waterfowl and colonial waterbirds and shorebirds have nested here. Ornithologists have validated this fact for over a hundred years. Famed bird watcher Ludlow Griscom studied birds on Monomoy in the early 1900s. In 1928, ornithologists E.H. Forbush and Arthur Cleveland Bent first proposed protection of the Monomoy Islands for migratory birds. Since the mid-1960s, South Monomoy has hosted a tern colony of over five thousand common terns; within or near this colony the federally endangered roseate tern also nests, although in much fewer numbers. These birds, along with, among others, piping plovers (also endangered), and American oystercatchers, scavenge the intertidal flats for plentiful invertebrates and raise their young among the coarse sand and intermingled vegetation. The common tern fiercely defends its nests through dive-bombing, tactical defecation, and pecking at predators. Such instinctive behavior shows how passionately these birds will fight to keep their nesting areas protected.

Passerines also use the Monomoy Wilderness as a migratory stopover. Although the migratory patterns of many passerines is not yet fully understood, studies have shown that their migratory paths along the Atlantic coast can be very long, perhaps stretching from as far as South and Central America to Maine, making stopovers such as the Monomoy Wilderness essential to their annual migrations.

In addition to birds, several small animals such as reptiles and amphibians dwell in the Monomoy Wilderness.

Monomoy Wilderness is also home to marine mammals, such as gray and harbor seals. Significantly, Monomoy NWR is one of the few sites in Massachusetts where gray seals live year-round and consistently pup. The largest haul out of gray seals on the Atlantic Seaboard traditionally occurs on the

Monomoy Wilderness, comprising at least several thousand seals. The food-filled waters with herring, lobster, and squid, surrounding the Refuge support such a large seal population that the great white shark has recently resumed its place atop of the food chain.

The beaches of Monomoy NWR are also an important spawning area for the horseshoe crab; their eggs are an attractive food source for shorebirds.

Monomoy Refuge has become a critical wilderness because so few undeveloped lands for coastal wildlife remain in the United States. Given this, if Monomoy Wilderness cannot support threatened species such as the piping plover and the northeastern tiger beetle, then these species' range-wide viability is at risk. In such instances, as previously described, more intensive management of indigenous wildlife is needed. Under this a scenario, other species' and populations may become unnatural.

In the early 1990s, herring gulls and great black-backed gulls reached unnaturally high numbers due to Monomoy Wilderness's desirable nesting sites and nearby artificial food sources such as open dumps (since closed). The less aggressive terns could not compete with these gulls for the available nesting sites, so the Service started an avian diversity restoration project in 1996 to create a "gull free zone". The project remains in effect and has significantly helped the common terns and other nesting species.

The migration of coyotes from the western to the eastern part of the nation may have resulted with such ease because the niche formerly occupied by the top New England predators such as the wolf and the mountain lion was vacant. In any event, the coyote population is now considered an unnatural added threat to the endangered species populations.

A few plant species are also non-native or invasive, the most threatening of which is *Phragmites australis*: this large common reed can grow in thick monotypic stands that outcompete the preferred native flora such as cattails.

The main risks to Monomoy's naturalness are the chances of its being overrun with non-native species or having its existing habitats shift or decline to climate change: uncharacteristic alterations in sea level, temperature, precipitation, soil moisture, and frequency and magnitude of storms, may cause a distorted landscape which would not have happened absent mankind's effect on global warming.

[3] UNDEVELOPED

Wilderness retains its primeval character and influence, and is essentially without permanent improvements or modern human occupation.



Photo Credit: Yianni Laskaris

The Monomoy Wilderness offers “unblemished beauty” [Wilderness Study] to its wide variety of wildlife and its nature-loving visitors.

This beauty is due in large part to the fact that motorized vehicles are prohibited on North Monomoy Island and South Monomoy. This prohibition not only preserves the wilderness’ scenic beauty, but also protects the federally threatened northeastern beach tiger beetle, which management imported from Martha’s Vineyard. This management is significant because only three groups of northeastern tiger beetle now exist north of Chesapeake Bay. The sand is, without “dune-buggy’s”, indented only by footprints, paw prints, track marks from birds or crabs, and the rippled grooves of the tide. On Monomoy, man and creature make their separate paths to be erased by wind, tide, or vegetation.

Man has a long history on Monomoy. Colonists, from 1717 to 1839, inhabited a seasonal fishing community, known as Whitewash Village, complete with a church and a school, at the current location of Powder Hole. The Monomoy Lighthouse, set on Monomoy Point, guided ships through the dangerous waters of Pollock Rip from 1823 to 1923 (Lighthouse reconstructed in 1849). The village diminished and was eventually abandoned due to sedimentation of the deep water harbor creating a low, brackish pond [Cape Cod Connection, Monomoy National Wildlife Refuge, History]. A number of Life Saving Service Stations were established beginning in 1872 and absorbed into the US Coast Guard. There also existed many private summer, fishing and hunting camps, before the Monomoy National Wildlife Refuge was established through a Declaration of Taking in 1944. The taking for the refuge by condemnation was in part necessitated by unclear title to the land on which they were erected, and the camps were placed under refuge special use permits on a life-tenancy basis. The last of these life tenancy permits expired in 2000.

Throughout this time, the islands joined and separated. When North and South Monomoy Islands were separate, it was more difficult to access the islands to remove personal property; transportation issues, among other reasons, caused many village remnants. Today, shards of glass and pottery, rusted pipes,

and even remnants of old cars used as “beach buggy’s” remain. Although considerable artifacts and human debris are left over, they appear and disappear with the shifting sands and vegetative regrowth. Even though man has been present on the islands for hundreds of years, nature has swallowed-up mankind’s traces. As stated in Monomoy’s Wilderness Study: “Pounded by the Atlantic, scoured by tidal currents and lashed by the wind, this ever-changing finger of sand shows little of man’s use during the past 200 years.”

Today, developments and physical structures on Monomoy are limited to management tools (e.g., nest enclosures), signage, and research equipment. As mentioned above, motorized vehicles, mechanical transport, and motorized equipment are precluded from visitor use; and the administrative use of such is only be permitted during outstanding occurrences and when deemed the minimum tool. In fact, such use is generally nonexistent due to access issues and the types of activities conducted.

If current management policies persist, enforcing the National Wilderness Preservation’s “leave no trace techniques,” and nature continues to decompose and obscure abandoned evidence, then Monomoy Wilderness should continue as an “unblemished beauty.”

[4] SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION

Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation.



The Monomoy Wilderness is a secluded retreat and fishing destination. This strategic sliver of sand, a halcyon for birds, also provides a unique recreation opportunity for visitors.

Monomoy Wilderness is considered an “ideal detachment” [Wilderness Study] where recreation relies on self-sufficiency in contrast to that provided on the nearby national seashore. The rim of Cape Cod provides a suite of coastal recreation through the national park, nature sanctuaries, and wildlife refuges. Of this suite, Monomoy represents the wilderness experience.

As described earlier, reaching the wilderness requires a strenuous several mile hike over soft sand or expert boat navigation. The journey, however, is worth it: one’s hike along the beach may be accompanied by gray seals bobbing out of the water with brazen and curious stares; at sunset, long

formations of cormorants fill the pastel sky. On a boat, the sea breeze and salt spray is invigorating as it gusts over choppy waves; the horizon is an expansive sky, accentuating the green fringe of the island and the glittering surf.

Once in the wilderness, visitors may explore the continuum of habitats. Over the years, users have created trails throughout the island in the natural ways that trails form, namely, the most direct route of least resistance. Without a steady tread of feet, the trails would fill-in with vegetation. Visitors on the trails or on the beach may spy wildlife or try their luck at recreational fishing. In addition, visitors are prohibited from hunting, camping, and making fires on the wilderness.

Outside of the wilderness boundary, commercial and recreational fishing regularly occur along with other coastal activities, such as kite surfing. Boat traffic is heavy during the summer: seal tours circulate South Monomoy as do fishing boats. Commercial, military, Coast Guard, and recreational aircraft sometimes fly low over the Monomoy Wilderness briefly interrupting a feeling of solitude or isolation.. Such solitude is also intruded upon by the characteristics of modern civilization on the close-at-hand mainland: within view of the wilderness are large stately houses and prominent water towers which sustain the mainland communities beneath them.

Nonetheless, the ocean side and interior wilderness give every indication that one is alone with nature.

[5] OTHER FEATURES OF THE WILDERNESS

A wilderness' future existence and significance evolves with the current flow of natural forces.



Photo Credit: USFWS

Although Monomoy has a lengthy history of human occupation, artifacts and cultural features are virtually nonexistent or lie undiscovered beneath the shifting sand.

The principal exception is the Monomoy Lighthouse. This forty-foot high, cherry-red tower, alongside the wood-shingled lightkeeper's house and brick oil shed, stands on one of two excluded portions of the wilderness of South Monomoy. The current Draft Comprehensive Conservation Plan recommends that these excluded portions become wilderness, in which case the lighthouse would become a cultural

feature. While a tall red tower is in stark contrast to the low lying dunes, it is a familiar and reassuring landmark; added to the National Register of Historic Places in the 1980's.

Section 3: Resources and Process

3.1 Documents Consulted

The following is a list of documents consulted to inform the wilderness character monitoring report.

Bureau of Land Management. Measuring Attributes of Wilderness Character: BLM Implementation Guide Version 1.4.

Giese, G. S., S. T. Mague, S. S. Rogers, and M. Borrelli. 2010. A Geomorphological Analysis of the Monomoy Barrier System. Prepared by Provincetown Center for Coastal Studies, Provincetown, MA. MRDGS.

Landres, P., et al. 2008. Keeping It Wild: An Interagency Strategy to Monitor Trend in Wilderness Character across the National Wilderness Preservation System. Gen. Tech. Rep. RMRS-GTR-212. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

U.S. Fish and Wildlife Service (USFWS). 1988. Environmental Assessment—Master Plan: Monomoy National Wildlife Refuge. Chatham, MA. 186 pp. USFWS, Hadley, MA. [AR, IC, 307-490] U.S. Department of the Interior, Fish and Wildlife Service, Region 5, Newton Corner, MA.

U.S. Fish and Wildlife Service. 2011. Monomoy National Wildlife Refuge: Field Season Biological Protocols and Permits.

U.S. Fish and Wildlife Service. 1967. Wilderness Area Proposal: Monomoy Island.

U.S. Fish and Wildlife Service. 1978. Wilderness Management Plan: Monomoy National Wildlife Refuge, Monomoy Wilderness.

U.S. Fish and Wildlife Service. 1967. Monomoy Island Wilderness Study Area: Monomoy National Wildlife Refuge Barnstable County, Massachusetts: Wilderness Study Report.

U.S. Fish and Wildlife Service. 2012. Working Monomoy National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Impact Statement. U.S. Fish and Wildlife Service, Hadley, Massachusetts.

3.2 People Consulted

The following is a list of staff and outside experts that were consulted in the process of identifying measures and researching Monomoy’s wilderness properties. Their time and effort is greatly appreciated.

Monomoy NWR Staff

Dave Brownlie, Refuge Manager
Kate Iaquinto, Wildlife Biologist
Matthew Boarman, Fish and Wildlife Biologist
Nick Ernst, Wildlife Biologist
Yianni Laskaris, Biological Technician

US Fish and Wildlife Staff

Rick Schauffler, Wildlife
Biologist (GIS specialist)

Outside Experts

Grahame Giese
Jesse Mechling

3.3 Process Used for Identifying Measures

To begin the wilderness character baseline assessment for Monomoy NWR, Wilderness Fellow, Taryn Sudol, spent the first week familiarizing herself with the wilderness area's ecology, threats to its character, historic land use, and staff management on site. This was accomplished through refuge literature including the 1988 Master Plan and the current draft of the Comprehensive Conservation Plan (CCP) as well as staff descriptions. Within the first week, the wilderness fellow also received a tour of the southern portion of South Monomoy's wilderness so that the extent of trails, invasive plants, abandoned village remnants in addition to numerous wildlife could be observed first hand.

With this foundation, the Fellow began developing draft measures for the monitoring report using past knowledge (the Fellow had completed a monitoring report for the Assateague Island wilderness prior to her assignment at Monomoy), completed reports from other wildernesses, and recommended measures devised by the National Park Service and Bureau of Land Management. At the end of the second week, the monitoring report's hierarchy design and the draft measures were discussed with the refuge manager, Dave Brownlie. The meeting included relevancy of draft measures, additional needs, and directions on possible data sources.

The next several weeks consisted of background research to provide context for the draft measures and developing protocols. Such research included the dynamics of shoreline change in Monomoy NWR, a record of Nor'easter events, the flow of marine debris and a visitor's solitude experience. This research and pursuit of data did occasionally cause the draft measures to be discarded, refined, or to devise new protocols. Some protocols were based in GIS, which required downloading data layers, data manipulation, and analysis.

Several of the measures required internal staff knowledge or professional judgment. For these measures, the Fellow organized several tables to be completed by the resident staff. These tables were circulated through email and given approximately three and half weeks to complete (That said, individual staff members took time off/vacation during that time, limiting their availability to complete the tables). One on one discussions were conducted with the staff biologist, which captured much of the report's professional judgment.

Throughout this time, the Fellow continued to read specific documents for Monomoy NWR such as the 1978 Wilderness Management Plan and Minimum Requirement Analyses. She also wrote sections of the report such as the "Setting of the Refuge" and "Wilderness Narrative." As context, protocols, and data were gained for the measures, these key features were also updated in the draft report.

The last significant discussion for the report consisted of what qualifies as a significant change as well as confidence (high, medium, or low) about the quality of the data and the overall condition of the measure for the wilderness. This discussion only made sense after data had been gathered for the measures. These decisions were then incorporated into the report. The report was then circulated for review, during which time the Fellow set up and entered the data into the Microsoft Access database.

Section 4: Framework for Wilderness Character Monitoring

The Wilderness Act mandates the “preservation of wilderness character.” Based off the legal description of the wilderness definition, the “Keeping It Wild” publication derived five specific qualities to support wilderness character: Untrammeled, Natural, Undeveloped, Opportunities for Solitude or Primitive and Unconfined Recreation and Other Features. This monitoring framework further divides the five qualities of wilderness character into successively finer elements. This hierarchy, from the top



down, is composed of qualities, monitoring questions, indicators, and measurements.

Qualities are the primary elements of the wilderness character that are directly related to the statutory language of the Wilderness Act.

Untrammeled –The Wilderness Act states that wilderness is “an area where the earth and its community of life are untrammeled by man,” and “generally appears to have been affected primarily by the forces of nature.” This quality is degraded by modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness. Any modern human action, authorized or unauthorized, that intentionally alters the wilderness is considered trammeling. This means that restraint in actions is a necessary tool in wilderness stewardship. An *action* for this monitoring report is an act or series of acts that purposefully manipulate the biophysical environment. Actions may degrade the untrammeled quality but have a desired impact on another quality.

Natural - The Wilderness Act states that wilderness should be free from the *effects* of “an increasing population, accompanied by expanding settlement and growing mechanization” and that the “earth and its community of life...is protected and managed so as to preserve its natural conditions.” This quality is degraded by intended

or unintended effects of modern people on the ecological systems inside the wilderness since the area was designated.

Native species’ communities and the structure and function of ecological systems within wilderness are meant to be protected. All ecological systems change over time and vary from one place to another. This monitoring is not intended to maintain static or unchanging natural conditions in the wilderness nor is one habitat composition more natural than another (if natural forces shaped them). Trends in the indicators may suggest the need for research or more intensive monitoring to verify the change and understand its cause.

Undeveloped –The Wilderness Act states that wilderness is “an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation,” “where man himself is a visitor who does not remain,” and “with the imprint of man’s work substantially unnoticeable.” This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport because these increase people’s ability to occupy or modify the environment.

Only non-recreational developments are measured under this quality, while recreational structures are measured under a different quality (to avoid double-counting). Some cultural developments may be an important part of wilderness character. These features are allowed to persist in the wilderness.

Solitude or Primitive and Unconfined Recreation –The Wilderness Act states that wilderness has “outstanding opportunities for solitude or primitive and unconfined type of recreation.” This quality is degraded by settings that reduce those opportunities, such as visitor encounters, signs of modern civilization, recreation facilities and management restrictions on visitor behavior. Solitude is meant to separate people from civilization. Primitive recreation relies on personal skills. Unconfined recreation is freedom from societal or managerial controls. Monitoring this quality assessment how the opportunity for people to experience is changing, not on how visitor experiences are changing.

Other Features – The Wilderness Act states that a wilderness “may also contain ecological, geological, or other features of scientific, education, scenic, or historical value.” This quality is degraded by the deterioration or loss of cultural resources integral to the wilderness character. Cultural resources may be damaged by natural disasters or humans.

Monitoring questions are major elements under each quality that are significantly different from one another, which are meant to frame particular management questions.

Indicators are distinct and important elements within each monitoring question. Each monitoring question typically has more than one indicator. There are a total of thirteen indicators. Every indicator must have a measure.

Measures are specific aspects of wilderness on which data are collected to assess the trend of an indicator. More than one measure can describe an indicator therefore providing management with a range of options to assess indicator trends. All measures for the Monomoy Wilderness will be summarized and described in detail in section five.

This hierarchy allows for national assessments of trends while still allowing flexibility for individual agencies and wildernesses to monitor the specific elements of wilderness character most meaningful to them. The Wilderness Act (P.L. 88-577, Section 7) requires the Secretaries of Agriculture and Interior to jointly report on the status of the National Wilderness Preservation System including descriptions of the areas, regulations in effect, and other pertinent information, together with any recommendations. This mandate necessitates individual wildernesses to monitor and assess wilderness character and report to the national level.

Baseline conditions must be set as a reference point against which change over time is measured and evaluated. Ideally, all baseline data would have been collected at the time of designation. Since few existing wildernesses actually have the data that extends back to designation for the measurements created at the time of the monitoring report, the initial condition assessment will be the substitute. For the Monomoy Wilderness, the baseline assessment year is FY 2012.

With the baseline in place, change can be monitored over time. The trend (improving, degrading, or stable) will be assessed based on what is determined as a significant change. If a significant change has occurred since the last monitoring point, a \uparrow is assigned for an increase, a \downarrow is assigned for a decrease and a \leftrightarrow for stable. These arrows translate into a numerical score: +1 for \uparrow , a -1 for \downarrow and a 0 for \leftrightarrow . These scores are summed together for the number of measures in each indicator to produce the trend for the indicator; the indicators' trends are summed for the monitoring question trend, the monitoring trends summed for the qualities' trend, and finally the qualities' trends summed for the overall wilderness character trend. If a +1 is added to a -1 this is an "offsetting stable". This process to compute the trend is automatically done in the wilderness character database when the measurement data is added at each monitoring period.

Section 5: Measures Selected for 2012 Wilderness Character Monitoring

This section provides the suite of measures selected to actively monitor wilderness character in FY 2012 for the Monomoy Wilderness. Each of the five qualities and their associated measurements has a sub-section. Each sub-section has a table which summarizes the monitoring questions, indicators, measures, and frequency of reporting for each quality. Secondly, each quality will have the detailed attributes for each of its measurements. The following outlines the general format and definitions of the attributes that describe each measure.

Definitions of Attributes of Measures	
Measure	A <i>measure</i> is a specific aspect of wilderness on which data are collected to assess the trend of an indicator. The measure being discussed is listed in this section
Indicator	An <i>indicator</i> is defined as a distinct and important element within each monitoring question. The indicator corresponding with each measure is specified in this section to provide context.
Context	The <i>context</i> describes why the measure is appropriate for the site and any background for understanding or interpreting trend in the measure.
Data Source(s)	The <i>data source(s)</i> provides information on where or with whom the data is located for reference. If the data source changes over time, this field should be updated with appropriate information.
Data Entry	The <i>data entry</i> specifies how often the data for the measure will be collected and entered into the database. Each data collection period (annually or every five years) contributes to the measure's trend over time.
Data Collection Process	The <i>data collection process</i> is the process used to compile or gather the data with as much detail as possible.
Significant change	A <i>significant change</i> provides information on what degree of change signifies a change in trend. This section also describes how a change in data would improve or degrade the quality or under what ranges the measurement is considered stable. A significant change can be defined as any change, a percent change, or other appropriate units.
Confidence	The <i>confidence</i> describes how the staff feel toward the accuracy or comprehensiveness of the data provided. It is ranked high, medium, or low.
2012 Data	The <i>2012 data</i> refers to the data being reported for the baseline year. This row will provide the data for the subsequent monitoring years as well.
Condition	The <i>condition</i> comments on the staff's general impression of the state of the wilderness with regard to the particular measurement. It is ranked as good, caution, poor, or unknown.

5.1 Untrammelled

Monitoring Question	Indicator	Measurement	Freq. of Reporting
What are the trends in actions that control or manipulate the "earth and its community of life" inside the	Actions authorized by the Federal land manager that manipulates biophysical the environment	Number of authorized actions to manage plants, animals, pathogens, soil, water or fire	Annually

wilderness?	Actions not authorized by the Federal land manager that manipulate	Number of unauthorized actions that manipulate the biophysical environment	Annually
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Measure 1.1	Number of authorized actions to manage plants, animals, pathogens, soil, water or fire																							
Indicator	Actions authorized by the Federal land manager that manipulates the biophysical environment																							
Context	An “action” is the implementation of an intentional decision to manipulate the biophysical environment. Large or significant actions taken within the wilderness trammels the biophysical environment. Predator control, prescribed burns, and animal capture for research/monitoring are trammeling, yet posting of signs or minimal set up of equipment is not significant. Some actions in the wilderness are accounted for in the management plan. Unforeseen actions will be added to the record as they occur. The tools, equipment, structures or transportation used in association with these actions will be included under the Undeveloped measurements.																							
Data Source(s)	Internal records																							
Data Entry	Annually																							
Data Collection Process	Actions are counted annually. The time spent on each activity (recorded as number of days that staff entered the wilderness and worked some period of time on the activity) is listed. It is assumed that the more time spent conducting the action, the more trammeling has occurred (this is not always the case, but is the easiest unit to tally and over a broad scale evens out). The days for each activity are summed together and compared year to year.																							
Significant Change	An increase of 20 days of trammeling per year of authorized trammeling degrades the measure. A 10 day decrease of trammeling improves the measure.																							
Confidence	High																							
2012 Data	<table border="1"> <thead> <tr> <th>Type of Actions</th> <th>Time Spent on Action Annually (Days)</th> <th>Area Affected</th> </tr> </thead> <tbody> <tr> <td>Lethal predator control (days with intent of shooting or setting up traps)</td> <td>50</td> <td>SMNY</td> </tr> <tr> <td>Rotation prescribed burning (burning, fire break, removing/installing grid PVC)</td> <td>6</td> <td>SMNY (35 acres)</td> </tr> <tr> <td>Color-banding AMOY (whoosh net)</td> <td>1</td> <td>NMNY (3 or 4 days of whoosh netting occurred outside the wilderness)</td> </tr> <tr> <td>Electric/ non-electrified fencing</td> <td>2</td> <td>NMNY</td> </tr> <tr> <td>Camp set up/break down</td> <td>4</td> <td>SMNY</td> </tr> <tr> <td>Hand capture (AMOY,</td> <td>41</td> <td>SMNY</td> </tr> </tbody> </table>			Type of Actions	Time Spent on Action Annually (Days)	Area Affected	Lethal predator control (days with intent of shooting or setting up traps)	50	SMNY	Rotation prescribed burning (burning, fire break, removing/installing grid PVC)	6	SMNY (35 acres)	Color-banding AMOY (whoosh net)	1	NMNY (3 or 4 days of whoosh netting occurred outside the wilderness)	Electric/ non-electrified fencing	2	NMNY	Camp set up/break down	4	SMNY	Hand capture (AMOY,	41	SMNY
Type of Actions	Time Spent on Action Annually (Days)	Area Affected																						
Lethal predator control (days with intent of shooting or setting up traps)	50	SMNY																						
Rotation prescribed burning (burning, fire break, removing/installing grid PVC)	6	SMNY (35 acres)																						
Color-banding AMOY (whoosh net)	1	NMNY (3 or 4 days of whoosh netting occurred outside the wilderness)																						
Electric/ non-electrified fencing	2	NMNY																						
Camp set up/break down	4	SMNY																						
Hand capture (AMOY,	41	SMNY																						

	ROST, COTE)		
	Horseshoe crab tagging	4	NMNY, SMNY
	Northeastern beach tiger beetle capture	2	SMNY
	Mist-netting	31	SMNY
	TOTAL	143	
	While no mechanical vegetation manipulation, herbicide applications or nest destruction occurred this year, if these actions occur in the future their days should be listed.		
Condition	Good		



Measure 1.2	Number of unauthorized actions that manipulate the biophysical environment
Indicator	Actions not authorized by the Federal land manager that manipulates the biophysical environment
Context	Actions may be taken on the islands without the authorization of the federal land managers. An unauthorized action is any action (see Measure 1.1) undertaken by any individual, group, or agency without specific approval by the authorized officer. The individuals, citizen groups, or agencies may take actions which are not necessarily violations but still trammel the environment. Likewise, not all violations are considered trammeling. In any case, the unauthorized action must intentionally trammel the environment. While certain actions such as littering or escaped campfires may manipulate the biophysical environment these consequences were unintentional so will not be included.
Data Source(s)	Staff observations
Data Collection Process	The type of unauthorized action will be listed and the number of occurrences each year. The number of occurrences will be summed and compared year to year. Some trammeling is strongly suspected to occur; for these types, the estimated averages are totaled and become part of the overall score.
Data Entry	Annually
Significant Change	More than 20 additional occurrences each year of unauthorized trammeling degrade the measure. Twenty fewer trammeling occurrences improve the measure.

Confidence	Medium –Some values are strong suspicions rather than known occurrences.	
2012 Data	Type of Action	Number of Occurrences
	Pets off leash (wildlife disturbance/ disease vector)	18 (suspected once per week June 1- Sept 30 2012)
	Commercial harvest of horseshoe crabs	7 (suspected once per week May 1-June 15 2012 –peak spawning season)
	Trespassing closed area (wildlife disturbance)	96 (suspected avg 4 times per week May 1- Oct 15 2012)
	TOTAL	121
Condition	Good	

5.2 Natural

Monitoring Question	Indicator	Measurement	Freq. of Reporting
What are the trends in terrestrial, aquatic, and atmospheric natural resources inside the wilderness?	Plant and animal species and communities	Community status index	Every five years
		Index of indigenous species status	Annually
		Population dynamics of selected non-native plant species	Every five years
		Population dynamics of selected non-native animal species	Every five years
	Physical Resources	Visibility	Every five years
		Ozone air	Every five years
		Total Nitrogen and total Sulfur deposition	Every five years
	Biophysical Processes	Mean Sea Level Rise	Every five years
		Days of high wind speed	Every five years
Days of high wave height		Every five years	

Measure 2.1	Community status index
Indicator	Plant and animal species and communities
Context	The suite of ecosystem types on Monomoy defines the landscape and thereby makes Monomoy unique. The ecosystem composition supports Monomoy’s diverse range of flora and fauna. This diversity of habitats protects wildlife resources as well as provides a variety of areas and species for public enjoyment, use, and understanding. Maintaining high quality ecosystems ensures that Monomoy’s natural wilderness character is being preserved.
Data Source(s)	Professional judgment (Kate Iaquinto 2012)
Data Entry	Every five years
Data Collection Process	The list of ecosystems has been derived from descriptions in the 2012 draft CCP. Each of the different ecosystems within the wilderness will receive a score based on ecosystem function and the biological community. The product of the ecosystem function and biological community will form the individual ecosystem score. The sum of all the ecosystems’ scores will be the measure score, which will be compared every five years.

The scores will be based on the following index:

Ecosystem Type/Location	Ecosystem Function Status	Biotic Community Status
	1 Ecosystem is functioning properly and not at risk	1 Native species composition is stable
	2 Ecosystem is functioning but is at risk	2 Nonnative species present but native species are persisting
	3 Ecosystem is not functioning	3 Nonnative species are outcompeting and reducing native species
		4 Native species are being extirpated

This measure assumes that these ecosystems should persist on the islands. Should a listed ecosystem in the future no longer exist on site, its score should remain a 12 in future years since losing this ecosystem is a loss of natural diversity. Also nonnatives may be noted in this index but this does not necessarily mean they will be listed in the nonnative measures.

Significant Change +/- 5 in the total score. If the total score increases by 5 points this degrades the measure. If the total score decreases by 5 points this improves the measure.

Confidence Medium

2012 Data	Ecosystem Type	Ecosystem Function Status	Biotic Community Status	TOTAL
	Sand/Mud flats	1	2	2
	Salt marsh	1	2	2
	Fresh water ponds	Unknown	2 (Mute Swans)	
	Open sand /beach	1	1	1
	Dune grasslands	1	1	1
	Upland interdunal	1	2	2
	Shrub lands	1	2	2
	TOTAL			10

Condition Good

Measure 2.2 Index of indigenous species status

Indicator Plant and animal species and communities

Context Monomoy provides key habitat for several species of state and federal concern. One purpose of the Monomoy NWR is to provide a wildlife sanctuary. The selected species below are intended to have a viable population size so that they may persist on the island.

Data Source(s) Monitoring data/professional judgment (Kate laquinto)

Data Entry Annually

Data Collection Process

MNWR staff monitors a selected set of species assuming budget and resources are available. Census and productivity information is collected annually for the listed species with exception of the northeastern beach tiger beetle for which peak adult counts are collected annually. Each year the staff will qualitatively evaluate the trend in nesting pairs/population number for the last five years and assign a 1 if the population is decreasing, a 2 if it is stable, and a 3 if it is increasing. Secondly, staff will calculate average productivity over the last five years and the standard error to compare this number to the corresponding productivity goal. If the average productivity falls within the standard error of the productivity goal, the productivity for that species is considered stable and is given a 2. If the average productivity plus the standard error remains below the productivity goal, it is given a 1 (decreasing). If the average productivity minus the standard error is above the productivity goal, it is given a 3 (increasing). The two scores are added for each species and then summed for an overall score.

Significant Change

ANY. The higher the measure score, the more improved the natural quality is. The lower the measure score, the more degraded the natural quality is –however, each species’ score should be looked at for changes. Any determined extirpation is significant. A change from improving to stable is insignificant. If a species is added to the list, its score should not contribute to the trend the first year but form a new baseline to be considered during the next monitoring period.

Confidence

High –Numbers actively being monitored

2012 Data

Nesting Pairs/ Population Number							
Species	2008	2009	2010	2011	2012	Status	Comments
Common Tern*	8162	4075	6647	7253	8106	2	2009 was a low year, but overall colony has levels we consider normal
Roseate Tern*	30	0	9	10	7	1	Since peak counts in 2007, numbers remain low.
Piping Plover**	27	34	33	41	39	3	
American Oyster catcher**	31	22	24	23	26	2	
North-eastern Tiger Beetle	X	X	X	800	2000	3	Numbers over 500 are considered stable though the population is currently dramatically increasing. (Only calculate average of last 2 years).

*Data collected from all islands (including Minimoy), and using the South Monomoy Lincoln Index number

**Data collected from all islands as a total count

Productivity

Species	2008	2009	2010	2011	2012	Avg/ St. Err	Goal	Status
Common Tern*	1.12	0.35	1.25	1.29	1.26	1.05 +/- 0.18	1.00	2
Roseate Tern*	1.00	0.00	0.90	1.43	1.40	0.95 +/- 0.26	1.00	2
Piping Plover	1.00	0.70	2.33	1.12	1.38	1.31 +/- 0.28	1.5	2
American oystercatcher	0.32	0.18	0.17	0.35	0.19	0.24 +/- 0.04	0.60	1

*Common tern productivity calculations are only for South Monomoy colony. Both tern productivity numbers are derived from A-period pairs.

Species	Population and Productivity Status
Common Tern	4
Roseate Tern	3
Piping Plover	5
American Oystercatcher	3
Northeastern Tiger Beetle	3
TOTAL	18

Condition Caution



Photo Credit: David Clapp

Measure 2.3 Population dynamics of selected nonnative plant species

Indicator Plant and animal species and communities

Context A wilderness area can provide protection for sensitive, native plant species. The presence of non-native plant species can shift the flora composition to a historically unnatural state. The proliferation of certain non-native plant species can out compete native species, resulting in a loss of diversity that makes Monomoy a distinct natural

location. As of 2012, *Phragmites australis* is the biggest invasive threat. Phragmites is a tall perennial grass that may exist in large monotypic stands. While Phragmites may provide cover or dune stabilization, it is inferior habitat compared to native grasses. Rugosa rose is used by herons for habitat and has not been removed. Other nonnative plants certainly exist in the Monomoy Wilderness but at this point in time are not considered a threat or present in large number.

Data Source(s)	Professional judgment (Kate Iaquinto)																						
Data Entry	Every five years																						
Data Collection Process	A list is compiled for selected non-native plant species. Scouting and vegetative surveys provide the acreage occupied for the selected non-native plants. This is limited to monotypic stands rather than interspersed species. The total measure will be the sum of each specie’s “Percent of acreage occupied” score.																						
	<table border="1"> <thead> <tr> <th>Species</th> <th>estimated percent of the wilderness on which it is found</th> <th>Score</th> </tr> </thead> <tbody> <tr> <td></td> <td>Very Low (or Spot) = <1%</td> <td>1</td> </tr> <tr> <td></td> <td>Low = 1-5%</td> <td>2</td> </tr> <tr> <td></td> <td>Moderate = 5-20%</td> <td>3</td> </tr> <tr> <td></td> <td>High = 20-35%</td> <td>4</td> </tr> <tr> <td></td> <td>Very High = 35-65%</td> <td>5</td> </tr> <tr> <td></td> <td>Extreme = >65%</td> <td>6</td> </tr> </tbody> </table>		Species	estimated percent of the wilderness on which it is found	Score		Very Low (or Spot) = <1%	1		Low = 1-5%	2		Moderate = 5-20%	3		High = 20-35%	4		Very High = 35-65%	5		Extreme = >65%	6
Species	estimated percent of the wilderness on which it is found	Score																					
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	Moderate = 5-20%	3																					
	High = 20-35%	4																					
	Very High = 35-65%	5																					
	Extreme = >65%	6																					
Significant Change	ANY. If the percent coverage score increases, then this degrades the measure. If the percent cover score decreases, this improves the measure.																						
Confidence	Medium –this estimation is based on professional judgment rather than vegetative surveys.																						
2012 Data	<table border="1"> <thead> <tr> <th>Nonnative Plant Species</th> <th>Percent Coverage Score of the Wilderness</th> </tr> </thead> <tbody> <tr> <td><i>Phragmites australis</i></td> <td>2</td> </tr> <tr> <td>Rugosa rose</td> <td>2</td> </tr> <tr> <td>TOTAL</td> <td>4</td> </tr> </tbody> </table>		Nonnative Plant Species	Percent Coverage Score of the Wilderness	<i>Phragmites australis</i>	2	Rugosa rose	2	TOTAL	4													
Nonnative Plant Species	Percent Coverage Score of the Wilderness																						
<i>Phragmites australis</i>	2																						
Rugosa rose	2																						
TOTAL	4																						
Condition	Good –Phragmites and rugosa rose are not anticipated to spread. While these nonnative plants are present, Monomoy currently is not highly vulnerable to invasive plants.																						

Measure 2.4	Population dynamics of selected nonnative animal species
Indicator	Plant and animal species and communities
Context	Several wildlife species’ population should be minimal or nonexistent on the Monomoy Wilderness based on their exotic origins and/or the strain they put of the ecosystem and/or threat they pose to native species. Certain species are actively being removed by management, which makes long term population estimates difficult. More certainty exists on whether selected nonnative species have been present within the last five years and the threat they pose to native flora and fauna. This measure, therefore, will list the nonnative species that pose a threat to native wildlife.
Data Source(s)	Professional judgment (Kate Iaquinto)
Data Entry	Every five years
Data Collection	A list of present, threatening nonnative species will be created every five years. For

Process	each listed species, it will be assigned a threat level. A level 1 threat means that the species was present and posed a threat in the last five years but has been controlled. A level 2 threat means the species is present in small numbers and has little impact on native species. A level 3 threat means the species is present in small numbers but is having a significant impact of native species. A level 4 threat means the species is present in high numbers and having a significant impact on native species. A level 5 threat means the selected species is having a large impact on native species and their population is unrestrained/growing. These threat levels are then totaled and this sum will be compared every five years.									
Significant Change	ANY. A higher score reflected a degradation to the natural quality, while a lower score shows an improvement.									
Confidence	Medium-Uncertain of mute swans impact									
2012 Data	<table border="1"> <thead> <tr> <th>Nonnative Animal Species</th> <th>Threat Level</th> </tr> </thead> <tbody> <tr> <td>Mute Swan</td> <td>2</td> </tr> <tr> <td>Eastern coyote</td> <td>3</td> </tr> <tr> <td>TOTAL</td> <td>5</td> </tr> </tbody> </table>		Nonnative Animal Species	Threat Level	Mute Swan	2	Eastern coyote	3	TOTAL	5
Nonnative Animal Species	Threat Level									
Mute Swan	2									
Eastern coyote	3									
TOTAL	5									
Condition	Caution									

Measure 2.5	Visibility
Indicator	Physical Resources
Context	Deciview is a cumulative index to express light extinction. In other words, deciview indicates the amount of visibility in the landscape. Ideally, a wilderness area will have skies clear of anthropogenic pollutants. Deciview measures the fine nitrates and sulfates in the air, the accumulation of which reduces visibility. Deciview is not measured on site for the Monomoy islands, so the nearest Deciview reading location will be used.
Data source	USFWS National Air Quality Office
Data collection process	Every five years the USFWS National Air Quality Office (Jill Webster in 2012) supplies the refuge with the latest air quality data (for 2012 the data spans from 2005 to 2009). For Monomoy the air quality data has been interpolated from the nearest air quality sites.
Data Entry	Every five years
Significant Change	For examining temporal changes, we cannot perform a rigorous statistical trend analysis on interpolated data (and for only 2 data points). Instead, we are assigning a trend based on an increase or decrease in the numerical values. Visibility (deciviews – dv): < 2 dv - Good 2-8 dv - Moderate > 8 dv - Significant Concern
Confidence	Medium
2012 Data	Group 50 Visibility minus natural conditions = 7.0 dv for 2005-2009
Condition	Moderate

Measure 2.6	Ozone air pollution
Indicator	Physical Resources

Context	Ozone can be a man-made air pollutant. It is capable of traveling long distances and so may be an unnatural presence in the Island wilderness.
Data source	USFWS National Air Quality Office
Data collection process	Every five years the USFWS National Air Quality Office (Jill Webster in 2012) supplies the refuge with the latest air quality data (for 2012 the data spans from 2005 to 2009). For Monomoy the air quality data has been interpolated from the nearest air quality sites.
Data Entry	Every five years
Significant Change	For examining temporal changes, we cannot perform a rigorous statistical trend analysis on interpolated data (and for only 2 data points). Instead, we are simply assessing whether the estimated value is increasing or decreasing. Ozone (parts per billion – ppb): <ul style="list-style-type: none"> < 60 ppb - Good 61-75 - Moderate > 76 - Significant Concern
Confidence	Medium
2012 Data	Ozone 4 th highest 8 hr= 79.8 ppb for 2005-2009
Condition	Significant Concern

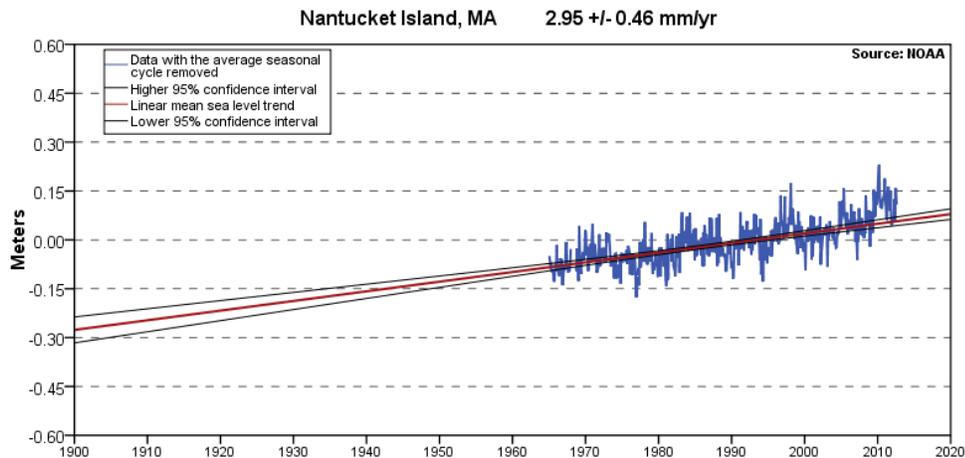
Measure 2.7	Total Nitrogen and Total Sulfur deposition
Indicator	Physical Resources
Context	Acid deposition is the concentration of sulfur and nitrogen in the rain or snow. High concentrations can be detrimental for algae, aquatic invertebrates, amphibians, fish, soil microorganisms, plants and trees.
Data source	USFWS National Air Quality Office
Data collection process	Every five years the USFWS National Air Quality Office (Jill Webster in 2012) supplies the refuge with the latest air quality data (for 2012 the data spans from 2005 to 2009). For Monomoy the air quality data has been interpolated from the nearest air quality sites.
Data Entry	Every five years
Significant Change	For examining temporal changes, we cannot perform a rigorous statistical trend analysis on interpolated data (and for only 2 data points). Instead, we are simply assessing whether the estimated value is increasing or decreasing. Total-N and S (based on wet deposition in kilograms per hectare per year – kg/ha/yr): <ul style="list-style-type: none"> <1 - Good 1-3 - Moderate > 3 - Significant Concern
Confidence	Medium
2012 Data	Total N= 3.2, Total S= 4.5 for 2005-2009
Condition	Significant Concern

Measure2.8	Sea level rise
Indicator	Biophysical resources
Context	Sea level rise is one of the most potentially serious consequences of climate change for Monomoy. Worldwide the oceans are experiencing global expansion and increased water

levels through the addition of melted glacial ice. Local impacts of global sea level rise can be influenced by land subsidence (if aquifers are drained), topography, and the presence of sea walls. Sea level rise can also influence the flow of sediment, which is a critical feature the islands' form and shape. Giese et al believe that the historic patterns of erosion and accretion will persist on Monomoy unless the IPCC maximum estimates are exceeded. Parts of South Monomoy, however, are considered highly vulnerable to sea level rise by the USGS. Sea level rise would cause a reduction of habitat areas including intertidal, salt marsh, and drier coastal uplands, thereby reducing shorebirds and coastal fish habitats.

Data	NOAA Tides and Currents.
Source(s)	http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8449130
Data Entry	Every five years
Data Collection Process	The mean sea level trend and a plot (from 1900 to 2010) shows the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. This data is taken from NOAA Tides and Currents at Nantucket Island, which is the nearest station to Monomoy.
Significant Change	At this point in time, sea level rise data will be collected but staff cannot yet comment on what amount of sea level rise would be considered unnatural. Long term trends over time may become more apparent. Staff discretion will be used every five years to determine the trend.
Confidence	Medium- site is at Nantucket, not Monomoy. Otherwise data collection is good.

2012 Data



The mean sea level trend is 2.95 mm/yr with a 95% confidence interval of +/- 0.46 mm/yr based on monthly mean sea level data from 1965-2006 which is equivalent of 0.97 feet in 100 years.

Condition	Caution-Trend shows increase in sea level since 1900.
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Measure 2.9	Hours of high wind speed
Indicator	Biophysical resources
Context	Storm events can influence the islands' shape in terms of shoreline and dune formation. Strong wind and waves can cause blow outs or overwash as well as erosion. Some meteorological models suggest an increase in storm events due to climate change, thereby exposing the island to possibly greater effects of high wind and powerful waves. Rather than quantify the number of storms, this measure will quantify how

	many hours in the past five years had wind speeds greater than 15 m/s or 35 mph.															
Data Source(s)	National Data Buoy Center –Station 44020 (LLNR 13665) Nantucket Sound http://www.ndbc.noaa.gov/station_page.php?station=44020 http://www.ndbc.noaa.gov/histsearch.php?station=44020															
Data Entry	Every five years															
Data Collection Process	Hours of wind speed can be gained each year by going to the second link in the data sources. This reaches the historical meteorological data search for station 44020. The year is selected then the criteria of “Wind Speed m/s” “>=” to “15”. This will produce an observation table. Record the Annual number of occurrences (this will be the number of hours) and the percent of records matching search criteria (this will tell if the top wind speeds are increasing over time. If the percentage increases then greater wind speeds likely make up the top percent). Click the detailed summary link and save as a textfile in the Wilderness folder of the P: Drive. Repeat for subsequent years. The hours each year will be averaged than compared each monitoring period.															
Significant Change	+/- 10% of the five year mean. If the five year mean (three year for baseline) increases by 10% since the last monitoring period this degrades the measure. If the five year mean (three year for baseline) decreases by 10% since the last monitoring period that degrades the measure.															
Confidence	Medium –Data used from Nantucket Sound rather than Monomoy															
2012 Data	<table border="1"> <thead> <tr> <th>Year</th> <th>Hours of Wind Speed >= to</th> <th>Percent of total records</th> </tr> </thead> <tbody> <tr> <td>2011</td> <td>96</td> <td>1%</td> </tr> <tr> <td>2010</td> <td>135</td> <td>2%</td> </tr> <tr> <td>2009</td> <td>52</td> <td>1%</td> </tr> <tr> <td>Average</td> <td>94</td> <td></td> </tr> </tbody> </table>	Year	Hours of Wind Speed >= to	Percent of total records	2011	96	1%	2010	135	2%	2009	52	1%	Average	94	
Year	Hours of Wind Speed >= to	Percent of total records														
2011	96	1%														
2010	135	2%														
2009	52	1%														
Average	94															
	Note: 2009 data did not include January and February															
Condition	Unknown –Three years show increase but not long enough time scale yet.															

Measure 2.10	Hours of High Wave Height
Indicator	Biophysical resources
Context	As described in measure 2.9, storms events may increase with climate change. Therefore, wind speeds and instances of large, powerful waves may increase with time. A wave height of 1.5 m suggests that it is capable of storm surges and erosion. Storm surges and erosion will shape the island and impact the available coastal habitats.
Data Source(s)	National Data Buoy Center –Station 44020 (LLNR 13665) Nantucket Sound http://www.ndbc.noaa.gov/station_page.php?station=44020 http://www.ndbc.noaa.gov/histsearch.php?station=44020
Data Entry	Every five years
Data Collection Process	Hours of 1.5 wave heights can be accessed by going to the second link in the data sources. This reaches the historical meteorological data search for station 44020. The year is selected, then the criteria of “Wave height (m)” “>=” to “1.5”. This will produce an observation table. Record the Annual number of occurrences (this will be the number of hours) and the percent of records matching search criteria (this will tell if the top wave heights are increasing over time). Repeat for subsequent years. Click the detailed summary link and save as a textfile in the Wilderness folder of the P: Drive. The hours each year will be averaged than compared each monitoring period.

Significant Change	+/- 10% of the five year mean. If the five year mean (three year for baseline) increases by 10% since the last monitoring period this degrades the measure. If the five year mean (three year for baseline) decreases by 10% since the last monitoring period that degrades the measure.		
Confidence	Medium –Data used from Nantucket Sound rather than Monomoy		
2012 Data	Year	Hours of Wave Height >= to 1.5	Percent of total records
	2011	143	2%
	2010	330	4%
	2009	111	2%
	AVERAGE	195	
	Note: January and February were not available for 2009		
Condition	Unknown –time scale not long enough yet.		

5.3 Undeveloped

Monitoring Question	Indicator	Measurement	Freq. of Reporting
What are the trends in non-recreational development inside the wilderness?	Non-recreational structures, installations, and developments	Index of authorized physical structures, installations, or developments	Annually
		Length of symbolic fencing	Annually
		Abandoned structures	Annually
		Inholdings	Every five years
What are the trends in mechanization inside the wilderness?	Use of motor vehicles, motorized equipment, and mechanical transport	Type and amount of administrative use of motor vehicles, motorized equipment, or mechanical transport	Annually
		Type and amount of motor vehicles, motorized equipment, or mechanical transport use not authorized by the Federal land manager	Annually

Measure 3.1	Index of authorized physical structures, installations, or developments
Indicator	Non-recreational structures, installations, and developments
Context	The wilderness area is meant to be free of man’s imprint on the landscape. Any significant man-made features therefore detract from the undeveloped quality. This measure consists of all functional physical structures, installations and developments that are currently within the wilderness including those present prior to designation and temporary structures. This includes significant unauthorized structures as these are currently not expected to be a problem in the future. This measure does not include recreational structures, or abandoned structures. These developments are included in subsequent measures. Furthermore, temporary symbolic fencing is being tracked in a separate measure.
Data Source(s)	Internal staff knowledge/documentation (Nick Ernst, Kate laquinto)
Data Entry	Annually
Data Collection	A list of structures, installations, and developments will be created based on inventories

Process already present in GIS as well as any unmapped features known to be on the ground. Each type of structure, etc. will be given a weight along with the fraction of the year it was in place. The number, weight, and fraction of the year will be multiplied. These products are then summed for a total. This total of structures, installations, and developments will be the measure for the five year monitoring period.

Significant Change +/- 5% An increase in the total is a degradation to the measure while a decrease in the total is an improvement to the measure.

Confidence High

2012 Data

Type of Structure	No. of structures	Weight	Time in Place	TOTAL
Field Camp	5	100	.2 (5/15-7/25)	100
Hard-side blinds	4	50	.81 (11/1-8/22)	162
Wooden chick shelters	200	1	.81 (11/1-8/22)	162
Wooden nesting structures (decoys, sounding system)	4 (3 decoys, 1 sounding system, 32 shelters)	10	.23 (5/31-8/22)	9.2
Predator exclosures	5	50	.23 (6/1-8/22)	57.5
Solar-powered electric fence	1	100	.37 (5/14-9/25)	37
Boat landing signs	2	100	1	200
Refuge regulation signs	1	50	1	50
Refuge boundary signs	10	10	1	100
Tern productivity plots	27	1	.25 (5/19-8/17)	6.75
Grid markers (rebar, PVC, flag)	46	5	.90 (11/1-9/26)	207
Middle markers (rebar)	37	3	1	111
TOTAL				1202.45

Condition Caution



Photo Credit: Sarah Tanedo



Photo Credit: Fumika Takahashi



Photo Credit: Carly Congdon



Photo Credit: Fumika Takahashi

Measure 3.2 Length of Temporary Symbolic Fencing

Indicator Non-recreational structures, installations, and developments

Context Symbolic fencing consists of posted signs connected by rope. This fencing does not allow visitors to access sensitive habitat, primarily for nesting waterbirds (Common terns, piping plovers and American oystercatchers). The amount of fence will change each year based off the number of nesting birds and where the nests are located. In general the fencing outlines the sensitive habitat facing the ocean, but does not continue to the islands interior. While the length of fence may be dependent on the birds, the type of fence (how many sign posts are used, what type of signage is used) is a management decision. Different types of fencing will be weighted to reflect the visible impact they have on visitors.

Data Source(s) Internal staff knowledge/GIS mapping

Data Entry Annually

Data Collection Process In 2012 the length of symbolic fencing was estimated based off the closed areas mapped in GIS. A new line polygon was drawn that traced the perimeter of the closed areas which faced the ocean (map shown below). The length of these drawn lines was then totaled to supply the 2012 data.
 In the future, the length of symbolic fence will be measured in the field.
 Weight for different type of symbolic fence:
 U-post Only -3
 Combination -2
 Fiber Rod post-1

Significant Change +/- 10%. If the total score increases by 10% each year this degrades the measure. If the total score decreases by 10% each year this improves the measure.

Confidence Medium

2012 Data	Area of Fencing	Length of fence	Weight for fence type	Time in place	TOTAL
	North Monomoy	6696 m	3	1	20088
	Area A	2128 m	3	1	6384
	Overwash	2676 m	3	1	8028
	South of overwash/lower SMNY	4192 m	3	1	12576

	TOTAL	15692 m			47076
Condition	Caution				

Measure 3.3	Abandoned structures				
Indicator	Non-recreational structures, installations, and developments				
Context	<p>Man has been historically present on Monomoy. Native Americans gave way to early colonists who remained for seasonal fishing and recreation. Monomoy became an outpost for lighthouses and life-saving stations with the Life Saving Service and then the U.S. Coast Guard. It also served as a military site before becoming a national wildlife refuge. Throughout these centuries, countless structures have been built and then abandoned. Even as a refuge, posts and signage may remain after serving their function. As of 2012, staff is aware of a telephone pole and chimney by hospital pond, a chimney at powder hole, two building foundations, a brick cistern, three-day markers, two lights run by harbor master, buried cars, bird houses, old posts from old signage, and abandoned posts and enclosures. Over time these abandoned structures may be obscured—buried under sand, hidden by vegetation, or naturally decomposed, making abandoned structures difficult to quantify. For this reason, this measure does not seek to account for the abandoned structures present but to monitor actions taken to remove abandoned structures or when existing structures have been abandoned. Marine debris is included in this measure because trash that washes up onshore is typically left in place. Removing marine debris through beach clean ups helps reduce the amount of abandoned, structures.</p>				
Data Source(s)	Internal records				
Data Entry	Annually				
Data Collection Process	<p>A list will be provided of any significant undertaking to remove abandoned structures from the wilderness. Any actions to remove abandoned structures will receive a + 1 (this does not include removing temporary structures off the island each season, but does include beach clean ups). When structures are knowingly left/abandoned on the island, these actions will receive a -1 (this does not include popsicle sticks/tongue depressors used for tern nesting monitoring). If events differ in magnitude they can be given a higher or lower score so long as the scores are relative to one another. The actions will be summed and compared every five years.</p>				
Significant Change	<p>If the sum of actions is positive, this improves the measure. If the sum is negative, this degrades the measure. If no actions occur the measure is stable. It is not necessary to compare to previous monitoring periods in the report.</p>				
Confidence	High confidence of objects removed.				
2012 Data	Event	Date	Added or Removed?		
	Beach clean up	September 17, 2012	+1		
Condition	Good				



Photo Credit: Taryn Sudol

Measure 3.4	Inholdings				
Indicator	Index of inholdings with wilderness				
Context	An inholding is any non-federal land within the wilderness boundary. It does not include cherry-stemmed parcels or external edge-holdings that may be acquired in the future. While inholdings existed at the time of the wilderness proposal, those rights have all since expired and been transferred to FWS. At the time of this baseline assessment, there are no inholdings on site nor is there any foreseeable property that may become inholdings. Some of those former inholdings are included in the abandoned structure measure.				
Data Source(s)	Internal inventory				
Data Entry	Every five years				
Data Collection Process	A count of each inholding and its acreage				
Significant Change	ANY change in the number of inholdings is significant. More inholdings degrade the measurement while fewer inholdings improve the measurement.				
Confidence	High				
2012 Data	Number of Inholdings and Their Acreage in the Monomoy Wilderness				
	<table border="1"> <thead> <tr> <th>Inholding</th> <th>Acreage</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> </tr> </tbody> </table>	Inholding	Acreage	0	0
Inholding	Acreage				
0	0				
	There are no inholdings in Monomoy in 2012.				
Condition	Good				

Measure 3.5	Type and amount of administrative use of motor vehicles, motorized equipment, or mechanical transport
Indicator	Use of motor vehicles, motorized equipment, and mechanical transport
Context	“Motor vehicles” are any machines used to transport people or material across or over land, water, or air, and powered by the use of a motor, engine, or other nonliving power source. This includes, but is not limited to, ATVS, motor boats, trucks and aircraft that either land or drop off or pick up people or material (i.e., not aircraft that merely fly over the wilderness). Motor boat transportation to Monomoy is not counted as a motor vehicle use because it only marginally enters the wilderness boundary and it would be infeasible to tell when the boats are within or outside the boundary.

“Motorized equipment” are any machines not used for transportation by powered by a motor, engine, or other nonliving source. This includes, but is not limited to, machines such as chainsaws and generators. It does not include small hand-carried devices such as shavers, wristwatches, flashlights, cameras, etc.

“Mechanical transport” refers to any contrivance for moving people or material in or over land, water, or air, having moving parts, that provides a mechanical advantage to the user, and powered by a living or non-motorized power source. This includes, but is not limited to, sailboats, bicycles, game carriers, carts, and wagons. It does not include wheelchairs when used as necessary medical appliances. It also does not include rafts, canoes, or similar primitive devices without moving parts.

Data Source(s) Staff records/knowledge (Dave Brownlie, Kate laquinto)

Data Entry Annually

Data Collection Process Use of motorized vehicles and equipment and mechanical transport is recorded based on activity, the number of times it was used (a “time” means it entered and exited the wilderness. A time does not exceed one whole day in length, but otherwise this does not indicate the length the vehicle or equipment was in use) and weight assigned to the type of machinery/transport. The weight is multiplied by the number of times each thing was used. The products are summed by activity and then all activities are summed for the total score.

Significant Change +/- 5 of total score. Each year if the total score increases by 5 this degrades the measure. If the total score decreases by 5 this improves the measure. (This year showed exceptional use of motorized vehicles. Most years will track wheeled carts. If ever a motorized vehicle is used in the wilderness this is significant.)

Confidence Medium –some estimations used.

2012 Data	Activity	Times motorized vehicle was used	Weight	+	Times mechanical transport was used	Weight	+	Times motorized equipment was used	Weight	Total
	Light station drywall				Wheeled cart- 10	1				10
	Light station restoration	Jeep 30 Back hoe 30	Jeep-50 Backhoe -100							4500
	Cart transport				Wheeled cart -20	1				20
	TOTAL									4530

Condition Poor –this year motorized vehicles traversed through wilderness as part of historic lighthouse structure restoration

Measure 3.6 Type and amount of unauthorized use of motor vehicles, motorized equipment, or mechanical transport

Indicator Use of motor vehicles, motorized equipment, and mechanical transport

Context Refer to measure 3.5 for motor vehicle, motorized equipment, and mechanical transport definitions. The use of these devices by any individuals, citizen groups or unauthorized Federal

and state agencies will be listed here. The awareness of unauthorized use depends in part on the amount of monitoring and patrolling (which has its own wilderness impacts). On Monomoy, there is potential for unauthorized motorized equipment use while shell fishing on certain parts of the island as well as mechanical transport. Since staff strongly believe these activities are occurring the estimations are included in the measure.

Data	Staff observation									
Source(s)										
Data Entry	Annually									
Data Collection Process	Motor use and mechanical transport by unauthorized persons will be organized by the type of activity and the corresponding motor use and mechanical transport involved. For example, shellfishing may involve one motorized pump and a cart, which sums to two. All of the activities' sums will be totaled and this value will be compared year to year.									
Significant Change	+/- 50 uses. If staff suspect/know 50 more unauthorized uses occur each year, then this degrades the measure. If staff suspect/know 50 less unauthorized uses occur each year, then this improves the measure.									
Confidence	Medium –patrolling of unauthorized activities is limited to chance observations.									
2012 Data	Activity	Times motorized vehicle was used	Weight	+	Times mechanical transport was used	Weight	+	Times motorized equipment was used	Weight	TOTAL
	Shell fish harvest				Wheeled cart -200	1				200
Condition	Caution									

5.4 Solitude or Primitive and Unconfined Recreation

Monitoring Question	Indicator	Measurement	Freq. of Reporting
What are the trends for outstanding opportunities for solitude within the wilderness?	Remoteness from sights and sounds of people inside the wilderness	Number of Visitors	Annually
	Remoteness from occupied and modified areas outside the wilderness	Viewshed	Every five years
		Water craft traffic	Every other year
		Night sky visibility	Every five years
What are the trends for outstanding opportunities for primitive and unconfined recreation inside the wilderness?	Facilities that decrease self-reliant recreation	User-created recreation facilities	Every five years
	Management restrictions on visitor	Index of management restrictions	Every five years
		Percent of land restricted from visitor use	Annually

Measure 4.1	Number of visitors				
Indicator	Remoteness from sights and sounds of people inside the wilderness				
Context	<p>While a feeling of solitude is subjective for each individual, this measure assumes that a greater number of visitors likely increase the chances for individual to individual (or group to group) encounters. Being within the sight and sound of people inside the wilderness may disrupt the sense of solitude and isolation from others. Should a visitor seek a wilderness setting, he/she is meant to have an opportunity to experience solitude.</p> <p>Visitor use on the Monomoy islands has only been observed, not measured. Weather and navigability influence access to the islands by boat. If the islands are connected to the mainland, like South Monomoy currently is, foot access is also possible.</p> <p>Visitors to Monomoy fish, sight-see, go birding, hike, photograph, or relax on the beach. These activities and the influx of visitors are highly seasonal and variable day by day.</p>				
Data Source(s)	Professional judgment (Dave Brownlie, Kate Iaquinto, Matthew Boarman, Nick Ernst)				
Data Collection Process	<p>For 2012, the amount of visitors will be organized by season and estimated by a range. Each staff member independently supplied an estimated range then sat together to agree on a single range for the measurement.</p>				
Significant Change	+/- 50 per week. If staff estimate/record 50 more visitors per week over all seasons combined occur each year, then this degrades the measure. If staff estimate/record 50 less visitors per week occur over all seasons combined each year, then this improves the measure.				
Confidence	Low –these are estimates.				
2012 Data		Winter (Nov-Mar)	Spring (Mar – May)	Summer (June – Aug)	Fall (Sept – Oct)
	Number of visitors	<5 per week	2-10 per week	20-100 per week	10-50 per week
Condition	Good –overall				

Measure 4.2	Viewshed				
Indicator	Remoteness from occupied and modified areas outside the wilderness				
Context	<p>Visitors to the wilderness are meant to feel isolated in nature and therefore should only see a natural landscape. Visible developments outside of the wilderness boundary detract from a feeling of solitude. This measure tracks to what degree the viewshed is developed as observed from within the Monomoy Wilderness. The degree of development is determined by the latest land use cover data supplied by the state of Massachusetts. The viewshed is determined by the topography and height of different structures/ vegetation. The viewshed is also influenced daily by weather. For the purposes of this study, sophisticated analysis that included topography proved too difficult. Instead general assumptions of length or limits of the mainland Cape Cod shoreline is visible and how far interior from that shoreline were made. Staff believe visitors can see to West Yarmouth Point and can see 200 feet interior to that. Land use within that area is then determined and categorized as Developed, Altered by man but</p>				

	not developed and Natural.								
Data Source(s)	MASS GIS layers: land use and state outline. http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/layerlist.html								
Data Entry	Every five years								
Data Collection Process	In 2012, the wilderness fellow created a viewshed polygon shapefile by created a 200 ft interior buffer around the state outline polygon. This polygon was then clipped to a polygon created by the wilderness fellow that truncated the state to the West Yarmouth land spit before Lewis Bay and Chatham. This is then the viewshed area. The downloaded land use shapefile was then clipped to the viewshed area. The attribute table was then opened for the land use/viewshed polygon. Data was sorted by land use then the acreage was summed for each land use (Check that units are in acres. Select all parcels of a particular land use then right-click statistics under the area column to get the acres sum for the selected parcels). Land use was then categorized as Developed, Man-altered, and Natural. Refer to Appendix D to see how these were categorized. The acreage was summed for each category to find the percentage. In the future staff must download the latest land use data (post-2005) for the Cape then clip that to the viewshed polygon already created. Acreages per land use will need to be compiled and then the land uses must be categorized to find the percentage.								
Significant Change	If there is an increase of 10% of developed lands in the viewshed or a decrease of 10% of the natural areas, this degrades the measure. If there is an increase of 10% of the natural area or a decrease of 10% of the developed lands, this improves the measure.								
Confidence	Low –Estimated viewshed likely inaccurate and land use data dates back to 2005.								
2012 Data	<table border="1"> <thead> <tr> <th colspan="2">Viewshed</th> </tr> </thead> <tbody> <tr> <td>Developed</td> <td>31.35%</td> </tr> <tr> <td>Areas altered by man</td> <td>3.23%</td> </tr> <tr> <td>Natural</td> <td>65.43%</td> </tr> </tbody> </table>	Viewshed		Developed	31.35%	Areas altered by man	3.23%	Natural	65.43%
Viewshed									
Developed	31.35%								
Areas altered by man	3.23%								
Natural	65.43%								
Condition	Good								

Measure 4.3	Watercraft Traffic
Indicator	Remoteness from occupied and modified areas outside the wilderness
Context	Monomoy’s surroundings waters are actively used for fishing and recreation. Watercrafts, primarily motorboats, are frequently within a wilderness visitor’s view or hearing. This disrupts a sense of solitude or isolation from civilization. Admittedly many visitors to Monomoy access the wilderness by boat so their presence may be somewhat tolerated or accepted. Ideally, however, a minimal amount of watercraft should be within sight or sound whilst visiting Monomoy.
Data Source(s)	Staff observation/ internal reporting
Data Entry	Annually
Data Collection Process	A snapshot of watercrafts will be gained through staff observations while enroute to the wilderness. Passengers on the USFWS motorboat will count the number of water craft seen (organized by type), whether the different types of water craft are stationary or in transit, and the number of water craft heard but not seen. They will also record the day and the route for their boat trip. The distance for each route taken can be calculated through the distances mapped in the Boat_Shape shapefile. The count for

each boat trip along with the distance and day is then added into an Excel spreadsheet. The number of water craft seen and heard will be summed and divided by the distance traveled for average number of watercraft seen/heard per mile. This average will be compared each monitoring period. Additionally, this spreadsheet can be sorted by weekday, weekend, and season to analyze temporal patterns or differences. Further analysis can be done of the distribution of the types of watercraft seen or the difference between heard and seen.

Significant Change +/- 1.5 watercraft per mile. If the watercraft seen per mile increases by 1.5 (as an average of the whole year) (approximately 2.5 watercraft per mile), then this degrades the measure. If in future years the number of water craft per mile decreases by 1.5 then this improves the measure.

Confidence Medium –Only a snapshot but fairly high frequency

2012 Data		Distance	Watercraft
	Total	33.24	30
	Average	0.90 watercraft/mile	

Condition Caution

Measure 4.4 Night Sky Visibility

Indicator Remoteness from occupied and modified areas outside the wilderness

Context Light pollution by artificial light sources reduces visibility of stars and nebulae. As light pollution increases only the brightest stars remain visible. A visible night sky can be associated with feelings of humility and being part of something larger. Also, light pollution can disorient wildlife.

Monomoy has limited control of light pollution from the surrounding areas but they may work with local communities. Given the seasonality of residents and tourism on Cape Cod, staff suspects night sky visibility may change between the summer (peak visitor season) and other times of year. If more people on the Cape leads to greater light pollution, this visibility may be affected. Based on how many stars are visible on a clear night, the refuge can estimate night sky visibility and compare over time.

Data Source(s) Staff observation (Keegan Tranquillo, bird bander, in 2012). Protocol derived from GLOBE at Night. http://www.globeatnight.org/observe_magnitude_orion.html

Data Entry Every five years

Data Collection Process An hour after sunset on a clear night, a staff/volunteer will travel to point within the wilderness (outside of field camp) and locate the Orion constellation. The amount of visible stars associated with this constellation will be compared to magnitude charts provided by GLOBE at Night. The visible constellation most similar to whichever magnitude chart (1-7) will receive that magnitude chart score. The higher the magnitude score, the better night sky visibility. Higher night sky visibility increases the remoteness of people within the wilderness.

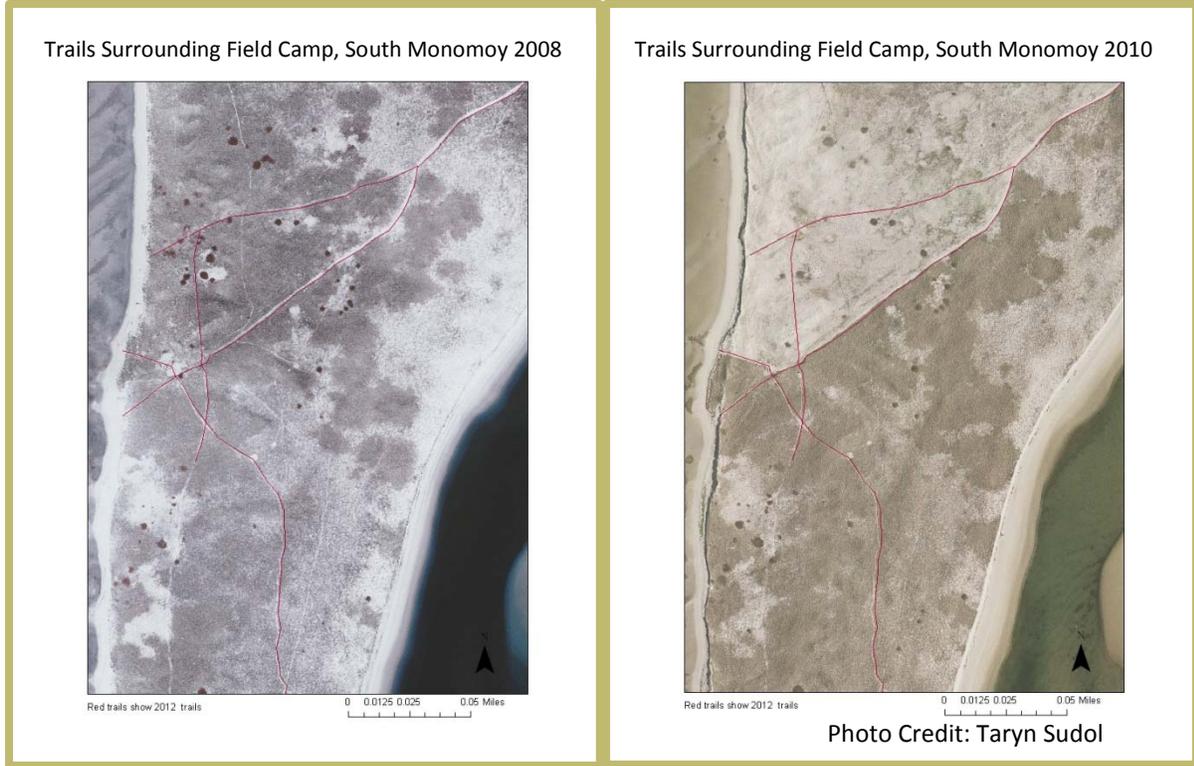
Given the seasonality of visitors on the Cape, this measure will be taken during the summer and at some point during the off season. These two magnitude scores will be averaged. This average will be compared every monitoring period.

Significant Change ANY change in the magnitude score is significant. If the magnitude score increases since the last monitoring data point, this improves the measurement. If the magnitude score decreases, this degrades the measurement.

Confidence High

2012 Data	On October 17, 2012 bird bander Keegan Tranquillo attempted the night sky protocol. While he was unable to locate the Orion constellation, he judged the amount of stars to be a magnitude 6 . On other days, when it was closer to morning or the moon was bright, night sky visibility was reduced to a magnitude 3 or 4.
Condition	Good

Measure 4.5	User-created Recreational Facilities				
Indicator	Facilities that decrease self-reliant recreation				
Context	<p>Recreation facilities reduce the feeling of primitive recreation, which is meant to be provided in a wilderness setting. Even though some visitors may enjoy or appreciate facilities, they are inconsistent with primitive recreation.</p> <p>While recreationists have the potential to create a variety of recreational facilities, the most commonly created are trails. A hiker gets from A to B with the least resistance, and if this route is repeated often enough by multiple people, a narrow foot path forms. These paths can damage native vegetation and fragile dune systems. Fire breaks are included since they also serve as trails on South Monomoy and even if not used repeatedly as trails they have a similar impact on the environment. If camp fires rings or campsites are observed in the future, they should be included. At this time no authorized recreation facilities exist nor are any intended to be provided. If user-created recreational facilities become frequent and damaging, authorized recreational facilities may be created. If this were to happen a new measure for authorized recreational facilities should be created.</p>				
Data Source(s)	On the ground observations, aerial photography, GIS mapping.				
Data Entry	Every five years				
Data Collection Process	A count of recreational facilities is completed as a list. Trails are identified and measured through mapping in GIS. Trails should be measured in miles in order to be compared to a number of facilities. Different facilities/trails can be weighted in the future.				
Significant Change	+/- 0.25 mile. If trails increase by 0.25 miles each year then this degrades the measure. If trails are reduced by 0.25 each year then this improves the measure.				
Confidence	High- length of trails derived through aerial photography and GIS. Other facilities expected to be nonexistent.				
2012 Data	Type of facility	No. of facilities	Length of facility	Weight	TOTAL
	Trails		2.83 miles		2.83 miles
Condition	Good				



*A close look at the above trail pictures show that if trails are not maintained or foot traffic is not steady, vegetation will fill in the narrow trails within two years' time.

Measure 4.6 Index of management restrictions

Indicator	Management restrictions on visitor behavior
Context	Being in a wilderness should provide an opportunity to experience freedom or to feel unconfined. Restrictions on activities will be tracked as degradation to unconfined recreation. While regulations in most cases serve to protect resources in the wilderness, a decrease in the level of restrictions indicates an improvement in unconfined recreation.
Data Source(s)	Internal staff knowledge of management policies.
Data Entry	Every five years
Data Collection Process	A score will be given to Monomoy based on the type of restrictions. These restrictions will be organized by category and the score assigned based on if there is no regulation or total prohibition. The higher the sum of the scores the more restrictions exist in the wilderness.

Category	Type of Restriction	Score
Camping	No Restriction	0
	Designated site or mandatory setback	1
	Total prohibition	2
Campfires	No Restriction	0
	Any mandatory setback (e.g. designated site)	1
	Total prohibition	2
Permits	Permit Not Required	0

	Permit Required	2
Fees	No Fees	0
	Fees charged of selected user type	1
	Fees charged of all visitors	2
Length of Stay	No restrictions on length of stay	0
	Length of stay limited	1
Group size limits	No restriction	0
	Group size limits in place	1
Leash requirement	No restriction	0
	Pets required to be on leash	1
	Total prohibition	2
Hunting Restrictions	No restriction	0
	Designated Season	1
	Total prohibition	2

Significant Change ANY change. Management policies are generally set and unchanging. Any deviation from current policies would be significant. An increase in the score degrades the measure while a decrease improves the measure.

Confidence High

2012 Data	Management Restriction	Score
	Camping	2
	Campfires	2
	Permits	0
	Fees	0
	Length of Stay	1
	Group Size limits	1
	Leash Requirement	2
	Hunting Restrictions	2
	TOTAL	10

Condition Caution

Measure 4.7 Percent of land restricted from visitor use

Indicator Management restrictions on visitor behavior

Context If areas of the wilderness are closed off then a restriction is imposed on visitor behavior and recreationists are confined to other (smaller in total) areas. This measure focuses on the percent of wilderness closed to public access over a certain number of days. Areas most commonly closed off to visitors are biologically sensitive, such as the tern colony or nesting bird habitat. While visitors are restricted from these areas, it benefits native wildlife and biotic diversity.

Data Source(s) Mapped GIS areas.

Data Entry Annually

Data Collection Process Each year staff closes off sections of Monomoy for nesting shorebirds. These areas are then mapped in GIS. The sum of the acreage for these closed off areas is then divided by Monomoy's total wilderness area. This quotient is the measure's score.

Significant +/- 1% of the wilderness. If the total amount of closed areas affects an additional 1% of

Change	the wilderness this degrades the measure. If the total amount of closed areas affected less than 1% of the previously closed wilderness area this improves the measure.
Confidence	Medium –The mapped closure areas included more area than was on the ground. Admittedly, the restricted areas are blocked by one line of signs rather than a closed off polygon, making total closure areas subjective to map and unclear to the visitors. That said, there does not appear to be a problem with unauthorized visitor entry into closed areas.
2012 Data	Within the wilderness (2,770 acres), 470 acres were estimated to be closed or 17% of land was restricted from visitor use. Areas closed included North Monomoy, except for the corridor, the tern colony on South Monomoy and Piping Plover nests.
Condition	Good –Closures take place only for wildlife that benefit from minimal human disturbance

5.5 Other Features

Monitoring Question	Indicator	Measurement	Freq. of Reporting
Other Features	Deterioration or loss of cultural resources integral to wilderness character	Number of actions that affect cultural resources (looting, trespass activities, non-compliance with NHPA)	Every five years

Measure 5.1	Number of actions that affect cultural resources								
Indicator	Deterioration or loss of cultural resources integral to wilderness character								
Context	Certain sites in the wilderness have cultural significance. Any damage or disturbance of these sites, including unauthorized activities such as looting, would result in a loss of Monomoy’s wilderness character. If actions are taken to preserve or restore these cultural sites, this will improve the measurement. If any cultural feature emerges in the future, any damages or preservation actions to it must also be tracked.								
Data Source(s)	Staff knowledge								
Data Entry	Annually								
Data Collection Process	A list of actions which either intentionally or accidentally affect cultural resources is created. If the activity is damaging it will receive a negative score. If the activity preserves or restores the site it will receive a positive score. The sum of the activities will be tracked during the five year monitoring period.								
Significant Change	ANY. If more actions damage cultural resources this degrades the measure. If fewer actions damage resources, or if more actions restore cultural resources, then this improves the measure.								
Confidence	High –can’t completely know if unauthorized damage occurred but don’t suspect it this year.								
2012 Data	<table border="1"> <tr> <th>Action</th> <th>Date</th> <th>Restored or Damaged?</th> </tr> <tr> <td>0</td> <td></td> <td></td> </tr> </table>	Action	Date	Restored or Damaged?	0				
Action	Date	Restored or Damaged?							
0									
	No known actions affected cultural resources in the wilderness in 2012.								
Condition	Good								

5.6 Measures Under Development

Measure	Time spent within sight and sound of persons in wilderness
Indicator	Remoteness from sights and sounds of people inside the wilderness
Context	Should a visitor seek a wilderness setting, he/she is meant to have an opportunity to experience solitude. Being within the sight and sound of people inside the wilderness may disrupt the sense of solitude and isolation from others. Visitor use on the Monomoy Islands is not uniform geographically or temporally. Tourism and recreation is generally much higher in the summer and tends to concentrate on the bayside beaches or by the lighthouse. At other interior locations or during the off season a visitor may be alone the majority of their time spent there. This measure intends to determine how often a visitor would be in sight or sound of others while walking an expanse of the wilderness.
Data Source(s)	Staff observation
Data Collection Process	A staff member or intern, such as the visitor services intern, will walk the length of a designated trail segment (TBD). As they walk the trail, the observer will record the time it takes to walk from start to finish. While on the route, how long were people visible and at what distance. Distance will be judged on a scale of 1 to 3 with 1 being visible but further than a football field, a 2 being within call distance or 100 feet, and 3 being proximal or a direct encounter. Should the recorder see someone in the distance but then approach them on a trail, he/she should measure the time the people were at a 1 then the time spent at a 2 and lastly the time spent encountering the people at a 3. In some instances, other visitors may be seen but not heard. In this case, the recorder should measure the length of time they heard voices/human activity, and assign a 1 if the voices are heard but indistinguishable and a 2 if the conversation/words can be clearly understood. At the end of the route the recorder will total the recorded time spent within sight and/or sound of others and divide this by the time of the route (ex. 45 minute spent within sight or sound on a 120 minute walk). This fraction will then be multiplied by the sum of the scores. This final number will be compared year to year. The walk must be done multiple times per month to account for day to day variability.
Significant Change	
Confidence	
Condition	
Measure	Aircraft activity over the wilderness
Indicator	Remoteness from occupied and modified outside areas the wilderness
Context	Aircraft over flights may cross the Monomoy islands for multiple reasons. Airliners may be high in the clouds, but other lower flying aircraft may cross for research, public safety, or recreation. Low flying aircraft can disrupt the tern colony. Other types of aircraft may pass Monomoy for multiple reasons. Additionally these flights can cause a visual and audible disruption to a visitor's solitude experience.
Data Source(s)	Staff observation
Data Entry	Annually
Data Collection Process	While at the field camp, a staff member/intern will be assigned to keep track of flights throughout the field day. For each flight seen, the recorder should measure the amount

of time in view (in minutes) and its distance based on a score. A score of 1 is an aircraft at very high altitude –it is more of a white dot, the aircraft’s wings or tail or propellers are not distinguishable. A score of 2 is an aircraft (likely an airliner) at high altitude with wings and tail visible. A score of 3 is a low flying aircraft. If a flight is seen but not heard, it will be given a score of 2 or 3, with 2 being more of a hum and 3 being a roar. The time spent within sight or sound of aircrafts will be totaled for the day and divided by the time spent in the field. This will then be multiplied by the total score. (If the numbers are too small, bump up the scores to 10, 20, or 30).

**Significant
Change**

Confidence

Condition

Measure **Marine debris on the island**

Indicator Remoteness from sights and sounds of people inside the wilderness

Context The presence of marine debris (or trash from littering) distracts from a wilderness visitor’s interaction and view of the natural environment. Debris and litter may furthermore endanger wildlife. No debris or a minimal amount contributes to an ideal wilderness experience, while the visible presence of debris reduces the sense of isolation from civilization.

Data Source(s) Staff survey

Data Entry Annually

**Data Collection
Process** The monitor walks two half mile transects, one of the west coast, facing Nantucket Sound, and one on the east coast, facing the Atlantic Ocean. These trail routes occur on the northern part of South Monomoy and are mapped in GIS as “Marine Debris Transects.” The monitor will walk the transects after high tide following the high tide line. They note and collect any man-made materials observed within a 30 ft swath of the high tide line (if debris is seen but is too heavy to carry, the monitor will try to move the debris outside of the 30 ft swath. Collecting or moving the debris is to prevent double counting). Type, quantity, and weight of the collected materials will be logged on a data sheet, and the collected debris disposed of. The monitor will conduct this survey three times a year: One at the end of summer, one at the beginning of summer, and one during the winter. The difference between the beginning and end of summer may reflect whether the material is litter (directly dropped on beach by visitors) or marine debris (washed ashore from the ocean). A survey is conducted in the winter because during high precipitation events nearby municipalities may have their storm sewers overwhelmed, causing a release of debris. Quantity and weight will be listed for each period and compared year to year.

**Significant
Change**

Confidence

Condition

5.7 Measures Not Used

Measures Not Used			
Quality	Indicator	Measure	Comments
Natural	Plant and Animal Species and Communities	Number of Extirpated Species	Staff is reluctant to say that any species has been completely extirpated from the islands, given the mobility of many of the species that may come or go from the wilderness. The Monomoy Wilderness is smaller than the typical individual home-range of several resident species. This count would be too uncertain to be useful.
Solitude or Primitive and Unconfined Recreation	Remoteness from occupied and modified areas outside the wilderness	Percent of wilderness affected by access or travel routes outside of wilderness	This measure was determined to be redundant with the measures that monitor boat traffic and flights. The only travel routes outside of the wilderness are boat channels, which are invisible and the boat traffic is already accounted for. Trails in exempted portions of the wilderness are not near enough to the wilderness boundary to have a significant impact.
Solitude or Primitive and Unconfined Recreation	Remoteness from occupied and modified areas outside the wilderness	Soundscape	While MNWR would be interested in the conclusions of a soundscape protocol the necessary equipment, time, and expertise is unfeasible at this field station. It is suspected that unnatural sounds at Monomoy consist of motorboats and airplanes – these sounds are accounted for in the boat traffic and flights measures. MNWR would welcome an external soundscape analysis.
Solitude or Primitive and Unconfined Recreation	Facilities that decrease self-reliant recreation	Agency-provided recreational facilities	In the foreseeable future, no agency-provided recreational facilities will be provided. Should the refuge supply recreational facilities, a new measure should be created to record these authorized recreational facilities.
Natural	Biophysical resources	Shoreline Change	Shoreline change is a natural and dynamic process on the Monomoy Islands. The flow of sediment, either through erosion or accretion, occurs in a 150 year cycle (approximately) in which the islands connect as a peninsula then erode to form a new breach and islands. This cycle however can be disrupted by human interference such as the installation of sea walls or jetties on other parts of the coastline. At this point in time, based on the Cape's tides and land use, no seawall or human feature currently appears to influence Monomoy's sediment-transport patterns. Since there is no foreseeable, significant, human-caused change to Monomoy's shoreline, this measure will not be used. If, in the future, MNWR suspects humans have influenced the islands' shorelines, this

measure should be installed and compared to rates of shoreline change during this time period or earlier.

6.0 Conclusion

The 2012 Wilderness Character Monitoring Report for the Monomoy NWR consists of 25 finalized measures. The data and protocols for each of these measures have been entered into the Microsoft Access database application created by the USFWS Inventory and Monitoring Program. This database is located within the Wilderness folder of the Monomoy NWR P: drive along with this final report and other supporting documents for the measures.

In addition, three measures are under development. The aircraft measure will be conducted once the next data collection period begins, such as the summer field season. The visitor encounters and marine debris measures would add to the Wilderness Character report but may only be completed if or when the necessary resources (funding and/or staff time) become available.

The data for the finalized measures in 2012 form the wilderness character baseline. Several of these measures required estimates about past events or limited data collection to the fall season. During 2013, when staff actively collect the data for certain measures throughout the year, including the summer field season, staff should have higher confidence about data accuracy. Furthermore, as of this date, the draft Comprehensive Conservation Plan recommends the two excluded wilderness areas in South Monomoy become part of the designated wilderness. If this comes to pass the features within these new areas will likely contribute to a significant change in several measures. Changes to the 2012 baseline are therefore anticipated.

Altogether the measures within MNWR's wilderness character monitoring report provide a comprehensive approach to tracking wilderness character over time. Refuge staff are committed to developing additional measures should the need and capabilities arise and to continue to collect data based on the data entry frequency for each measure. As a living document, this monitoring report may inform the Wilderness Stewardship Plan and management action decisions.



Appendix A: Prioritization of Measures

In each row, write the indicator and potential measure in the left column. Use the following criteria and ranking guide to create an overall score for each measure. Those measures with the highest overall scores should be the highest priority for assessing trends in wilderness character.

A. Level of importance (the measure is highly relevant to the quality and indicator of wilderness character, and is highly useful for managing the wilderness):

High = 3 points, Medium = 2 points, Low = 1 point

B. Level of vulnerability (measures an attribute of wilderness character that currently is at risk, or might likely be at risk over 10-15 years):

High = 3 points, Medium = 2 points, Low = 1 point

C. Degree of reliability (the measure can be monitored accurately with a high degree of confidence, and would yield the same result if measured by different people at different times):

High = 3 points, Medium = 2 points, Low = 1 point

D. Degree of reasonableness (the measure is related to an existing effort or could be monitored without significant additional effort):

High = 1 point, Low = 0 point

Criteria for Prioritizing Potential Measures						
Potential Measure	A. Importance	B. Vulnerability	C. Reliability	D. Reasonableness	OVERALL SCORE	Prioritization
Indicator: Plant and animal species and communities Measure: Community Species Status	3-Indicates health of different habitats and what may need improvement	2-Community status may change based off of several threats: sea level rise, invasives, and lack of disturbance?	2-Status assigned off of professional judgment rather than quantifiable analysis	1-Requires time to make decision	8	Medium
Indicator: Plant and animal species and communities Measure: Index of indigenous species	3-Monitors key species on the refuge, whose preservation is provided for in refuge's mission. Directly relevant to measure	3-Several species are vulnerable to numerous threats and their population would likely decline without management	3-Monitoring protocols have been in place for several years	1-Monitoring already in place	10	High
Indicator: Plant and animal species and communities Measure: Population dynamics of nonnative plant species	3-Measure shows threat to native plant and animal composition	3-Invasive plants would likely spread without management	2-Estimation used for percent cover. No wilderness-wide quantification	1-Estimate can be made quickly	9	High
Indicator: Plant and animal species and communities Measure: Population dynamics of nonnative animal species	3-Measure shows threat to native plant and animal composition	3-Unknown population dynamics without management. Likely significant impact on target	2-Measure does not exactly count population size. More broad scale.	1-Requires brief estimation	9	High

Criteria for Prioritizing Potential Measures						
Potential Measure	A. Importance	B. Vulnerability	C. Reliability	D. Reasonableness	OVERALL SCORE	Prioritization
		species.				
Indicator: Plant and animal species and communities Measure: Number of Extirpated species	3-Measure shows loss of biodiversity	2-There are no expected extirpations.	1- Impractical to track all species. Can't say with certainty about extirpations.	1-Requires brief estimation	7	Medium
Indicator: Physical Resources Measure: Visibility						
Indicator: Physical Resources Measure: Ozone air pollution						
Indicator: Physical Resources Measure: Total Nitrogen and Total Sulfur deposition						
Indicator: Biophysical Processes Measure: High Winds	2-Measure is one component of effects of climate change	2-Remains to be seen if significant storms patterns change	3-Count of high wind determined by NOAA Nantucket buoy	1-Requires minimal look up of weather records	9	High
Indicator: Biophysical Processes Measure: Wave Height	2- Measure is one of the components of	2-Remains to be seen if significant storm patterns	3-Count of wave height determined by NOAA	1-Requires minimal look up of weather	9	High



Criteria for Prioritizing Potential Measures						
Potential Measure	A. Importance	B. Vulnerability	C. Reliability	D. Reasonableness	OVERALL SCORE	Prioritization
	climate change	change	Nantucket buoy	records		
Indicator: Biophysical Processes Measure: Mean Sea Level Rise	2-Measure is one component of effects of climate change	3-Projections show increase of sea level which has major effect on island dynamics	3-Sea level rise tracked by NOAA	1-Data supplied through NOAA website.	9	High
Indicator: Biophysical processes Measure: Shoreline Change	2-Shoreline change influences habitat composition	1-No foreseeable human interfere with shoreline change besides sea level rise.	2-Would require analysis of shoreline change in place.	1-Shoreline change monitoring is in place.	6	Low
Indicator: Actions authorized by the Federal land manager that manipulates biophysical the environment Measure: Number of actions to manage plants, animals, pathogens, soil, water or fire	3-Directly relevant to measure	2-Actions fairly limited and each is considered by management	2-Requires staff reporting of actions. If not logged, must be completed from memory	1-Does not require additional fieldwork but does require minimal documentation of actions done	8	Medium
Indicator: Actions not authorized by the Federal land manager	3-Directly relevant to measure	2-Unauthorized actions are fairly low and not	1-Unauthorized actions are rarely witnessed. Accurate	1-Only time required is to document	6	Low

Criteria for Prioritizing Potential Measures						
Potential Measure	A. Importance	B. Vulnerability	C. Reliability	D. Reasonableness	OVERALL SCORE	Prioritization
that manipulate the biophysical environment Measure: Number of unauthorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire		anticipated to increase.	monitoring not in place. Fair amount of confidence in estimations	unauthorized actions		
Indicator: Non-recreational structures, installations, and developments Measure: Index of authorized physical structures, installations, or developments	3-Directly relevant to measure	1-Amount of structures are stable	3-Able to quantify physical structures	1-Can log physical structures. Good lay of the land.	8	Medium
Indicator: Non-recreational structures, installations, and developments Measure: Abandoned village remnants	2-Abandoned village remnants make up a considerable portion of manmade structures in the wilderness.	1-No expected additional structures to be abandoned	2-Measure protocol can be quantified but measure does not accurately count all remnant structures	1-Easy to count actions to remove	6	Low



Criteria for Prioritizing Potential Measures						
Potential Measure	A. Importance	B. Vulnerability	C. Reliability	D. Reasonableness	OVERALL SCORE	Prioritization
Indicator: Inholdings Measure: Inholdings	3-Directly relevant to indicator	1-No new inholdings	3-Can count inholdings	1-Can count inholdings	8	Medium
Indicator: Use of motor vehicles, motorized equipment, and mechanical transport Measure: Type and amount of administrative use of motor vehicles, motorized equipment, or mechanical transport	3-Directly relevant to measure	2-Mechanical transport or motorized equipment could increase if certain management projects are undertaken.	2- Requires staff reporting of actions. If not logged, must be completed from memory	1-Does not require additional fieldwork but does require minimal documentation of actions done	9	High
Indicator: Use of motor vehicles, motorized equipment, and mechanical transport Measure: Type and amount of motor vehicles, motorized equipment, or mechanical transport use not authorized by the Federal land manager	2-A subset of the indicator	1-Currently unauthorized use is zero or near zero. No expected change in behavior although there is potential.	2-Unauthorized use is rarely witnessed although general staff knowledge/confidence may be high.	1-Requires minimal documentation	6	Low
Indicator: Remoteness from sights and sounds	3-Encounters of other visitors	2-Visitors may increase or decrease	2-Very difficult to have an accurate	0-Requires new monitoring,	7	Medium

Criteria for Prioritizing Potential Measures						
Potential Measure	A. Importance	B. Vulnerability	C. Reliability	D. Reasonableness	OVERALL SCORE	Prioritization
of people inside the wilderness Measure: Number of visitors	may be the main detractor from solitude within the wilderness	within the next 10-15 years. Hard to say although no expectation of large fluctuations.	number of wilderness visitors. Protocol is not meant to be subjective	documentation, and possibly fieldwork.		
Indicator: Remoteness from occupied and modified areas outside the wilderness Measure: Permanent viewshed	2-Viewshed is variable at different locations of the wilderness and under different weather conditions	1-Level of development is viewshed may not be too considerable	2-Protocol is a rough estimate but will have minimal subjectivity.	0-Requires new data analysis although not that extensive once protocol in place.	5	Low
Indicator: Remoteness from occupied and modified areas outside the wilderness Measure: Motorboats and airplanes	3- Motorboats and airplanes are the main sites outside the wilderness	2-Boat and airplane traffic may or may not increase.	1-Protocol is only a snapshot and is not comprehensive	0-Requires new though minimal monitoring	6	Low
Indicator: Remoteness from occupied and modified areas outside the wilderness Measure: Night Sky Visibility	2-One component of outside effects.	2-Night pollution may increase as development on the mainland increases	2-Protocol has some subjectivity when assigning values.	1-Protocol requires very brief fieldwork every five years	7	Medium

Criteria for Prioritizing Potential Measures						
Potential Measure	A. Importance	B. Vulnerability	C. Reliability	D. Reasonableness	OVERALL SCORE	Prioritization
Indicator: remoteness from occupied and modified areas outside the wilderness Measure: Percent of wilderness affected by access or travel routes outside of wilderness	1— Not important because no nearby travel routes	1— Not expected for travel routes to form.				
Indicator: Remoteness from occupied and modified areas outside the wilderness Measure: Soundscape	2— Unknown what affect sounds interfere with wilderness. Known boats and airplanes.	2— Outside sounds may increase in the future, but unknown.	1— No technique that is reliable enough for staff's time or expertise	0— Requires time training and equipment	5	Low
Indicator: Facilities that decrease self-reliant recreation Measure: Authorized recreation facilities	1— Not important because no authorized recreational facilities	1— No intended recreation facilities to be provided in the future.				
Indicator: Facilities that decrease self-reliant recreation Measure: User-created recreation facilities	3— Directly relevant to measure	2— Amount of user-created trails could increase	2— Trails can be mapped but other unauthorized facilities could be unnoticed.	1— Count should not take considerable time	8	Medium
Indicator: Management restrictions on visitor behavior	3— Directly relevant to	1— No anticipated change in management	3— Policies known	1— Policies known and	8	Medium

Criteria for Prioritizing Potential Measures						
Potential Measure	A. Importance	B. Vulnerability	C. Reliability	D. Reasonableness	OVERALL SCORE	Prioritization
Measure: Type of management restrictions	measure	policies		easily scored		
Indicator: Management restrictions on visitor behavior Measure: Extent of management restrictions	3-Directly relevant to measure	2-Areas that are restricted can change with biotic community needs	2-Closed off areas should be known but may not be completely defined	0-Requires GIS mapping each year.	7	Medium
Indicator: Deterioration or loss of cultural resources integral to wilderness Measure: Number of actions that affect cultural resources	3-Directly relevant to measure	1-Few activities affect cultural resources	3-Known whether activity affects cultural resource or not	1-Can readily log activities that affect cultural resource.	8	Medium

Names of team members filling out this worksheet:

Taryn Sudol

Appendix B: Effort

Effort Required for Wilderness Character Monitoring

FWS Wilderness Fellows, 2012

Table completed by: Taryn Sudol

Refuge: Monomoy NWR

Quality	Indicator	Measure	Were data gathered from office paper files, computer files, or field work (professional judgment <u>is</u> an option)?	Time you spent gathering data for each measure (in whole hours)	Comments
Untrammeled	Authorized actions	Number of actions to manage plants, animals, pathogens, soil, water or fire	Office paper files/professional judgment	2	Only requires time for staff to recollect actions taken during each year.
Untrammeled	Unauthorized actions	Number of unauthorized actions that manipulate the biophysical environment	Professional judgment	1	Same as above.
Natural	Plant and animal species	Community status index	Professional judgment	1	
Natural	Plant and animal species	Index of indigenous species	Field work/professional judgment	3	Requires compiling data for several species, but data is already being put together for annual reports and should be readily available.
Natural	Plant and animal species	Population dynamics of nonnative plants	Professional judgment	1	

Natural	Plant and animal species	Population dynamics of nonnative animals	Professional judgment	1	
Natural	Physical resources	Air Quality	Computer files	1	Data should be supplied by USFWS and only requires entering into database or in future monitoring report.
Undeveloped	Biophysical processes	Sea Level Rise	Computer files	1	Data readily pulled from website
Undeveloped	Biophysical processes	Wind Speed	Computer files	1	Same as above.
Undeveloped	Biophysical processes	Wave Height	Computer files	1	Same as above.
Undeveloped	Non-recreational structures, installations, and developments	Index of physical structures, installations and developments	Internal documentation/professional judgment	4	Hard to estimate amount of time spent in the field keeping track of number of structures

Undeveloped	Non-recreational structures, installations, and developments	Symbolic Fencing	Internal documentation/GIS	2	Cannot estimate length of time spent to measure length in the field. Once this is done, it just must be entered into a table. Spent less than 2 hours mapping it in GIS.
Solitude +	Non-recreational structures, installations, and developments	Abandoned village remnants	Internal documentation/professional judgment	1	
Solitude +	Inholdings	Inholdings	N/A	1	Practically no time at all. Continue to enter zero into database or table.
Solitude +	Use of motorized or mechanical	Type and amount of administrative use of motor vehicles etc.	Internal documentation/professional judgment	2	Each staff member must spend some time (about 30 minutes to note mechanical vehicles) and then come to agreement.
Solitude +	Use of motorized or mechanical	Type and amount of unauthorized use of motor vehicles etc.	Professional judgment	2	Same as above.
Solitude +	Remoteness from inside	Number of visitors	Professional judgment	1	May take time to reach consensus
Solitude +	Remoteness from outside	Permanent Viewshed	Computer files/GIS	2	Running the analysis in GIS requires few steps, especially now that a viewshed shapefile has been created. May take time to find land use

					shapefile and upload it into ArcMap in the future.
Solitude +	Remoteness from outside	Watercraft Traffic	Field work/GIS	8?	In 2012, maybe spent less than 30 minutes putting the few records into the database. If this protocol becomes a regular routine, data collection occur simultaneously with boat travel. Depending on the amount of records, entering data into the database and calculating route distances may take a workday.
Solitude +	Remoteness from outside	Night sky visibility	Field work	1	Requires quick observation while in the field
Solitude +	Facilities that decrease self-reliant recreation	User-created facilities	GIS/professional judgment	2	Will need to map new trails that form in GIS. Should not take time for staff to supply other user-created facilities estimation.
Solitude +	Mgmt restrictions on visitor behavior	Index of management restrictions	Internal documentation	1	Every brief update of management policy table.

Solitude +	Mgmt restrictions on visitor behavior	Percent of land restricted from visitor use	GIS	2	Requires closed areas acreage to be calculated in GIS, which also requires mapping in the field (time estimate?). If closed areas are mapped then GIS calculation is very quick.
Other Features	Loss of cultural resources	Number of actions that affect cultural resources	Internal documentation	1	Requires brief staff recollection.

Effort Required for Wilderness Character Monitoring

FWS Wilderness Fellows, 2012

Table completed by: Taryn Sudol

Refuge: Monomoy NWR

Title of staff involved in identifying, prioritizing, and selecting measures	Staff time to identify, prioritize, and select measures (in whole hrs)	Comments
Wildlife Biologist	27	
Fish and Wildlife Biologist	3	
Refuge Manager	22	This includes a tour of the wilderness
Wildlife Biologist	6	

Effort Required for Wilderness Character Monitoring

FWS Wilderness Fellows, 2012

Table completed by: Taryn Sudol

Refuge: Monomoy NWR

Time you spent to identify, prioritize, and select all the measures (in whole hours)	Time you spent to learn how to enter data into the WCM database application (in whole hours)	Time you spent to enter all data into the WCM database application (in whole hours)	Time you spent on other tasks directly related to WCM (e.g., reading CCP, giving presentations, talking with staff) (in whole hours)	Time you spent doing <u>other</u> Refuge tasks not directly related to WCM (in whole hours)
116	2	3	139	94

Appendix C: Summary of Measures

Measure	Priority (H, M, or L)	Detailed Description of the Data <i>Source(s)</i> and How the Data Were Gathered
Untrammelled		
Number of actions to manage plants, animals, pathogens, soil, water or fire	M	<i>Source:</i> Internal records <i>Protocol:</i> Actions are counted annually. The time spent on each activity (recorded as number of days that staff entered the wilderness and worked some period of time on the activity) is listed. It is assumed that the more time spent conducting the action, the more trammeling has occurred (this is not always the case, but is the easiest unit to tally and over a broad scale evens out). The days for each activity are summed together and compared year to year.
Number of unauthorized actions that manipulate the biophysical environment	L	<i>Source:</i> Staff observations (Dave Brownlie) <i>Protocol:</i> The type of unauthorized action will be listed and the number of occurrences each year. The number of occurrences will be summed and compared year to year. Some trammeling is strongly suspected to occur; for these types, the estimated averages are totaled and become part of the overall score.
Natural		
Community status index	M	<i>Source:</i> Professional judgment (Kate Iaquinto) <i>Protocol:</i> The list of ecosystems has been derived from descriptions in the 2012 draft CCP. Each of the different ecosystems within the wilderness will receive a score based on ecosystem function and the biological community. The product of the ecosystem function and biological community will form the individual ecosystem score. The sum of all the ecosystems' scores will be the measure score, which will be compared every five years. The scores will be based on the following index (see measure 2.1).
Index of indigenous species	H	<i>Source:</i> Monitoring data/professional judgment (Kate Iaquinto) <i>Protocol:</i> MNWR staff monitors a selected set of species assuming budget and resources are available. Census and productivity information is collected annually for the listed species with exception of the northeastern beach tiger beetle for which peak adult counts are collected annually. Each year the staff will qualitatively evaluate the trend in nesting pairs/population number for the last five years and assign a 1 if the population is decreasing, a 2 if it is stable, and a 3 if it is increasing. Secondly, staff will calculate average productivity over the last five years and the standard error to compare this number to the corresponding productivity goal. If the average productivity falls within the standard error of the productivity goal, the productivity for that species is considered stable and is given a 2. If the average productivity plus the standard error remains below the productivity goal, it is given a 1 (decreasing). If the average productivity minus the standard error is above the productivity goal, it is given a 3 (increasing). The two scores are added for each species and then summed for an overall score.
Population	H	<i>Source:</i> Professional judgment (Kate Iaquinto)

dynamics of nonnative plants		<i>Protocol:</i> A list is compiled for selected non-native plant species. Scouting and vegetative surveys provide the acreage occupied for the selected non-native plants. This is limited to monotypic stands rather than interspersed species. The total measure will be the sum of each specie’s “Percent of acreage occupied” score.
Population dynamics of nonnative animals	H	<i>Source:</i> Professional judgment (Kate Iaquinto) <i>Protocol:</i> A list of present, threatening nonnative species will be created every five years. For each listed species, it will be assigned a threat level. A level 1 threat means that the species was present and posed a threat in the last five years but has been controlled. A level 2 threat means the species is present in small numbers and has little impact on native species. A level 3 threat means the species is present in small numbers but is having a significant impact of native species. A level 4 threat means the species is present in high numbers and having a significant impact on native species. A level 5 threat means the selected species is having a large impact on native species and their population is unrestrained/growing. These threat levels are then totaled and this sum will be compared every five years.
Air Quality	H	<i>Source:</i> USFWS National Air Quality Office <i>Protocol:</i> Every five years the USFWS National Air Quality Office (Jill Webster in 2012) supplies the refuge with the latest air quality data (for 2012 the data spans from 2005 to 2009). For Monomoy the air quality data has been interpolated from the nearest air quality sites.
Sea Level Rise	H	<i>Source:</i> NOAA Tides and Currents. http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8449130 <i>Protocol:</i> The mean sea level trend and a plot (from 1900 to 2010) shows the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. This data is taken from NOAA Tides and Currents at Nantucket Island, which is the nearest station to Monomoy.
Hours of High Wind Speed	H	<i>Source:</i> National Data Buoy Center –Station 44020 (LLNR 13665) Nantucket Sound http://www.ndbc.noaa.gov/station_page.php?station=44020 http://www.ndbc.noaa.gov/histsearch.php?station=44020 <i>Protocol:</i> Hours of 15 m/s wind speed can be gained each year by going to the second link in the data Sources. This reaches the historical meteorological data search for station 44020. The year is selected, then the criteria of “Wind Speed m/s” “>=” to “15”. This will produce an observation table. Record the Annual number of occurrences (this will be the number of hours) and the percent of records matching search criteria (this will tell if the top wind speeds are increasing over time). Repeat for subsequent years. The hours each year will be summed together than compared each monitoring period.
Hours of High Wave Height	H	<i>Source:</i> National Data Buoy Center –Station 44020 (LLNR 13665) Nantucket Sound http://www.ndbc.noaa.gov/station_page.php?station=44020 http://www.ndbc.noaa.gov/histsearch.php?station=44020 <i>Protocol:</i> Hours of 1.5 wave heights can be accessed by going to the second link in the data Sources. This reaches the historical meteorological data search for station 44020. The year is selected, then the criteria of “Wave height (m)” “>=” to “1.5”. This will produce an observation table. Record the Annual number of

		occurrences (this will the number of hours) and the percent of records matching search criteria (this will tell if the top wind speeds are increasing over time). Repeat for subsequent years. The hours each year will be summed together than compared each monitoring period.
Undeveloped		
Index of physical structures, installations and developments	M	<i>Source:</i> Internal staff knowledge/documentation (Nick Ernst, Kate laquinto) <i>Protocol:</i> A list of structures, installations, and developments will be created based off of inventories already present in GIS as well as any unmapped features known to be on the ground. Each type of structure, etc. will be given a weight along with the fraction of the year it was in place. The number, weight, and fraction of the year will be multiplied. These products are then summed for a total. This total of structures, installations, and developments will be the measure for the five year monitoring period.
Length of structures	M	<i>Source:</i> Internal staff knowledge/GIS mapping <i>Protocol:</i> In 2012 the length of symbolic fencing was estimated based off the closed areas mapped in GIS. A new line polygon was drawn that traced the perimeter of the closed areas which faced the ocean (map shown below). The length of these drawn lines was then totaled to supply the 2012 data. In the future, the length of symbolic fence can be measured will in the field.
Abandoned village remnants	L	<i>Source:</i> Internal records <i>Protocol:</i> A list will be provided of any significant undertaking to remove abandoned structures from the wilderness. Any actions to remove abandoned structures will receive a + 1 (this does not include removing temporary structures off the island each season, but does include beach clean ups). When structures are knowingly left/abandoned on the island, these actions will receive a -1 (this does not include popsicle sticks/tongue depressors used for tern nesting monitoring). If events differ in magnitude they can be given a higher or lower score so long as the scores are relative to one another. The actions will be summed and compared every five years.
Inholdings	M	<i>Source:</i> Internal inventory <i>Protocol:</i> A count of each inholding and its acreage.
Type and amount of administrative use of motor vehicles etc.	H	<i>Source:</i> Staff records/knowledge (Dave Brownlie, Kate laquinto) <i>Protocol:</i> Use of motorized vehicles and equipment and mechanical transport is recorded based on activity, the number of times it was used (a "time" means it entered and exited the wilderness. A time does not exceed one whole day in length, but otherwise this does not indicate the length the vehicle or equipment was in use) and weight assigned to the type of machinery/transport. The weight is multiplied by the number of times each thing was used. The products are summed by activity and then all activities are summed for the total score.
Type and amount of unauthorized use of motor vehicles etc.	L	<i>Source:</i> Staff observation (Dave Brownlie) <i>Protocol:</i> Motor use and mechanical transport by unauthorized persons will be organized by the type of activity and the corresponding motor use and mechanical transport involved. For example, shellfishing may involve one motorized pump and a cart, which sums to two. All of the activities' sums will be totaled and this value will be compared year to year.
Solitude or Primitive and Unconfined Recreation		
Number of	M	<i>Source:</i> Professional judgment (Dave Brownlie, Kate laquinto, Matthew Boarman,

visitors		<p>Nick Ernst)</p> <p><i>Protocol:</i> For 2012, the amount of visitors will be organized by season and estimated by a range. Each staff member independently supplied an estimated range then sat together to agree on a single range for the measurement.</p>
Permanent Viewshed	L	<p><i>Source:</i> MASS GIS layers: land use and state outline</p> <p><i>Protocol:</i> In 2012, the wilderness fellow created a viewshed polygon shapefile by created a 200 ft interior buffer around the state outline polygon. This polygon was then clipped to a polygon created by the wilderness fellow that truncated the state to West Yarmouth sand spit east of Lewis Bay and Chatham. This is then the viewshed area. The downloaded land use shapefile was then clipped to the viewshed area. The attribute table was then opened for the land use/viewshed polygon. Data was sorted by land use then the acreage was summed for each land use (Check that units are in acres. Select all parcels of a particular land use then right-click statistics under the area column to get the sum for the selected parcels). Land use was then categorized as Developed, Man-altered, and Natural. Refer to Appendix D to see how these were categorized. The acreage was summed for each category to find the percentage.</p> <p>In the future staff must download the latest land use data (post-2005) for the Cape then clip that to the viewshed polygon already created. Acreages per land use will need to be collected and then the land uses must be categorized to find the percenta</p>
Watercraft Traffic	L	<p><i>Source:</i> Staff observation/internal reporting</p> <p><i>Protocol:</i> A snapshot of watercrafts will be gained through staff observations while in route to the wilderness. Passengers on the USFWS motorboat will count number of water craft seen (organized by type), whether the different types of water craft are stationary or in transit, and the number of water craft heard but not seen. They will also record the day and the route for their boat trip. The distance for each route taken can be calculated through the distances mapped in the Boat_Shapes shapefile. The count for each boat trip along with the distance and day is then added into an Excel spreadsheet. The number of water craft seen and heard will be summed and divided by the distance traveled for average number of watercraft seen/heard per mile. This average will be compared each monitoring period. Additionally, this spreadsheet can be sorted by weekday, weekend, and season to analyze temporal differences. Further analysis can be done of the distribution of the types of watercraft seen or the difference between heard and seen.</p>
Night sky visibility	M	<p><i>Source:</i> Staff observation (Keegan Tranquillo, bird bander, in 2012). <i>Protocol</i> derived from GLOBE at Night. http://www.globeatnight.org/observe_magnitude_orion.html</p> <p><i>Protocol:</i> An hour after sunset on a clear night, a staff/volunteer will travel to point within the wilderness (outside of field camp) and locate the Orion constellation. The amount of visible stars associated with this constellation will be compared to magnitude charts provided by GLOBE at Night. The visible constellation that is most similar to whichever magnitude chart (1-7) will receive that magnitude score. The higher the magnitude score, the better night sky visibility. Higher night sky visibility increases the remoteness of people within the wilderness.</p> <p>Given the seasonality of visitors on the Cape, this measure will be taken during</p>

		the summer and at some point during the off season. These two magnitude scores will be averaged. This average will be compared every monitoring period.
User-created facilities	M	<i>Source:</i> On the ground observations, aerial photography, GIS mapping <i>Protocol:</i> A count of recreational facilities is completed as a list. Trails are identified and measured through mapping in GIS. Trails should be measured in miles in order to be compared to a number of facilities. Different facilities/trails can be weighted.
Index of management restrictions	M	<i>Source:</i> Internal staff knowledge of management policies <i>Protocol:</i> A score will be given to Monomoy based on the type of restrictions. These restrictions will be organized by category and the score assigned based on if there is no regulation or total prohibition. The higher the sum of the scores the more restrictions exist in the wilderness.
Percent of land restricted from visitor use	M	<i>Source:</i> Mapped GIS areas <i>Protocol:</i> Each year staff closes off sections of Monomoy for nesting shorebirds. These areas are then mapped in GIS. The sum of the acreage for these closed off areas is then divided by Monomoy's total wilderness area. This quotient is the measure's score.
Other Features		
Number of actions that affect cultural resources	M	<i>Source:</i> Internal records/staff knowledge <i>Protocol:</i> An inventory of the cultural sites will be created then any actions that occur on these sites will be listed. If the activity is damaging it will receive a negative score. If the activity preserves or restores the site it will receive a positive score. The sum of the activities will be tracked during the five year monitoring period.

Appendix D: Viewshed Land Use Categorization

The viewshed measure used 2005 state of Massachusetts land use data with a detailed description found here: <http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/lus2005.html>

Below are the different types of land uses and their acreages found within the Monomoy viewshed as described in measure 4.2. These land uses are divided into three categories: N –natural, M-landscape influenced by man but not considered developed, and D-developed. The table below is for future reference on how to categorize land uses during the next monitoring period.

Land Use	Acreage	Type	Sum of Acreage and percent
Commercial	110	d	
High Density Residential	369.11	d	
Industrial	0.45	d	
Low Density Residential	553.22	d	
Medium Density Residential	539.34	d	
Multi-family Residential	43.2	d	
Transportation	6.36	d	
Urban Public Institutional	18.91	d	1640.59
Cemetery	0.46	m	31.35%
Cropland	0.07	m	
Golf course	28.88	m	
marina	20.55	m	
Participation Recreation	9.4	m	
Power line Utility	2.43	m	
Transitional	0.3	m	
Very low density residential	68.15	m	
Water-based Recreation	38.58	m	168.82
Brushland/Succesional	55.52	n	3.23%
Cranberry bog	1.64	n	
Forest	565.49	n	
Forested Wetland	8.03	n	
Non-forested wetland	61.46	n	
Open land	28.11	n	
Saltwater Sandy Beach	1898.36	n	
Saltwater Wetland	685.1	n	
Water	120.46	n	3424.17
	5233.58		65.43%

Appendix E: Boat Traffic Template

While collecting boat traffic in the field the following template may be used. This data is then added into an excel spreadsheet which accounts for distance and time of year.

Date:

Route:

	Motor	Man-power	Wind	Kite Board	Recreation (Jet ski)
Stationary					
Moving					
Heard (Not Seen)					

Date:

Route:

	Motor	Man-power	Wind	Kite Board	Recreation (Jet ski)
Stationary					
Moving					
Heard (Not Seen)					

Date:

Route:

	Motor	Man-power	Wind	Kite Board	Recreation (Jet ski)
Stationary					
Moving					
Heard (Not Seen)					

Date:

Route:

	Motor	Man-power	Wind	Kite Board	Recreation (jet ski)
Stationary					
Moving					
Heard (Not Seen)					

Route Stops

- 1 Morris Island**
- 2 SMNY North Tip Eastside**
- 3 North tip of North Monomoy**
- 4 NMNY Corridor**
- 5 NMNY Broad Creek**
- 6 Minimoy**
- 7 Connection**
- 8 SB Cooler Dune**
- 9 SB Wasteland**
- 10 SMNY Lighthouse boat landing**
- 11 SMNY Big Stick**
- 12 SB Outermost drop**
- 13 SMNY Powder Hole**
- 14 SMNY south tip eastside**
- 15 SMNY North Tip Westside**

Report route as the number of stops visited. Ex –A trip from Morris Island to Minimoy then to the lighthouse and back to Morris Land is a 1-6-10-1.

Notes: Include the FWS boats as a motor boat seen, moving. Count each stop location as a motor boat seen except for starting location.

Count every boat you see even if it is the same boat seen coming and going.