Baseline mosquito management actions on Monomoy NWR will involve monitoring and surveillance of mosquito vector populations. Annual surveillance monitoring on refuge lands for arbovirus incidence in adult mosquito vectors and wildlife (especially birds) will be allowed. Mosquito vector monitoring on the refuge will document mosquito species composition to genus or species level, and estimate population size and distribution across refuge wetland habitats during the breeding season, using standard methods employed by mosquito control professionals.

Mosquito population monitoring objectives are to:

- Establish baseline data on species and abundance.
- Map breeding and harboring habitats.
- Estimate relative changes in population sizes and evaluate associated health risks.
- Use this information to guide integrated pest management of mosquito populations.

All sites identified as potential mosquito habitat have been logged and recorded in the CCMCP GIS system. Throughout the mosquito season, CCMCP crews conduct larval surveys on two- week rotations. The CCMCP checks all sites known to harbor mosquitoes for mosquito larvae using a standard (350 ml) dipper, and may search for new larval habitats, i.e., artificial containers, on or adjacent to refuge lands. Carbon dioxide light traps are placed on the Morris Island portion of Monomoy NWR. When the traps are deployed, adult mosquitoes are collected from them weekly, taken back to the lab, identified to the species level, and counted. Landing rates of adult mosquitoes are also noted. Monitoring will be conducted by the CCMCP, primarily on foot. Use of motorized vehicles on refuge lands is not authorized unless escorted by refuge staff. To avoid harm to wildlife or habitats, access to traps and sampling stations will comply with the Stipulations Necessary to Ensure Compatibility included in this determination.

Refuge staff will work with the CCMCP to develop a mosquito management plan that will provide specifics on how and when the refuge will allow, if necessary, control of mosquitoes on refuge lands, using predetermined threat levels and mosquito vector population densities. A phased approach will be used to guide appropriate control response up to and including the use of adulticides. That will occur when Federal and State public health officials, using arbovirus monitoring and surveillance data, have determined that the refuge is in a high-risk area for mosquito-borne disease transmission, and it has been demonstrated through surveillance that refuge-based mosquitoes have been shown to carry specific diseases. A high-risk determination indicates an imminent risk of serious human disease or death.

Pesticide treatment may not be used on Monomoy NWR solely for nuisance mosquito relief, but may be considered when there is a demonstrated human or wildlife health risk, mosquitoes are detrimental to refuge goals and objectives, and mosquito management actions will not interfere with refuge goals and objectives. Only pesticides identified in the special use permit and for which a pesticide use proposal (PUP) has been submitted and approved will be used on the refuge. The preferred larvicide treatments for use on the refuge are *Bacillus thuringiensis israelensis* (Bti) or *Bacillus sphaericus* (Bs), because of the bacterium's limited non-target effects. Due to specificity of the effects of Bti on the insect order Diptera, Aquabac is deemed compatible for use, under the stipulations prescribed at the end of this compatibility determination. Bti is the preferred chemical control option and will be used under appropriate conditions before methoprene is considered. We favor using the larvicide that would have the least adverse impacts on non-target invertebrates, produce fewer disruptions to food webs critical for migratory birds, and reduce lethal effects on natural mosquito predators, such as larval forms of odonates, hemipterans, and coleopterans. CCMCP will conduct post-larvicide monitoring to determine effectiveness.

Treatment regimens will vary annually, depending on the current threat level; the process for determining the threat level will be clearly delineated in the Monomoy NWR Mosquito Management Plan. Because disease threat levels vary from year to year, mosquito management on the refuge is unlikely to include all phases in any given year. Action thresholds that trigger chemical interventions will incorporate various factors listed in Service Policy 601 FW 7, Exhibit 3, as developed with refuge staff, State mosquito control section, public human health services, and vector control agencies. Thresholds must be genus and life-stage specific and be related to the refuge decision-making response matrix.

We will rarely allow CCMCP staff to undertake targeted larvicide applications (Aquabac granular Bti) to protect human safety if the mean number of *O. cantator* or *O. sollicitans* mosquito larvae is less than the threshold that is established in consultation with public human health personnel. At a minimum, the threshold will be 10/dip, with at least 10 dips taken on the same day within each source pool across the 5-acre site; this is subject to change depending on the results of future coordination with public health officials. Mosquito vector populations below this level will not be treated. The CCMCP will coordinate with the refuge manager prior to surveillance, monitoring, and control activities on the refuge.

Variations in annual permit restrictions may be necessary to accommodate wildlife breeding, roosting, and feeding activity, endangered species, administrative needs, public use management, research, or monitoring protocols. Other conflicts that may arise will be incorporated into the annual permit to ensure there are no significant adverse impacts on refuge wildlife and habitats. Because mosquito management takes place only on Morris Island, there is no need to develop restrictions or stipulations to protect wilderness character.

The CCMCP is required to provide the refuge manager with an annual quantitative summary of refuge mosquito monitoring and surveillance results, control activities on the refuge (e.g., type of pesticides applied, amount of pesticides applied, locations of application, method of application), and regional disease surveillance. All surveillance and control activities would be spatially referenced as technologies develop at CCMCP, e.g., use of global positioning satellites (GPS) and geographic information systems (GIS). Comparisons of mosquito management within and among years should be presented to permit analysis of patterns that may indicate success of habitat management efforts or suggest the need for a new management approach.

(e) Why is this use being proposed?

The use is proposed to minimize health risks to humans and wildlife from mosquito-borne disease. Two mosquito-borne viral diseases are currently endemic in Massachusetts: eastern equine encephalitis and West Nile virus. Mosquito population monitoring is necessary to detect changes that indicate increased human or wildlife health risks. In addition, surveillance for incidence of mosquito-borne disease by testing wildlife, especially birds, and adult mosquitoes for pathogens is needed to help characterize the level of health risk. There is a documented history of human West Nile virus infections in Barnstable County and eastern equine encephalitis focused in eastern Massachusetts, just west of Cape Cod in Barnstable County, which warrant continuing to annually monitor mosquitoes for the foreseeable future. The goal of early mosquito larvae monitoring is rapidly detection of relative and absolute changes in population size that can indicate an increased short-term risk to human, wildlife, or domestic animal health.

CCMCP surveillance on Morris Island in Chatham since 1991 has documented the occurrence of several primary and bridge vector mosquito species associated with eastern equine encephalitis and West Nile virus transmission to humans. Some of these mosquitoes are bridge vectors, meaning these species feed on birds and other animals, thereby enhancing the risk of disease transmission to people. The following table shows the presence of disease-carrying mosquitoes on the refuge. We have some historical records that show these species have been found on the refuge, with *Ochlertatus sollicitans* and *Ochlerotatus cantator* being the most common.

Table 1. Arbovirus Mosquito Vectors and Flight Ranges found on Monomoy NWR

Mosquito Vector	EEEV	WNV Vector	Number of years present out of 13 years for which we have data	Flight Range
Culiseta morsitans	X Birds		1	
Coquillettidia perturbans	X Bridge	X Bridge	2	5 km
Ochlerotatus canadensis	X Bridge	X Bridge	5	2 km
Aedes vexans	X Bridge	X Bridge	1	>25 km
Culex pipiens	X Bridge	X Birds	4	2 km
Culex restuans	X Bridge	X Birds	1	2 km
Culex salinarius	X Bridge	X Bridge	2	10 km
Ochlerotatus excrusians			4	
Ochlerotatus sollicitans (Formerly Aedes sollicitans)	X Bridge	X Bridge	6	>25 km
Ochlerotatus cantator (Formerly Aedes contator)	X Bridge	X Bridge	6	>10 km
Ochlerotatus triseriatus	X Bridge	X Bridge	3	0.2 km

West Nile virus was first detected in birds, mosquitoes, and humans in Barnstable County in 2003, and in mosquito pools in 2003 to 2006 (towns of Falmouth and Barnstable) and 2008 and 2009 (towns of Barnstable and Bourne). West Nile virus was detected in dead birds (primarily corvids) in Barnstable County in 2005 (3 positive samples, including 1 from Harwich) and 2006 (9 positive samples, including 2 each from Dennis and Brewster) before testing of dead birds was discontinued in 2009. Two human West Nile virus cases were documented in the Town of Barnstable, one case in 2003 and another in 2007. There have been no human West Nile virus cases documented for Chatham or surrounding communities (Harwich, Dennis, Brewster, or Orleans), and West Nile virus has not yet been detected from humans, dead birds, or mosquito pools in Chatham.

Periodic outbreaks of eastern equine encephalitis with an epicenter in southeastern Massachusetts just west of Cape Cod are also documented. The majority of human eastern equine encephalitis cases have occurred in Norfolk, Bristol, and Plymouth counties, although some cases are documented for Middlesex County, Essex County, and as far west as Worcester County. Although the historic eastern equine encephalitis epicenter lies just to the north and west, Cape Cod and the Islands (Martha's Vineyard and Nantucket) have no documented human eastern equine encephalitis cases or deaths. The first documented incidence of eastern equine encephalitis isolated from a Cape Cod mosquito pool was collected in Nickerson State Park in Brewster in August 2012.

Refuge pools on Morris Island are known to harbor the brown salt marsh mosquito *Ochlerotatus cantator* and the eastern salt marsh mosquito *O. sollicitans*, which are both bridge vectors for the transmission of both West Nile virus and eastern equine encephalitis to humans. These pools have been treated in the past, although it appears the threshold for treatment can be raised given the low risk of disease occurrence on Cape Cod. According to Kilpatrick (2005), West Nile virus transmission risk from *O. sollicitans* in Suffolk and Rockland counties, New York, was only 0.07 percent; 80 percent of the West Nile virus transmission was from *Culex pipiens* and *Culex restuans*. *O. cantator* was not even identified as a risk species for West Nile virus in these salt marshes. Despite the incidence and spread of West Nile virus and eastern equine encephalitis in southeastern Massachusetts, and the potential for spread of other mosquito-borne diseases, portions of Monomoy National Wildlife Refuge are still viewed as a low-remote potential mosquito-borne disease reservoir.

AVAILABILITY OF RESOURCES:

The CCMCP will conduct monitoring and control, coordinated with the refuge manager on an annual basis through the issuance of an special use permit. Existing funds are available to support the refuge manager and other staff in coordinating this use (table 2). As funding becomes available, refuge staff will take an active and, in most cases, a lead role in planning and implementing tidal circulation enhancement and wetland restoration projects aimed at improving wildlife habitat while reducing mosquito production on non-wilderness portions of Monomoy NWR. Developing a mosquito management plan for the refuge will be a one-time effort that is likely to take 0.20 of a full-time employee (FTE). A notice of intent needs to be submitted to the Environmental Protection Agency for the use of pesticides in the salt marsh, and it will be the responsibility of the CCMCP to draft a notice of intent and either acquire the permit, or provide all the information needed so the Service can obtain the permit. This will be listed as a condition for issuing a special use permit for mosquito control.

Table 2. Staffing needs to conduct use of Mosquito Management on Monomoy NWR

Position	Involvement	FTE	Cost
Refuge Manager	General oversight	0.02	$2,500
Wildlife Biologist	Field visits, mosquito management plan review and implementation; preparation of pesticide use proposal, special use permit, and pesticide use report; oversight of mosquito-borne disease monitoring, vector control activities. Involvement in coordination and oversight of mosquito monitoring activities.	0.05	$3,375
Total FTES and Staffing Costs		0.07 FTE	$5,875

ANTICIPATED IMPACTS OF THE USE:

Direct impacts of monitoring and control include temporary disturbance to habitat and possible direct effects to non-target wildlife. Areas of vegetation may be crushed underfoot, with impacts ranging from temporary in nature to loss of habitat over time. Invasive weeds may be introduced or spread by foot. Indirect effects associated with mosquito control include reducing mosquito populations and other non-target species that serve as the base of food chains for wildlife species.

Impacts to birds as a result of physical access (trampling of vegetation, nests) for mosquito management could occur, but are unlikely, as these actions would not significantly affect bird populations of the refuge given the small size and limited bird habitat that the areas receiving mosquito management provide.

Chemical Treatment Effects on Target Mosquito Populations

The use of mosquito larvicides generally is considered preferable to the use of adulticides because larvicides prevent the appearance of the blood feeding adults; larvicides can provide up to a month of control, rather than the few hours provided by fogging with adulticides; the commonly used larvicides are less toxic than the adulticides and the application method greatly reduces human exposure; and larvicides generally are applied to smaller areas than are adulticides.

A natural soil bacterium, *Bacillus thuringiensis var. israelensis* (Bti), like other varieties of *Bacillus thuringiensis* (Bt), is a stomach poison that must be ingested by the larval form of the insect in order to be effective. Bti is an EPA toxicity class III general use pesticide and is practically non-toxic to animals (Extoxnet 1996). Bti is specific to certain primitive dipterans, especially mosquitoes, black flies, and some chironomid species (Boisvert and Boisvert 2000), and is not known to be directly toxic to non-dipteran insects; there are no toxic inert ingredients included in Bti products (Extoxnet 1996). Bti produces protein endotoxins, activated in the alkaline mid-gut of target insect species, that bind to protein specific receptors of dipteran larvae species, resulting in mortality. Bti must be ingested by the target insect to be effective and is most effective on larval salt marsh mosquito instar stages 1 and 2; it is considerably less effective against instar stages 3 and 4. Bti has no effect on pupae or adult mosquitoes.

Methoprene is a contact insecticide that does not need to be ingested like Bti (Tomlin 1994); it ranks as a toxicity class IV, and is considered slightly to practically nontoxic (EPA 2001). Methoprene compounds like Altosid Liquid Concentrate and Altosid Single-Brood Granule all mimic the action of an insect growth hormone and interfere with the normal mosquito maturation process, acting as an insect growth regulator (IGR) preventing mosquito larvae from pupating and reaching the adult stage.

Adulticides appear to effectively control adult mosquito populations and spread of mosquito- borne disease such as West Nile virus (Carney et al 2008), but only for a brief time, and are therefore only recommended during a disease event to break the disease transmission cycle (*http://www.townofsilvercity.org/vector/scienceofvector.html*). Adulticides kill only mosquitoes that contact insecticide droplets. The fog soon dissipates. Although the local mosquito population is reduced for a few days, fogging does not prevent mosquitoes from re-entering the sprayed area. Adulticides will be considered only in the case of a declared public health emergency. Focused timing and location of adulticide application to control mosquito disease vector source populations is essential for effectiveness (*http://wildpro.twycrosszoo.org/s/00man/WNVOverviews/wnvindtech/wnvcontrolaerialadulticides.htm*).

Only the pyrethroid adulticide sumithrin (Anvil 10+10) has seen recent use in Massachusetts, although Monomoy NWR was not included in that application. Neither Naled (organophosphate) nor Malathion (or any other oxon derivative) has been used for adult mosquito control at Monomoy NWR, nor do we expect they will be used.

The Ecotoxnet database (*http://extoxnet.orst.edu/*) includes the following summary of how pyrethroids act as insecticides.

"Human-made pyrethroids are based on natural pyrethrins in chrysanthemums, which is a neurotoxic chemical to insects. Pyrethroids act by inhibiting the nervous system of insects. This occurs at the sodium ion channels in the nerve cell membrane. Some type II pyrethroids also affect the action of a neurotransmitter called GABA. Pesticide products containing pyrethrins usually contain a synergist (such as piperonyl butoxide). Synergists work by restricting an enzyme that insects use to detoxify the pyrethrins. A synergist allows the insecticide to be more effective. These products are dissolved in petroleum-based products."

Pesticide Toxicity and Other Effects to Non-target Organisms

The few small refuge sites receiving pesticide application for the purpose of mosquito management typically provide limited habitat for native wildlife and plants. These areas are mostly shallow swales within the intertidal marsh plain (4 to 6 feet) that hold water for extended periods (e.g., following high tides); the area lacks tidal channels that permit drainage. These characteristics result in poor tidal hydrology and, in turn, lower biotic productivity for a variety of plant and wildlife species relative to other refuge areas with better tidal flushing. Bti (EPA 1998) and methoprene (EPA 2001) are non-toxic to vegetation.

Giving full consideration to the protection and integrity of non-target organisms and communities, the greatest concerns the Service has with chronic mosquito control chemical use are the subsequent degradation of biological integrity and diversity, and disruption of vital food webs. Aquatic invertebrates play important roles in wetland ecology. They aid in the breakdown of fresh and salt marsh-derived organic matter and provide important food resources for different life stages of fish, breeding and migrating birds, and other wildlife. As such, they are critically important and directly linked to the future conservation and management of refuge-specific resources of concern listed in CCP goals and habitat objectives.

Impacts to birds, mammals, reptiles, or amphibian may occur as a result of ground access. However, bird and mammal impacts are considered limited because areas that need mosquito management are small in size, and provide only limited habitat. The use of pesticides for the purpose of mosquito management may directly or indirectly affect resident and migratory bird, mammal, reptile or amphibian populations of the Refuge. Direct effects may occur from direct contact with the pesticides. Indirect effects are related to the potential reduction in the invertebrate food supply. Pesticide effects on reptiles and amphibians may occur through reductions in insects that serve as a food source (Hoffman et. al. 2008), through direct individual effects from pesticide application, or from trampling of individuals or habitat. Birds are often used as a surrogate for effects on reptiles, and fish as a surrogate for amphibians (Hoffman et al. 2008). Bti has practically no acute or chronic toxicity to mammals, birds, fish, or vascular plants (EPA 1998).

Migratory birds that depend on invertebrate food resources may not be mobile enough to seek alternative feeding sites, post-treatment, particularly during the breeding season. Precocial young seek food items on their own. Since they are flightless, food items must be available within a relatively small home area. Reduction of invertebrate food resources within even a small geographic area may be detrimental to breeding wetland birds and precocial young.

Altricial birds, those with young that are relatively helpless and restricted to a discrete nest site during the first few weeks of life, are solely dependent upon the parents for food. When invertebrate foods are scarce, parents may have to make more extended feeding forays and be less able to provide sufficient nutrition to all offspring, potentially resulting in increased chick mortality. Adults making extended flights into less familiar territory may be more likely to suffer predation or to experience inter- or intra-specific competition. Young subjected to extended periods at the nest without parental attention may be more likely to suffer predation or weather-related stress.

The use of larvicides and pupacides for the purpose of mosquito management is not likely to directly affect native mammal populations of the refuge. Adverse effects on mammals from Bti, methoprene, and Agnique (monomolecular film) are not expected when applied according to the label instructions. Extensive acute toxicity studies indicated that Bti is virtually innocuous to mammals (Siegel and Shadduck 1992). These studies exposed a variety of mammalian species to Bti at moderate to high doses and no pathological symptoms, disease, or mortality were observed. Methoprene is not considered toxic to mammals. Impacts to the mammalian community as a result of reduced invertebrate populations are not expected because most mammal species that inhabit wetlands of the refuge are herbivorous and invertebrates are not a primary component of their diet. Insectivorous shrews experiencing reduced arthropod food availability may be reduced over the short-term post-treatment. Negative effects on fish populations are not expected from proposed larvicides and pupacides.

Using larvicides can adversely affect non-target insects, especially non-biting midges (Chironominae), and Bti concentration is important with regard to impacts on non-target organisms such as ecologically important non-biting midge larvae. Chironomid larvae are often the most abundant aquatic insects in freshwater, brackish and salt marsh wetland environments and represent a major component in food webs for many wetland-dependent wildlife species (Miller 1987, Euliss et al 1991, Helmers 1992, Skagen and Oman 1996, MacKenzie 2005). Chironomids also frequently make up the largest proportion of wetland invertebrate biomass (Elridge 1992, Rehfisch 1994, Davis and Smith 1998, MacKenzie 2005).

The effect on local populations of invertebrate species over time with periodic and continued use of Bti is unknown but potential for negative effects is a possibility. Host range and effect on non-target organisms indicates that Bti is relatively specific to the Nematocera suborder of Diptera, in particular filter-feeding mosquitoes (Culicidae) and blackflies (Simuliidae) (Glare and O'Callaghan 1998). Bti is pathogenic to some species of midges (Chironomidae) and Tipulidae, although to a lesser extent than to mosquitoes and biting flies; it is not reported to affect a large number of other invertebrate species (Glare and O'Callaghan 1998). Other factors, such as temperature, water depth, aquatic vegetation, and suspended organic matter, may act to reduce its toxicity to chironomids in the environment (Charbonneau et al. 1994; Merritt et al 1989, Lacey and Merritt 2004). Negative impacts on chironomid density and biomass could have deleterious effects on wetland and wildlife food webs and could lower biodiversity. The effects of a single Bti application are difficult to predict because of documented differences in toxicity based on formulation, potency, application rate, and timing. Published studies (Hershey et al. 1998, Niemi et al. 1999) have examined the long-term, non-target effects of Bti. In Minnesota, 27 wetlands were sampled for macroinvertebrates over a 6-year period with no effects observed on the bird community (Niemi et al. 1999). In judging the potential for adverse ecological effects of Bti applications, one should consider the non-target aquatic organisms of concern that would be impacted from the potential loss of both mosquito and chironomid larvae.

Methoprene is considered practically non-toxic to birds (Extoxnet 1996, EPA 2001) at EPA- approved application rates. Methoprene products are more toxic than Bti products, killing a wider range of non-target larval insects. This makes methoprene more likely to cause disruptions to invertebrate food webs. Using short-term residual methoprene formulations and avoiding Briquets and other extended residual products would maintain concentrations at the low end, and mitigate any adverse impacts to non-targets in higher concentration scenarios. Altosid was found to have very little effect, if any, on 35 species of exposed non-target organisms, including earthworms, waterfleas, damselflies, snails, tadpoles, and mosquito fish when used at lower larviciding concentrations (Extoxnet 1996b). Some studies have suggested methoprene impacts other organisms that may form part of the food base for birds. McKenney and Celestial (1996) noted significant reductions in number of young produced in mysid shrimp at 2 ppb. Sub-lethal effects on the cladoceran, *Daphnia magna*, such as reduced fecundity, increased time to first brood, and reduced molt frequency, have also been observed at concentrations as low as 0.1 ppb (Olmstead and LeBlanc 2001).

As with Bti, concerns over methoprene use include potential negative impacts on chironomid larvae due to their importance in food webs. As with any pesticide, toxicity is a function of dose plus exposure. At mosquito control application rates, methoprene is present in the water at very low concentrations (4 to 10 ppb, initially). With regard to exposure, chironomid larvae occur primarily in the benthos, either within the sediments or within cases constructed of silk and detritus. Differences may exist with regard to exposure to methoprene between chironomid and mosquito larvae, as the latter occur primarily in the water column. The published literature on the effects of methoprene to chironomids is not as extensive as that for Bti. However, evidence is found for potential toxicity to chironomid and other aquatic invertebrates from methoprene treatments.

Methoprene is likely to be lethal to non-target terrestrial invertebrates, including pollinating species, in their larval stages if they come into direct contact with this chemical. Lepidopterans (butterflies and moths) may be highly susceptible. However, larval stages that develop in tree tissues or underground are unlikely to come in contact with methoprene. Methoprene and Bti both also have the potential to negatively affect the local chironomid (midge) population. The extent to which the use of Bti and methoprene will limit the food resources for individual birds or local avian populations is unknown. Though often discounted as inefficient pollinators, some researchers have suggested that the efficiency of pollinating flies (dipterans), mosquitoes (dipterans) and midges can exceed that of bees (*http://eol.org/pages/421/entries/24921263/details#relevance_to_humans_and_ecosystems*). Further, dipterans appear to be crucial for the pollination of certain flowers in some habitats.

Monomolecular films are not known to cause direct chronic or acute toxicological effects to birds, but are potentially lethal to any aquatic insect that lives on the water surface or requires periodic contact with the air-water interface to obtain oxygen; this may result in a negative impact to the avian food base, e.g., Chironomid invertebrates (USFWS 2005). The film interferes with larval orientation at the air-water interface or increases wetting of tracheal structures, suffocating the organism. As the film spreads over the water surface, larvae tend to concentrate, which may increase mortality from crowding stress (Dale and Hulsman 1990).

Pyrethroid insecticides are subject for review as potential developmental neurotoxicants because of their mode of action on voltage-sensitive sodium channels (Lu et al. 2006). Permethrin, the most widely used pyrethroid insecticide, is suspected to be an endocrine-disrupting chemical and was classified as a potential carcinogen at high exposure levels (EPA 2006). Pyrethroids may also have a suppressive effect on the immune system and may cause lymph node and spleen damage. Pyrethroids are reported to degrade rapidly in the environment and to be broken down to nontoxic products. However, Tyler et al. (2000) and Hong Sun et al. (2007) argue that products of the metabolism of permethrin are potentially far more potent as endocrine disruptors than the parent compound because of their ability to interact with steroid hormone receptors. Pyrethrins have a slight toxicity to bird species (National Pesticide Information Center 1998, Extoxnet 1994). Non-target effects to birds from pyrethrin application may also occur as a result of a reduced food base (e.g., Chironomid invertebrates) if non-target invertebrate populations are significantly reduced.

The application of adulticides has the potential to adversely affect fish and aquatic invertebrate populations. Pyrethrins are considered highly toxic to fish and invertebrates (EPA 2006).

Because pyrethrins are broad-spectrum insecticides, they are potentially lethal to most insects. All adulticides are very highly toxic to aquatic invertebrates in concentrations as low as one part per billion (Milam et al. 2000). Pyrethrins are known to cause acute toxicological effects to benthic invertebrates at rates used for mosquito abatement (EPA 2006). Because most adulticides can be applied over or near water when used for mosquito control, risks to aquatic invertebrates from direct deposition and runoff of the pesticides exist.

The pyrethroid insecticides are extremely toxic to fish, with 96-hour LC50 values generally below 10 ug/l. Corresponding LD50 values in mammals and birds are in the range of several hundred to several thousand mg/kg. Fish sensitivity to the pyrethroids may be explained by their relatively slow metabolism and elimination of these compounds. The half-lives for elimination of several pyrethroids by trout are all greater than 48 hours, while elimination half-lives for birds and mammals range from 6 to 12 hours. Generally, the lethality of pyrethroids to fish increases with increasing octanol/water partition coefficients. The pyrethroid resmethrin is slightly toxic to birds and highly toxic to fish and to bees. Its LD50 in California quail was greater than 2,000 mg/kg; the LC50 in mosquito fish is 0.007 ppm. The LC50 for resmethrin synergized with piperonyl butoxide in red swamp crawfish, *Procambarus clarkii*, is 0.00082 ppm. The LC50 in bluegill sunfish is 0.75 to 2.6 ug/l, and 0.28 to 2.4 ug/l in rainbow trout. DeMicco et al. (2010) found a dose-dependent increase in zebrafish embryo mortality and pericardial edema, which was consistent with mammalian studies that demonstrated slight teratogenesis at high doses. Resmethrin is highly toxic to bees, with an LD50 of 0.063 ug/bee. Adulticides (pyrethrins) may adversely affect amphibians such as tadpoles that occur within seasonal freshwater wetlands of the refuge (Gunasekara 2005).

De Guise et al. (2005) studied a die-off of lobsters following mosquito spraying with resmethrin; they found that adult lobsters are no more sensitive than other aquatic species to the lethal effects, but are very sensitive to immune and endocrine endpoints tested (sublethal effects). Modulation in immune functions could result in increased susceptibility to infectious agents, contributing to mass mortality with sufficient exposure. Weston et al. (2005) examined toxicity of run-off sediments to an amphipod *Hyalella azteca* in creeks draining a Roseville, California, single-family subdivision. Nearly all creek sediments collected caused toxicity in laboratory exposures, and about half the samples caused nearly complete mortality. The pyrethroid bifenthrin was implicated as the primary cause of the toxicity, with additional contributions to toxicity from the pyrethroids cyfluthrin and cypermethrin originating from residential (structural) pest control by professional applicators or homeowner use of insecticides, particularly lawn care products.

The small scale and low frequency in past use of adulticides suggests that any future adulticide use on the refuge is unlikely to cause significant adverse effects to fish and invertebrate populations. Application would only occur in swales and not to channels, sloughs, or other open water areas. Application would only occur during low tides to avoid potential impacts to fish that may move into the tidal marsh plain during higher high or extreme tides. Oral exposure of mammals to pyrethrins could occur through consumption of plants or plant parts that have been sprayed. A terrestrial exposure model showed no acute or chronic risks to mammal or bird species (EPA 2006).

The Service recognizes that spray drift could enter the refuge from neighboring (Morris or Stage Island, or mainland Chatham) communities. The refuge has no jurisdiction over mosquito control on lands outside the refuge boundary; therefore, no SUP is required for off-refuge mosquito management. Since the State employs best management practices and follows the EPA-approved label, the Service expects impacts to refuge resources to be minimal.

Refuge habitat management actions that increase biological integrity, diversity, and environmental health (BIDEH) and avian diversity have the potential to provide a buffer against future disease outbreaks. Recent infectious disease models illustrate a suite of mechanisms that can lower incidence of disease in areas of higher disease host-diversity (defined as the dilution effect). These models are particularly applicable to human zoonoses, i.e., infectious diseases of wildlife or domestic animals that spill over into human populations (Keesing et al 2006; Krasnov et al. 2007, Ostfeld and Kessing 2000) such as avian influenza, anthrax, Lyme disease, and West Nile virus.

Research conducted in the eastern U.S. in 2002 when the WNV outbreak was in full swing, found fewer incidences of West Nile virus in humans in areas with a diverse array of bird species (Swaddle and Calos 2008). This link between higher bird diversity and reduced human West Nile virus infection is attributed to the fact that crows, jays, thrushes, and sparrows are competent (amplifying) hosts of the West Nile virus, making them able to contract the disease and pass it on through a vector more efficiently. When bird diversity is low, competent host species tend to represent a higher proportion of the bird population, increasing the likelihood that a mosquito will encounter an infected bird and transmit the virus during its next bite. A diverse suite of bird species, with large numbers of incompetent hosts in the population, reduces the transmission rate to other birds or mammals, including humans. A similar study showed increased mammalian diversity decreased Lyme disease risk to humans (LoGiudice et al. 2003).

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning (CCP) process for the Monomoy National Wildlife Refuge, this compatibility determination will undergo a 60-day public comment period concurrent with the release of our draft CCP/Environmental Impact Statement.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

The following stipulations are required to ensure compatibility:

- The CCMCP must apply for and receive a special use permit annually from the refuge manager prior to conducting any mosquito and mosquito-borne disease surveillance and monitoring activities.
- The CCMCP will notify the refuge manager prior to monitoring and conducting disease surveillance. All personnel entering the wetlands will be oriented at the beginning of the surveillance period or escorted by refuge staff to avoid disturbance to endangered, threatened, or other sensitive species on the refuge.
- The CCMCP will be responsible for monitoring disease activity in reservoir hosts for pathogens or antibodies, and collecting adult mosquito samples in same-genus pools for virus or any other monitoring required to substantiate a high-risk disease situation on or near the refuge.
- The CCMCP will assume all monetary costs and perform all activities associated with mosquito monitoring, disease surveillance, and treatment. Service personnel may accompany CCMCP personnel to examine exact locations of heavy mosquito breeding problems to ascertain the presence of non-targets or mosquito predator species in these areas.
- Motorized access may only be used on non-wilderness portions of the refuge when escorted by refuge staff and no other practical means of conducting mosquito management exists.
- The CCMCP will limit the number of travel pathways used for mosquito management within the marsh.
- Caged sentinel chickens may not be used for reservoir host surveillance due to the risk of spreading disease to wild birds.

- The CCMCP will remove equipment and refuse resulting from operations on refuge lands daily, and will promptly repair all damage to government property that may result.
- All decisions for chemical interventions to control mosquitoes will be made by the refuge manager and will be based on meeting or exceeding predetermined mosquito abundance and disease thresholds.
- Current mosquito population data is necessary before mosquito larvicide treatments may be applied on the refuge.
- Only approved larvicides may be applied on refuge salt marshes within the prescribed area on Morris Island as identified in the special use permit.
- The refuge manager will be contacted at least 24 hours in advance of each larvicidal application.
- The CCMCP must provide a copy of the Clean Water Act NPDES permit from the Environmental Protection Agency prior to conducting any chemical treatment.
- Application of chemical mosquito control measures will be conducted in accordance with approved pesticide use proposals.
- Insecticide applications will avoid areas known to contain butterfly and moth host-plants in order to conserve and protect rare or specialist insect pollinators and also ensure that adequately buffered habitat around host plants or refugia is available during and after insecticide spraying.
- Application of pesticides will be in discrete, mosquito-producing areas of the refuge and at the lowest possible dilution rate (ultra-low volume) required for effectiveness.
- The CCMCP will minimize the use of pesticides on refuge lands, and continually investigate formulations and compounds that are least damaging to fish and wildlife populations.
- The CCMCP must provide the refuge manager with monitoring and disease surveillance data demonstrating that action thresholds have been reached or exceeded before pupacides are applied. Refuge manager approval must be obtained prior to CCMCP staff elevating to the next action or response threshold.
- Only the refuge manager, in consultation with the CCMCP and public health officials, may authorize application of mosquito adulticide and only when there is evidence of refuge-based mosquitoes contributing to a declared public health emergency.
- Immediately after any pesticide application, the CCMCP will monitor mosquito vector populations to assess the effectiveness of all pesticide treatments.
- Treatment in populated areas off-refuge will be considered first.
- General mosquito control will not be allowed during high tide events in order to avoid impacts to tidal marsh species. Unless permitted by the refuge manager, pesticide application should not occur within 100 feet of natural sloughs and channels.
- A final report of all monitoring and control activities conducted on the refuge must be provided to the refuge manager before the end of the calendar year.
- The CCMCP will meet with the refuge manager during the first quarter of each calendar year as a condition of the special use permit renewal for the upcoming year. Prior to that meeting, the CCMCP will review the previous year’s pesticide proposals and submit to the refuge manager any changes in the pesticides or formulations of pesticides they expect to use in the upcoming year.

JUSTIFICATION:

Mosquitoes are a natural component of tidal wetlands but can pose a significant potential threat to human and wildlife health when refuge wetlands are within the known mosquito flight ranges of populated areas and refuge mosquitoes have been demonstrated to be infected with arboviruses. WNV and EEEV have been of particular concern across the United States and in the Cape Cod and Islands region. Mosquito species known as vectors of these diseases occur on the refuge.

The staff of Monomoy NWR and the CCMCP advocate an integrated approach to mosquito management that includes a range of tools to improve habitat conditions for estuarine wildlife while reducing threats to public health from mosquito species capable of transmitting disease to humans. With the continued existence of West Nile virus and eastern equine encephalitis and the potential for spread of other mosquito-borne disease, pressure is increasing to manage mosquito populations that occur on lands of the National Wildlife Refuge System, especially in populated areas such as the Cape Cod and Islands region. Understanding the actual risk of refuge-based mosquitoes to the spread of West Nile virus and eastern equine encephalitis is an important part of managing a mosquito control program on the refuge.

The use of larvicides and other pesticides, if necessary, will receive periodic compatibility review if future studies bring more information to light on the ecological impacts of mosquito control. In addition, new chemicals that may come to market in the future may be evaluated for potential use on Monomoy NWR.

The stipulations above address the Service's laws and Refuge System policies to maintain, enhance, and restore biological integrity, diversity, and environmental health, manage an IPM program, and protect the public from mosquito-borne health threats.

This activity will not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purpose for which the refuge was established.

SIGNATURE:

Refuge Manager: ______________________________ ______________________________
(Signature) (Date)

CONCURRENCE:

Regional Chief: ______________________________ ______________________________
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: ______________________________

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FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Monomoy National Wildlife Refuge

Use: Motorized and Nonmotorized Boating

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ["no" to (a)], there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ["no" to (b), (c), or (d)] may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No ____.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ______ **Appropriate** ✔

Refuge Manager: ________________________ Date: ______________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: ________________________ Date: ______________

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Monomoy National Wildlife Refuge

Use: Motorized and Nonmotorized Boating

NARRATIVE:

Access to the Monomoy Islands is restricted to boat. Allowing the operation and landing of motorized and nonmotorized boats such as kayaks provides a safe means for visitors to access and explore Monomoy NWR beyond the Morris Island portion of the refuge. This access allows visitors to take part in priority wildlife-dependent recreation on the refuge, including wildlife observation, wildlife photography, and recreational fishing. Motorized and nonmotorized boat use will not interfere with the Service's work to protect and conserve natural resources. Motorized boats must land in designated areas to minimize potential impacts to wildlife. The level of use for these activities on the refuge is moderate, and the associated disturbance to wildlife is temporary and minor. Although motorized and nonmotorized boat uses are not priority public uses, they are not detrimental activities under the conditions described above. Boat access for waterfowl hunting, fishing, wildlife observation and photography, and environmental education and interpretation, which are priority uses, allows visitors to enjoy the outdoors and wild lands. Boating on Monomoy refuge will not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purposes for which the refuge was established.

Nearly half (47 percent) of the refuge and most (86 percent) refuge land above mean low water is congressionally-designated wilderness, including much of the intertidal areas of the refuge. Motor boats are not generally allowed in wilderness. However, Public Law 91-504, which established the Monomoy wilderness, referenced the original Wilderness Act designation, thereby providing an exception to this prohibition, as the use of motorboats at Monomoy refuge had already been established and was deemed desireable.

For these reasons, the operation and landing of motorized and nonmotorized boats within Monomoy NWR is appropriate.

COMPATIBILITY DETERMINATION

USE:

Motorized and Nonmotorized Boating

REFUGE NAME:

Monomoy National Wildlife Refuge

DATE ESTABLISHED:

June 1, 1944

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Migratory Bird Conservation Act (16 U.S.C. § 715d) Public Law 91-504, 16 USC § 1132(c)

REFUGE PURPOSE(S):

"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." (16 U.S.C. § 715d).

"…wilderness areas…shall be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness. (PL 88-577 § 2(a), Wilderness Act; as referenced in P.L. 91-504 § 1(g), An Act to Designate Certain Lands as Wilderness).

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is the landing of motorized boats and the landing and launching of nonmotorized boats on Monomoy NWR. The majority of the boats will be privately owned motorboats, commercial ferries, canoes, and kayaks. The use is not a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). However, it does facilitate the priority public uses of wildlife observation, wildlife photography, environmental education, interpretation, waterfowl hunting, and fishing by allowing visitors to access the Monomoy Islands, including Nauset/South Beach.

(b) Where would the use be conducted?
Motorized boat access is allowed in designated landing sites on North and South Monomoy Islands, and nonmotorized boats are allowed to access any part of the refuge beach that is open to the public on both Monomoy Island and Morris Island. At this time, landing sites on Nauset/South Beach have not been

established but will if deemed necessary to protect wildlife or visitor safety. Public access is dictated by wildlife use. In general, much of the intertidal area is open to pedestrian traffic for most of the year. Some areas of beach are closed seasonally to protect nesting shorebirds and seabirds, and some intertidal areas are closed for loafing seals. Visitors should contact Monomoy NWR staff for up-to-date information on seasonal closures, or visit the refuge Web site.

(c) When would the use be conducted?
Monomoy NWR is open to the public from ½ hour before sunrise to ½ hour after sunset. Surf fishing is permitted on Morris Island 24 hours a day; this is the only activity allowed at night on Monomoy NWR. Motorized and nonmotorized boat use would be allowed during regular refuge hours.

(d) How would the use be conducted?
Motorized and nonmotorized boating will be allowed as a means to facilitate refuge public use programs, namely the priority public use programs of waterfowl hunting, fishing, wildlife observation and photography, and environmental education and interpretation. The use would be conducted in a manner consistent with refuge and State regulations, with some additional restrictions to protect fish, wildlife, and habitat. Visitors can access Monomoy Island using motorboats; however, the refuge does not provide boat trailer access. Visitors can launch nonmotorized boats from cars in areas where the beach is open to public use. Additional opportunities to launch motorized and nonmotorized boats exist on nearby non-refuge lands.

(e) Why is this use being proposed?
Waterfowl hunting, fishing, wildlife observation and photography, and environmental education and interpretation are the six priority public uses of the Refuge System. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses. Motorized and nonmotorized boating provides a means to facilitate the priority public uses. By allowing these uses, we are providing opportunities to visitors to access the Monomoy Islands and facilitating refuge programs that offer high-quality, wildlife-dependent recreation and maintain the current level of fish and wildlife values.

AVAILABILITY OF RESOURCES:

This use requires that staff provide information to visitors and conduct periodic law enforcement patrols, particularly to ensure that boaters stay out of closed areas. Costs are outlined below:

GS-9 Law Enforcement Officer—3 weeks	$5,400
Sign posting and maintenance	$2,000
Total annual costs	**$7,400**

ANTICIPATED IMPACTS OF THE USE:

Allowing motorized and nonmotorized access to the refuge will result in some impacts from visitors. The approach of motorized boats to pick up and discharge passengers creates a temporary disturbance to migratory birds feeding or resting on the beach nearby. However, motorized boat landing sites are located outside areas used heavily by nesting, feeding, and roosting terns, shorebirds, and colonial waterbirds. Any energy expended by migratory birds to avoid disturbance associated with beaching a boat and loading and unloading passengers is negligible. North and South Monomoy Islands make up the Monomoy Wilderness Area. The untrammeled environment and solitude of the Monomoy Wilderness Area, accessible by boat only, make it unique among wildland areas on Cape Cod. Motorized boating, not generally allowed in wilderness areas, is permitted at Monomoy NWR due to a provision in the National Wilderness Preservation Act and the legislation designating Monomoy wilderness. That said, Monomoy has an unusually low absorption capacity for human impacts. Lack of topographic relief and low vegetation mean that other people are often visible from a long distance. Providing visitors with a convenient way to get out to the islands will result in a diminished degree of solitude, but impacts to the wilderness character of the area will be temporary.

Access to the refuge beach and boat landing sites for the purpose of landing nonmotorized boats poses minimal impacts to plant and wildlife species. Access for kayaking is typically by individuals or small groups. Based on biological data, conservation management plans, unreasonable harassment of wildlife, or destruction of the habitat, the refuge manager may restrict the use or close some beaches and other areas from this and other public use, if it is determined that they could have negative impacts on the resources and bird-nesting activities.

Damage to habitat by walking or dragging a kayak to and from the launch sites is minimal and temporary. At current levels of use, we do not expect increased impacts from boating activities. Several enforcement issues may result from the use, including trampling vegetation, trespass into closed areas, illegal taking of fish (undersized, over limit), illegal fires, and disorderly conduct. Damage to submerged aquatic vegetation, such as eelgrass beds, can result from repeated passes by motorized propellers or boat anchors.

Popular boating seasons coincide in part with spring-early summer nesting and brood-rearing periods for many species of migratory birds. Boaters may disturb nesting birds by approaching nests too closely, causing nesting birds to flush. Flushing may expose eggs to predation or cooling, resulting in egg mortality. Both adult and flightless young birds may be injured or killed if struck by motorized boats operated at higher speeds. Some disturbance of roosting and feeding shorebirds probably occurs (Burger 1981), but will be minimized if closed areas are respected. We will continue to close refuge areas seasonally to all public use, including boating around sensitive nest sites, in conjunction with our conservation partners. We will also continue our public outreach and placement of warning signs.

Pedestrian travel has the potential of impacting shorebird, waterfowl, and other migratory bird populations feeding and resting near the trails and on beaches during certain times of the year. Conflicts arise when migratory birds and humans are present in the same areas (Boyle and Samson 1985). Response of wildlife to human activities includes departure from site (Owen 1973, Burger 1981, Kaiser and Fritzell 1984, Korschgen et al.1985, Henson and Grant 1991, Kahl 1991, Klein 1993), use of sub-optimal habitat (Erwin 1980, Williams and Forbes 1980), altered behavior (Burger 1981, Korschgen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increased energy expenditure (Morton et al. 1989, Belanger and Bedard 1990).

Numerous studies have documented that migratory birds are disturbed by human activity on beaches. Erwin (1989) documented disturbance of common terns and skimmers and recommended that human activity be restricted to a distance of 100 meters around nesting sites. Klein (1993) in studying waterbird response to human disturbance found that, as intensity of disturbance increased, avoidance response by the birds increased, and found that out-of-vehicle activity to be more disruptive than vehicular traffic. Pfister et al. (1992) found that the impact of disturbance was greater on species using the heavily disturbed front side of the beach, with the abundance of the impacted species being reduced by as much as 50 percent. In studying the effects of recreational use of shorelines on nesting birds, Roberton et al. (1980) discovered that disturbance negatively impacted species composition. Piping plovers, which intensively use the refuge, are also impacted negatively by human activity. Pedestrians on beaches may crush eggs (Burger 1987, Hill 1988, Shaffer and Laporte 1992, Cape Cod National Seashore 1993, Collazo et al. 1994). Dogs may chase plovers (McConnaughey et al. 1990), destroy nests (Hoopes et al. 1992), and kill chicks (Cairns and McLaren 1980). Other studies have shown that if pedestrians cause incubating plovers to leave their nest, the eggs can overheat (Bergstrom 1991) or can cool to the point of embryo death (Welty 1982). Pedestrians have been found to displace unfledged chicks (Strauss 1990, Burger 1991, Hoopes et al. 1992, Loegering 1992, Goldin 1993).

Several studies have examined the effects of recreation on birds using shallow water habitats adjacent to trails and roads through wildlife refuges and coastal habitats in the eastern United States (Burger 1981; Burger 1986; Klein 1993; Burger et al. 1995; Klein et al. 1995; Rodgers and Smith 1995, 1997; Burger and Gochfeld 1998). Overall, the existing research clearly demonstrates that disturbance from recreation activities always have at least temporary effects on the behavior and movement of birds within a habitat or localized area (Burger 1981, 1986; Klein 1993; Burger et al. 1995; Klein et al. 1995; Rodgers and Smith 1997; Burger and Gochfeld 1998). The findings that were reported in these studies are summarized as follows in terms of visitor activity and avian response to disturbance.

Presence: Birds avoided places where people were present and when visitor activity was high (Burger 1981; Klein et al. 1995; Burger and Gochfeld 1998).

Distance: Disturbance increased with decreased distance between visitors and birds (Burger 1986), though exact measurements were not reported.

Approach Angle: Visitors directly approaching birds on foot caused more disturbance than visitors driving by in vehicles, stopping vehicles near birds, and stopping vehicles and getting out without approaching birds (Klein 1993). Direct approaches may also cause greater disturbance than tangential approaches to birds (Burger and Gochfeld 1981; Burger et al. 1995; Knight and Cole 1995a; Rodgers and Smith 1995, 1997).

Noise: Noise caused by visitors resulted in increased levels of disturbance (Burger 1986; Klein 1993; Burger and Gochfeld 1998), though noise was not correlated with visitor group size (Burger and Gochfeld 1998).

As detailed above, the proposed use has the potential of intermittently interrupting the feeding habits of a variety of shorebirds, gulls, and terns, but encounters between boaters, pedestrians and migratory birds will be temporary. Refuge staff will manage access via seasonal closures to minimize disturbance to nesting, resting, and foraging waterbirds on the refuge.

Visitors accessing South Monomoy Island including Nauset/South Beach could potentially impact the larval stage of the threatened northeastern beach tiger beetle. The recovery plan for this species describes that many of the species' habitats are threatened by human impacts such as habitat alteration and recreational activities (USFWS 1994). Larval burrows are especially susceptible to trampling, which results in excess energy expenditure and reduced time hunting for the inhabiting individual. We will continue to survey to determine the location and extent of larval beetle occurrence and habitat. We will use area closures to reduce impacts, and re-route trails to avoid larval habitats.

Visitor use also has the potential to disturb loafing seals. Gray and harbor seals haul out on the refuge year-round. We will enforce a 150-foot buffer around all seals as required by the National Oceanic Atmospheric Administration to ensure compliance with the Marine Mammals Protection Act.

Trash left on the beach, particularly food or wrappers, can attract predators that prey on nesting piping plovers and least terns or roosting shorebirds. Litter also impacts the visual experience of visitors (Marion and Lime 1986). Refuge policy advocates leave-no-trace and wilderness stewardship. Impacts are likely to be minimal if conducted in accordance with refuge regulations.

Motorized boats generally anchor in the subtidal waters to avoid stranding on the intertidal flats with the outgoing tide and are therefore anchored outside the Monomoy Wilderness. Motorized boats operating just offshore but outside of the Monomoy wilderness impact the sense of quiet and solitude that some refuge visitors in the wilderness area seek; however, boaters coming to the refuge only temporarily impact quiet as they approach the island at slow boat speeds in order avoid running aground. Kayakers produce little noise and therefore have little impact on the solitude of the wilderness area.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning (CCP) process for the Monomoy National Wildlife Refuge, this compatibility determination will undergo a 60-day public comment period concurrent with the release of our draft CCP/Environmental Impact Statement.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

Operating and landing of motorized boats will only be allowed in designated areas. Nonmotorized boats will be allowed on sections of the beach that are otherwise open for public use. All refuge lands and waters are subject to seasonal closures to public use, including boating, to protect sensitive wildlife and habitat.

Harassment of wildlife and excessive damage to vegetation is prohibited.

No boats, kayaks, or related equipment may be left overnight on the refuge unless the owner is surf fishing on Morris Island, which is the only authorized nighttime use.

Providing outfitting or commercial services for motorized and nonmotorized boating on the refuge requires a special use permit issued by the refuge (see Commercial Tours and Services compatibility determination).

Occasional law enforcement patrol and regular staff and conservation partner presence should minimize potential violations. Refuge regulations will be posted and enforced.

Periodic evaluations will be done to insure that visitors are not causing unacceptable adverse impacts. Areas open to these uses will be evaluated on an annual basis, depending on geomorphology and wildlife use.

The refuge is a leave-no-trace, carry-in-carry out facility. All food containers, bottles, and other waste and refuse must be taken out. Littering, dumping, and abandoning property are prohibited by Federal regulation at 50 C.F.R. 27.93.94.

JUSTIFICATION:

Access to Monomoy Island is restricted to boat. Allowing the operation and landing of motorized and nonmotorized boats provides visitors with a safe means to access and explore Monomoy NWR beyond Morris Island. This access allows visitors to take part in priority wildlife-dependent recreation on the refuge, including wildlife observation, wildlife photography, and recreational fishing. Motorized and nonmotorized boat use will not interfere with the Service's work to protect and conserve natural resources. Motorized boats must land in designated areas to minimize potential impacts to wildlife. The level of use for these activities on the refuge is moderate, and the associated disturbance to wildlife is temporary and minor. Although motorized and nonmotorized boat uses are not priority public uses, under the conditions described above, they are not detrimental activities. Boat access for waterfowl hunting, fishing, wildlife observation and photography, and environmental education and interpretation, which are priority uses, allows visitors to enjoy the outdoors and wild lands. Boating on Monomoy National Wildlife Refuge will not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purposes for which the refuge was established.

SIGNATURE:

Refuge Manager: ______________________________ ______________________________
(Signature) (Date)

CONCURRENCE:

Regional Chief: ______________________________ ______________________________
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: ______________________________

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COMPATIBILITY DETERMINATION

USE:

Nonmechanized harvesting of subterranean shellfish (softshell clams, razor clams, and quahogs) without the aid of artificial extraction methods

REFUGE NAME:

Monomoy National Wildlife Refuge

DATE ESTABLISHED:

June 1, 1944

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Migratory Bird Conservation Act (16 U.S.C. § 715d) Public Law 91-504, 16 USC § 1132(c)

REFUGE PURPOSE(S):

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

…wilderness areas…shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness. (PL 88-577 § 2(a), Wilderness Act; as referenced in P.L. 91-504 § 1(g), An Act to Designate Certain Lands as Wilderness)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the National Wildlife Refuge System (Refuge System) is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (Publ. L. 105-57; 111 Stat. 1252).

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
This compatibility determination is for nonmechanized harvesting of subterranean shellfish and is limited to softshell clams, razor clams, and quahogs; these are the only shellfish species we allow to be harvested on refuge tidal flats and waters. Use of mechanized harvest equipment and artificial extraction methods such as salt or chlorine are not allowed and not considered further in this determination. This compatibility determination does not include other shellfish species, such as mussels or scallops, and does not include eels or marine worms that are defined as shellfish by the Town of Chatham. All clammers operating on the refuge must comply with the Town of Chatham shellfish regulations in addition to other requirements that may be imposed by the U.S. Fish and Wildlife Service (Service).

Fishing is a priority public use of the Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). Shellfishing is a type of fishing and, therefore, a wildlife-dependent public use; however, we also consider it a refuge economic use, as per §50 CFR 25.12 and §50 CFR 29.1, which must contribute to the achievement of refuge purposes or the Refuge System mission.

(b) Where would the use be conducted?
The majority of shellfish harvesting in recent years (10+ years) on the refuge has occurred in intertidal habitat primarily on the western side of North Monomoy Island, especially the southern end, the northern end of South Monomoy, and the eastern side of Minimoy. It also very occasionally occurs in extreme shallow subtidal areas adjacent to intertidal habitat. Shellfish harvest also occurs intermittently within the Powder Hole area in the southwest portion of South Monomoy (see map D.2). This use can occur in any intertidal area of the refuge that supports harvestable populations of these shellfish species. Area closures may occur at any time on Monomoy Refuge based on the need to protect sensitive habitats or species of conservation concern. When these conditions exist, the refuge manager is responsible for ensuring these areas are closed to all public access, including shellfish harvesters. Harvest areas may also be closed to harvest, typically seasonally due to bacterial contamination, by action of the Town of Chatham.

(c) When would the use be conducted?
Shellfish harvesting takes place during daylight hours year-round, from ½ hour before sunrise to ½ hour after sunset, with the number of harvesters peaking during the summer tourism months. Additionally, the Town of Chatham prohibits any harvesting on dry ground or on shoal areas that may become dry on any days when the air temperature is below 30 degrees or does not reach 30 degrees by 11:00 a.m. (*http://www/chatham-ma.gov/public_documents/ChathamMa_shellfish/shellfishregulations120811.pdf*). Harvesters typically arrive around mid-tide on the falling tide (about 3 hours after high tide), and stay on the exposed flat for approximately 6 hours, until the midpoint of the incoming tide (about 3 hours after low tide) when their boats refloat. Arrival and departure times change approximately one hour daily, reflecting the normal daily change in tidal cycle range.

(d) How would the use be conducted?
Shellfish harvesters typically depart for the shellfish flats on and around Monomoy Refuge by boat from one or more off-refuge locations such as Outermost Harbor, Stage Harbor, Chatham Harbor, or Harwichport. Shellfish harvesters at the refuge usually land their boats as near to harvest areas as possible, anchor the boat, and let it ground out with the falling tide. Softshell clam harvesters in coastal New England and on Cape Cod typically use short hand rakes and spend most of their time bent over at the waist or on hands and knees harvesting patches of shellfish. They generally traverse the exposed mudflats only to move among patches of shellfish (Burger 1981, Leavitt and Fraser 2004). Harvesters can turn over approximately 40 m^2 of sediment in a low tide event (Leavitt and Fraser 2004). Quahog harvesters similarly move at a slow pace and generally work in localized patches, but in contrast to softshell clam harvesters, they are usually standing upright and scraping the sediment surface with a long-handled rake. Quahog harvesters generally harvest in water, but in some intertidal areas of Monomoy Refuge, quahog populations have established and can be harvested when the intertidal areas are exposed at lower tides. Hand harvest methods are defined in the Town of Chatham, Shellfish Rules and Regulations §306 (Shellfishing Devices) as those commonly known as the long-rake, scratcher, tong, or clam-hoe. Use of shovels, pitchforks, garden spades, etc., is prohibited. Use of basket rakes attached to a T-handle is also prohibited by town regulation in any areas that become dry at any time during the tidal cycle, e.g., intertidal or supra-tidal areas. Use of hydraulic pumping or other mechanized or motorized harvest methods, formerly permitted in subtidal areas within the Powder Hole area, was prohibited by town regulation in 2011 at the request of the Service. Use of a hand operated plunger is still permitted within the Powder Hole area under town regulations.

Town of Chatham regulations require all harvesters to obtain and have a shellfish permit in their possession while harvesting shellfish. Additionally, all shellfish harvesters must comply with all refuge regulations and with State and Federal guidelines for terns, piping plover, marine mammal, and coastal dune protection. Harvesters are expected to stay apprised of and respect all closures and regulations. Information on annual, seasonal, and daily closures, known hazards, and other regulations is disseminated from refuge headquarters, and closures are marked with informational signs or symbolic fencing.

Map D.2 *Approximate Intertidal Areas Open to Clamming*

Take limits are set by town regulation and the town provides oversight to ensure that clam populations are maintained. If the Service believes clams are being overharvested or the harvest of clams appears to be impacting refuge wildlife populations, the Service will collaborate with the Commonwealth, the town, or through refuge regulations to lower harvest levels on the refuge.

(e) Why is this use being proposed?
Shellfish harvest from intertidal areas for human consumption using simple hand methods has been practiced continuously since the earliest known human occupation of the area, and remains an important part of local culture and diet (Lotze and Milewski 2004, Lotze 2010). Hand harvesting of shellfish from intertidal areas was an established subsistence use in and around Monomoy Point well before the area was established as a national wildlife refuge in 1944, and it continued through the evaluation and designation of the Monomoy Wilderness in 1970. The use remains a popular and significant activity to local communities. The Town of Chatham began administering a traditional shellfishery in the early 1900s that still continues a century later.

The Service has consistently determined since refuge establishment that harvesting shellfish for human consumption from intertidal areas using traditional, hand harvest methods is a compatible use of the refuge. The environmental assessment for the 1988 refuge master plan included shellfish harvesting as part of the public use program, and acknowledged Monomoy Refuge's importance to local shellfishers as a source of softshell clams, quahogs, and surf clams. That 1988 master plan established an index to local shellfish harvest trends by summarizing town-issued shellfish harvest permits.

In a 1994 compatibility determination, the Service found that hand harvest of shellfish (softshell clams) from intertidal areas of the refuge, conducted in accordance with Town of Chatham and refuge regulations and closures, was compatible with the purposes for which Monomoy Refuge was established.

Shellfish harvesting using traditional hand raking methods has coexisted for decades with migratory birds and other wildlife species of conservation concern that use the expansive and dynamic intertidal flats around Monomoy NWR. Shellfish harvest using traditional hand raking methods within the Monomoy Wilderness can provide a rare, outstanding opportunity for solitude or primitive and unconfined type of recreation in a primarily natural, undeveloped coastal barrier system landscape. Nonmechanized shellfish harvest from intertidal refuge areas affords refuge visitors an opportunity to increase their understanding and appreciation of the refuge, its resources, resource management, and refuge regulations along with traditional, local cultural practices.

AVAILABILITY OF RESOURCES:

The Town of Chatham Shellfish Constable bears primary (full time) responsibility for sustainable shellfish stewardship and regulatory enforcement throughout the town, including Monomoy NWR. Demands on Service resources (staff time and funding) resulting from this use are limited to coordinating shellfish regulation or management concerns identified with the Town Shellfish Constable, Shellfish Advisory Committee, and other town officials, as well as biological monitoring and law enforcement compliance oversight. The following breakdown shows the estimated amount of funds needed annually to cover costs associated with managing the hand harvest of subterranean shellfish on the refuge.

Staff Time to Administer the Program

Identifier	Cost
GS-12 Refuge Manager — coordinate w/ Town of Chatham (4 person-days/year)	$2,000.00
GS-09/06 Law Enforcement Staff — compliance oversight(20 person-days/year)	$6,000.00
GS-11 Refuge Biological Staff — monitoring, proposing closures, producing maps, coordinating with the Town of Chatham (10 person-days/year)	$4,000.00
Total recurring annual cost	**$12,000.00**

ANTICIPATED IMPACTS OF THE USE:

Background/Introduction

The magnitude and duration of both beneficial and adverse impacts on the intertidal substrate and waters, invertebrate populations, and higher trophic-level organisms, are influenced by the frequency, intensity (areal extent and depth), and efficiency of harvest effort. Actual shellfish harvest impact stems from the spatial extent and degree that the pre-disturbance and post-disturbance intertidal environments differ (Beukema 1995, Ray 2005). Impacts of hydraulic or mechanical shellfish dredges on intertidal bottom structure and benthic invertebrates are typically greater and longer lasting than those from hand harvest (Ferns et al. 2000, Piersma et al. 2001, MacKenzie and Pikanowski 2004, Verhulst et al. 2004, Munari et al. 2006, Kraan et al. 2007, Peterson and Estes in press). However, those mechanical harvest methods are not allowed on the refuge, and are not considered further in this compatibility determination.

The following summaries of potential impacts from shellfish harvesting are focused on those derived from non-mechanical hand harvest. Harvesting shellfish can range from a single surface sediment turning event (low intensity-impact) by hand digging to a repetitive (high intensity-impact) excavation of the same location within a short (days to weeks) time period (Leavitt and Fraser 2004). For Monomoy NWR, intertidal sediment disturbance from hand digging occurs on an annual to bi-annual basis, rotating between different areas during post-harvest recovery intervals, and we deem it to be generally low intensity and low impact in nature.

The following impacts discussion focuses on potential and expected impacts from shellfish harvesting as they relate to the refuge's two establishment purposes and related physical and biological resources. Although the topics are interrelated, for ease of presentation we chose to organize this section into four main categories: substrate and water quality, benthic communities, migratory shorebirds and other species of conservation concern, and wilderness character.

We reference low, moderate, and high interest levels for shellfishing in our impacts discussion. Those levels are based on permit issuance data reported by the Town of Chatham in annual reports from 1989 to 2011. Low corresponds to 0 to 350, moderate corresponds to 350 to 500, and high corresponds to more than 500 permits issued annually by the town.

Substrate and Water Quality

Nonmechanized hand harvest methods addressed in this compatibility determination include the use of rakes to harvest shellfish and the use of hand plungers in Powder Hole, but only where at least 1 foot of water depth occurs at mean low tide. The potential concern is the disturbance to bottom sediments that, in turn, can affect water quality when the sediments become re-suspended during subsequent tidal cycles. These filter-feeding shellfish also can provide significant water purification services within nearshore estuarine systems (Burke 2009, see also *http://www.ct.gov/doag/cwp/view.asp?a=1367&q=478090;* last accessed 09/19/2013).

An individual softshell clam harvester in New England can turn over approximately 40 m^2 of sediment in a single low tide event (Leavitt and Fraser 2004). Clam rakes typically penetrate just the top 12 inches or less of substrate. If there are, on average, 200 tides (days) harvested annually, then each harvester potentially disturbs approximately 8,000 m^2 (0.8 hectares or 2 acres) annually to a depth of approximately 12 inches (2 acre-feet/year/harvester). Once an area is harvested, it generally takes 1 to 3 years before harvestable clams have repopulated the flat (Brown and Wilson 1997, Leavitt et al 2010). At historically low interest levels, approximately 250 permitted harvesters would impact 200 ha (494 acres), at moderate interest levels, approximately 450 permitted harvesters would impact 360 ha (889 acres), and at high interest levels, approximately 600 permitted harvesters would impact 480 ha (1,186 acres) of shellfish substrate throughout town-administered shellfishing beds. To put this level of potential impact into a local context, the State-designated shellfish harvest area surrounding Monomoy Island (SC47), which includes nearly 80 percent of the Town of Chatham's intertidal shellfish flats, encompasses 37,831 acres. Even if all shellfish permit-holders in Chatham harvested exclusively within SC47 during years of high interest (a worst-case scenario), only 3.1 percent (1,186 acres) of those 37,831 acres would be impacted annually. Current levels of interest are generally low, and there are 16 other State-designated shellfish harvest areas elsewhere in Chatham that receive some of the total annual shellfish harvest effort by residents and visitors.

When the incoming tide re-floods the exposed intertidal substrate, sediment can be re-suspended (Coen 1995, Ray 2005, Munari et al. 2006, Peterson and Estes in press). Observed effects are typically site-specific and influenced by sediment grain size and type, hydrological conditions, faunal influences, currents, water mass size, and configuration (Hayes et al. 1984, LaSalle 1990, Barnes et al. 1991, Coen 1995). Although we are unaware of studies that specifically evaluate the impacts of nonmechanized shellfish harvesting on substrates and water quality, other studies do provide some evidence of possible impacts from sediment re-suspension.

Effects of sediment re-suspension can include reduced light available for photosynthesis, burial or smothering of benthic biota and spawning areas resulting in anoxic conditions, and negative effects on feeding and metabolic rates of intertidal organisms (Johnson 2002). Re-suspension may also impact nutrient budgets due to burial of fresh organic matter and exposure of deep anaerobic sediment, upward flux of dissolved nutrients in pore water, and changes in benthic infauna metabolism (Mayer et al. 1991, Pilskaln et al. 1998). However, the finer particles re-suspended are often quickly flushed back out of the area by tidal currents in dynamic, higher wave energy situations such as those of moderate energy on the refuge's intertidal flats, leaving behind only heavier and coarser particles that settle out of suspension more rapidly (Leavitt et al. 2010).

Undisturbed clam flats tend to progress from dynamic sand or sand-mud textures, which are indicative of higher wave energy situations and high softshell clam productivity, toward finer silt-like sediments higher in organics and indicative of lower wave energy and lower clam productivity (Rask 1986, Leavitt and Fraser 2004, Leavitt et al 2010). The flats surrounding Monomoy Refuge are currently at the sand or sand-mud and higher clam productivity end of this gradient. Wave energy alone helps retard the natural maturing of the clam flats surrounding Monomoy NWR. Over long time frames, as undisturbed substrate texture gets finer and the organic fraction increases and decomposes, consuming oxygen in the process, dissolved oxygen levels decline (hypoxia) and can eventually lead to anaerobic or anoxic conditions within the substrate. Once decomposition shifts to anaerobic conditions, hydrogen sulfide, a known toxin for many aquatic organisms is also produced. Also, undisturbed tidal sediments can tend toward a more compact condition (Rowell and Woo 1990, Leavitt and Fraser 2004). The finer sediment particles grow closer together over time, reducing interstitial spaces (Leavitt and Fraser 2004).

Periodic disturbance of the surface sediments, such as results from hand harvesting shellfish, aerates the surface sediments and can halt or retard this very long-term tendency toward anoxic conditions, loosening more compact (low clam productivity) substrate conditions. Such disturbances increase bottom roughness, decrease organic loading, and reduce compaction within the substrate (Leavitt and Fraser 2004).

Seston are minute living organisms and particles of nonliving matter floating in the water that contribute to turbidity. In their Maine intertidal study area, Kyte et al. (1975) found that ambient, natural seston levels (6.9 to 441 mg/1) where baitworm digging occurs using a method similar to hand raking, often met or exceeded the short-term maxima (turbidity level 584 mg/l) associated with shellfish harvesting.

Re-suspension of sediments occurs naturally during storms, or from other human activities such as operating boats in shallow estuarine areas. This relationship between naturally occurring and human-caused sediment suspension has not been studied on Cape Cod. However, Monomoy Refuge is characterized by a more dynamic system of tide- and wind-driven shifting sands than the area Kyte et al. (1975) studied. Water turbidity from suspended sediments is not commonly reported as a concern for the intertidal waters surrounding the refuge. It is therefore likely that, for the refuge, natural tide-driven and wind-driven sand movements cause more sediment re-suspension than shellfish harvesting activity does.

Benthic Community

The larger size-class shellfish sought by harvesters for human consumption are part of the available mature, breeding population for shellfish species that, like many other marine organisms, exhibit sporadic and somewhat unpredictable reproductive success. For the Monomoy intertidal areas, the interval required for softshell clams to attain harvestable size from larval recruitment is approximately 1.5 to 2 years (Leavitt and Fraser 2004, citing S. Moore personal communication), after which growth slows as energy intake is redirected to reproduction. The clams typically exhibit a patchy, uneven distribution across intertidal areas (Newell and Hidu 1986, Leavitt and Fraser 2004, Leavitt et al 2010). Once an area is harvested of legal-sized clams, harvesters move to a new location (Leavitt et al 2010).

Additionally, shellfish targeted by harvesters are but one component of a diverse marine invertebrate community. The invertebrate assemblage is at the base of a complex food web. Many other higher trophic level organisms depend on the invertebrate fauna inhabiting intertidal flats are also valued by people or are otherwise of conservation concern. Direct and indirect mortality induced by shellfish harvest, recruitment or reproductive failures that delay population recovery, and shifts in species diversity toward smaller, short-lived and more mobile species can reduce the abundance of preferred prey items for higher trophic level predators such as amphipods, copepods, echinoderms, gastropods, crabs, fish, or birds (Piersma et al. 2001, Verhulst et al. 2004, Peterson and Estes in press). Therefore, in this section we consider impacts to non-target species.

Direct Harvest Impacts

Experienced hand harvesters routinely remove a majority (84 percent according to Dow and Wallace 1957) of the largest (legal-sized) clams from a given location during a single digging event. These larger individuals are the reproductively active adults on which future recruitment and shellfish resource sustainability depends. In their 2004 literature review, Leavitt and Fraser state that adult softshell clam removal permits increased larval recruitment (citing Pfitzenmeyer 1962 and Peterson et al. 1987), more rapid juvenile growth (citing Turner 1951), and reduced predation (citing Boulding and Hay 1984). Evidence indicates softshell clams can saturate intertidal habitat, reaching very high densities, with intense competition for food and growing space, and substantially reduced reproductive, larval recruitment, and growth rates (Leavitt and Fraser 2004, citing Belding 1930, Turner 1953, Dow and Wallace 1957, Goshima 1982, Newell and Hidu 1986, and Ellis 1998). The net result is a dense population of smaller-sized adult clams existing nearer the surface where they are more vulnerable to predation, combined with low recruitment rates. Older, less mobile adult clams at high densities are susceptible to die-off, burial from moving sediment, or anoxia from depleted dissolved oxygen, forming "clam graveyards" (Leavitt and Fraser 2004, citing Dow and Wallace 1957), bed compaction, and reduced larval recruitment (Leavitt and Fraser 2004, citing Kyte and Chew 1975).

Direct mortality or injury of residual, unharvested shellfish (generally sub-legal sized) can occur from harvesting rakes that contact shellfish, from trampling underfoot, or from rough handling by the harvester during measuring and sorting (Heffernan 1999, Ferns et al. 2000, Johnson 2002). During shellfish harvest activities, many invertebrates are discarded and left on the intertidal flats near where they were taken, alive and intact, injured, or dead. Reasonably intact live individuals rebury themselves within a few minutes, leaving only moribund ones on the surface (Ferns et al. 2000). Kaiser et al. (2001) found hand raking for cockles led to an initial three-fold increase in the damage rate of under-sized cockles compared with control plots. In contrast to hand harvesting, mechanical harvesters, e.g., escalators, typically produce less mortality to discarded target bivalve species because physical impact damage is less likely (Kyte and Chew 1975, Peterson et al. 1983, 1987). However, hand harvesters typically harvest much smaller total quantities than more efficient mechanical methods. Thin-shelled bivalves and soft-bodied invertebrates such as marine worms or starfish show higher damage than solid-shelled bivalves in fished areas (Rumohr and Krost 1991). Animals able to retract below the seafloor surface or living below the fishing gear penetration depth sustain less harvest damage than epibenthic organisms. McLaughlin et al. (2007) found hand raking did not affect the ability of cockles (*Cerastoderma edule*) to rebury themselves at Strangford Lough, Ireland, and small cockles had a faster mean burial rate than larger cockles (51.7 percent and 31.1 percent, respectively). The research of Savage (1974-1976) on Narragansett Bay, Rhode Island, hard clams showed that, in the warm summer temperatures it took 10 to 20 minutes to burrow into the bottom after being left on the surface, while it took an hour at 10°C (50° F). This means that between mid-November and early May when temperatures were cooler, clams left on the surface by rakes or transplantation were more vulnerable to predators because of their longer surface exposure.

Indirect Harvest Impacts

The initial impact of physical disturbance associated with shellfish harvesting on intertidal flats is a reduced standing crop of most non-target species within the disturbed area (Leavitt and Fraser 2004, Leavitt et al 2010). Many researchers have documented decreased infauna biomass following disturbance (Kyte et al. 1975, Hall et al. 1990, Hall and Harding 1997, Spencer et al. 1998, Engelhard and Withers 1999, Leavitt and Fraser 2004). Biomass loss can range from 40 percent (van den Heiligenberg 1987) to 100 percent (McLusky et al. 1983).

Benthic recovery following harvest disturbance depends on the intensity and frequency of disturbance, life history of the benthic organisms disturbed, and elapsed time since disturbance. Repopulation and recovery of disturbed areas results from migration, passive translocation from surrounding areas, and recruitment of new individuals from natural reproductive cycles (Leavitt and Fraser 2004, citing van den Heiligenberg

1987, Hall et al. 1990, Guenther 1992, Shull 1997). Large or hard-bodied organisms such as target and non-target shellfish, or sedentary bait worms such as lugworms *Arenicola* sp., may depend more on recruitment than immigration for post-disturbance recovery (Cryer et al. 1987, Leavitt and Fraser 2004). Due to annual periodicity of seasonal reproductive cycles, this can mean slower re-colonization of disturbed areas (Shull 1997, Leavitt and Fraser 2004).

Anoxia and hydrogen sulfide toxicity within the intertidal substrate results in the mortality of nearly all sedentary organisms, including shellfish and many other invertebrates (Evans 1967, Leavitt and Fraser 2004). Increasingly anoxic and more compact substrate conditions reduce softshell clam productivity (Leavitt and Fraser 2004). Cox (1991) noted that baitworm digging, similar to the hand harvest methods included in this compatibility determination, redistributed anaerobic sediment layers upwards to the surface, with losses of all invertebrate infauna except small species that are tolerant of anoxic conditions. Feeding invertebrates like crabs, bivalves, and crustaceans, along with marine worms and echinoderms with limited mobility, will die if oxygen is deprived for sustained periods (Peterson and Estes in press).

Organic fractions that may be re-suspended from the intertidal sediments during hand harvesting can increase food availability for filter feeding shellfish, thereby benefitting shellfish survival, growth, and reproductive output (Leavitt and Fraser 2004). Compaction of the substrate over time in undisturbed sediments can resist benthic fauna from anchoring or burrowing in the substrate. For example, newly settled softshell clam larvae attach and anchor themselves in the substrate by means of byssal threads, important for evading predation. Loosening and roughening of the surface sediment layers that results from hand harvesting can maintain more favorable conditions for recruitment of new individuals into the population, aiding post-harvest recovery (Turner 1951, Ellis 1998, Mullineaux et al.1999, Leavitt and Fraser 2004, Leavitt et al. 2010). However, this impact is likely more pronounced (shorter time scale) in finer texture, high organic fraction situations than the more naturally dynamic sand-dominated substrate conditions that exist around Monomoy Refuge.

Depending on the spatial scale involved, changes in bottom topography can have profound effects on benthic infauna (Ray 2005). Dernie et al. (2003) showed that a difference of only 10 cm in the amount of material removed during mechanized harvest from a sand flat in Wales, United Kingdom, resulted in a substantial decrease in benthic fauna recovery rate. Plots where 20 cm of sediment were removed required 208 days for infaunal community reestablishment; plots with 10 cm removed recovered in 64 days. While hand harvest as employed at the refuge does disturb some surface sediment in limited intertidal areas, the disturbed sandy sediment largely remains onsite, is reworked during subsequent tidal cycles, but is not removed from the site (Leavitt and Peters 2005).

In contrast, invertebrates may be inadvertently reburied at depths exceeding their ability to migrate upwards or extend filter-feeding structures into the water. Smothering with anoxic sediments during harvesting and backfilling can cause benthic invertebrate mortality (Cox 1991, Coen 1995). Logan (2005) found sediment turnover from clam hand digging in a mid-coast Maine intertidal mudflat can deposit *Corophium volutator* (an amphipod that is an important shorebird prey item) at greater depths below the sediment surface; without any connection to the sediment surface, mortality can result. In an upper Bay of Fundy intertidal mudflat, the overall density of *C. volutator* decreased by 38.8 percent in the first year of baitworm hand raking harvesting due to lower juvenile recruitment and direct mortality. Juveniles were particularly susceptible to disturbance (a 55 percent decrease), and because juveniles must overwinter to become the next year's potential breeders, this decrease compounds with each subsequent year of harvesting (Shepherd and Boates 1999). Some *C. volutator* are also killed during digging. The survivors may migrate (swim) and risk death in search of better habitat, likely because the loosening of sediment and increase in water content makes re-excavation of burrows difficult (Shepherd and Boates 1999). The mud substrate in the above referenced Bay of Fundy study area is much finer textured and higher in organic content than the sand-dominated substrate present around Monomoy Refuge (D. Brownlie, personal communication 2013). Bait worm harvest is also typically a more intensive and frequent disturbance than clam harvest around Monomoy Refuge (Leavitt et al. 2010).

In addition to depositing *C. volutator* at greater depths below the sediment surface, clam digging disturbance in a mid-coast Maine intertidal mud flat destroyed *C. volutator* tube dwellings. The subsequent high energy demands for tube reconstruction placed on surviving individuals potentially resulted in reduced growth and reproduction or eventual mortality (Logan 2005). Mean density of *C. volutator* ranged from 89.1 ± 179.6

individuals/m^2 for weekly disturbance, to 1,522.6 ± 378.8 individuals/m^2 for undisturbed controls. *C. volutator* abundance was reduced for all disturbance frequencies in relation to control conditions, even in plots that were only disturbed on day one of the experiment. This significant decrease in abundance suggests that *C. volutator* abundance, and potentially other amphipod abundance, can be significantly reduced even by low digging frequencies.

Many relevant studies have not shown long-term significant changes to benthic communities resulting from shellfish harvest, with the exception of changes in distribution of the target (harvested) species. Coen (1995) surmised that since many small benthic organisms, e.g., crustaceans, polychaetes, mollusks, have rapid generation times, high fecundities, and excellent re-colonization capacities, it is generally accepted that this benthic community effect is only short-term (Godcharles 1971, Peterson et al. 1987, Bennett et al. 1990, Hall et al. 1990). For example, MacKenzie and Pikanowski (2004) found little to no effect on benthic communities resulting from raking in sandy, subtidal substrates, and attributed this lack of effect to invertebrates' adaptation for survival in environments where sediments are naturally re-suspended by severe storms.

Sandy-bottom communities such as those around Monomoy, subjected to higher energy (more frequent natural disturbance), tend to exhibit relatively rapid rates of re-colonization and recovery compared to more sheltered, lower energy, finer textured or biogenic substrates (Munari et al. 2006, Peterson and Estes in press). Newell et al. (1998) point out that benthic assemblages in fine-grained sediments recover faster than those in coarse-grained sediments. Coen (1995) also cites other studies using hand and mechanical shellfish harvesting gear in diverse habitats in Florida (Godcharles 1971), Washington (Tarr 1977, Vining 1978, Goodwin and Shawl 1978, 1980), Maine (Kyte et al. 1975), North Carolina (Peterson et al. 1983, 1987), Rhode Island (Glude and Landers 1953), Scotland (Hall et al. 1990), and Canada (Adkins et al. 1983), and all found no discernible long-term effects on local infaunal populations, with the exception of the more sedentary harvested bivalve species (compare Kyte et al. 1975, Peterson et al. 1987, Hall et al. 1990). Similarly, Logan (2005) found sediment turnover from clam digging in a mid-coast Maine intertidal mudflat did not affect the abundance of 10 benthic macroinvertebrate species, including polychaetes, crustaceans, and bivalves. However, Heffernan (1999) references Spencer's (1996) observation that a single hand-raking clam harvest caused about 50 percent reduction in species diversity, with a time frame of 8 months for site recovery.

Repeated physical disturbance can decrease productivity of affected communities (Odum 1985, Gray 1989). The effects of a single passage of a rake as is typical around Monomoy Refuge may be relatively limited; chronic raking, atypical for the Monomoy Refuge vicinity, may produce long-term changes in benthic communities (Jennings and Kaiser 1998). If disturbance is routine, the post-disturbance benthic communities are likely to be less abundant and diverse than in undisturbed habitats (Ray 2005). Marinelli and Woodin (2002) demonstrated that disturbing the surface of soft sediments altered sediment chemistry, making it less attractive for recruiting infauna.

Although the rate of recovery from hand raking can be highly variable in space and time, low intensity traditional harvesting appeared to have little impact on benthic communities (Kaiser et al. 2001). Kaiser et al. 2001 found that benthic communities subjected to hand raking for cockles showed community changes, compared to control plots 14 days after the initial disturbance. The small raked plots had recovered 56 days after the initial disturbance whereas the large raked plots remained in an altered state. Even in sands, recovery can be delayed (100 days to over a year) so that frequent intense harvesting will maintain the resident benthic communities in a permanently disturbed state (Piersma et al. 2001, Peterson and Estes in press). Kaiser et al. (2001) concluded from benthic samples collected from plots over a year after hand raking for cockles that small-scale variations in habitat heterogeneity had been altered, suggesting that, while effects of hand raking may be significant within a year, they were unlikely to persist beyond that time scale unless larger, long-lived species are present within the community.

The ability of invertebrates to recolonize depleted areas is very variable, depending heavily on recruitment of young. Many polychaetes are highly mobile and capable of colonizing depleted areas of intertidal habitat quite rapidly, while mollusks that bury more deeply, e.g. *Macoma balthica,* or tube dwellers such as *Lanice conchilega,* are capable of much more limited movement. The fact that more complex and productive intertidal communities take longer to achieve stability after disruption is not surprising. Another recovery rate factor is the longevity of the species involved. Large species such as *Arenicola marina*, softshell clams and *Ensis* *sp.* take several years to reach maturity and, therefore, take much longer to recover than smaller species (Beukema 1995).

Given the higher (moderate) wave energy, the dynamic sand-dominated intertidal sediments surrounding Monomoy Refuge, and an abundance of expansive flats allowing a relatively low intensity-frequency of disturbance events from hand raking for shellfish, post-harvest depletion of benthic fauna biomass is expected to be a relatively short 0.5 to 12 month duration (Leavitt et al. 2010). Benthic invertebrate faunal community recovery of small invertebrate prey for migratory shorebirds to pre-disturbance levels is expected at harvested sites well before the 1.5 to 2 years required for recruits in the target shellfish species in the Monomoy Refuge area to attain the minimum legal size harvesters seek (Leavitt and Peters 2005, citing S. Moore).

Migratory Shorebirds and Other Species of Conservation Concern

Migratory shorebirds and horseshoe crabs are among the predators of clams and other benthic invertebrates inhabiting the intertidal substrates around Monomoy NWR. These species benefit from abundant small-sized clams and other associated benthic invertebrates.

Protecting high-quality stopover sites, which shorebirds use while migrating long distances between breeding and non-breeding grounds, is a particularly important shorebird conservation concern (Senner and Howe 1984, Myers et al. 1987, Helmers 1992). High-quality stopover sites provide abundant food and a disturbance-free environment, allowing shorebirds to maximize foraging time, replenish energy reserves, and continue migration in good body condition (Myers et al. 1987, Helmers 1992, Brown et al. 2001). Lower-quality stopover sites may affect shorebirds' ability to reach breeding or non-breeding grounds, and may reduce survivorship (Pfister et al. 1998, Baker et al. 2004). Monomoy Refuge is an important stopover site, especially during the southbound (fall) shorebird migration.

Declining prey availability at Delaware Bay, a critical stopover site for northward shorebird migrants, has been implicated in reduced breeding success and annual survival of red knots (*Calidris canutus*) (Baker et al. 2004). Similarly, the annual return rate of semipalmated sandpipers (*Calidris pusilla*) at a southbound stopover site in Massachusetts was higher for birds with more body fat at time of departure (Pfister et al. 1998), suggesting body condition at departure was related to survival. Vulnerability to changes in habitat availability or suitability is likely amplified for migrating shorebirds because large concentrations of shorebirds rely on just a few sites (Myers 1983, Senner and Howe 1984, Myers et al. 1987). Coastal stopover sites, in particular, are increasingly subjected to development and human disturbance, and loss of high- quality stopover habitat is likely one factor contributing to declines in local abundance and overall populations of shorebirds in North America (Myers et al. 1987, Pfister et al. 1992, Brown et al. 2001).

Monomoy NWR was designated a Western Hemisphere Shorebird Reserve Network Site of Regional Importance in 1999, based on a maximum one-day fall count of approximately 21,000 shorebirds (WHSRN 2006). The refuge provides habitat for significant numbers of shorebird species that are listed as: highly imperiled or high concern by the U. S. Shorebird Conservation Plan (Brown et al. 2001), as highest or high priority within Bird Conservation Region 30, New England / Mid Atlantic Coast (Atlantic Coast Joint Venture 2005), and as birds of conservation concern in Region 5 (Maine to Virginia) by the Service (2008). Some species of shorebirds, such as American oystercatcher (*Haematopus palliates*) (Veit and Petersen 1993) and the federally threatened piping plover (*Charadrius melodus)* (Hecht 1997, unpublished memo), are also extremely dependent on Monomoy Refuge during the breeding season. Surveys conducted in 2006 and 2007 estimated relative abundance of all shorebird species at Monomoy Refuge (Koch and Paton 2009).

Human disturbance at stopover sites can reduce habitat quality through direct impacts that may displace shorebirds or alter their behavior, or indirect impacts that have an effect on prey populations (Brown et al. 2001).

Direct Impacts to Migratory Shorebirds

Human disturbance causing changes in foraging shorebird behavior and distribution of shorebirds at foraging and roosting sites has been well-documented. Sites with extensive disturbance caused by humans walking or jogging and the presence of dogs reduce foraging time for migrating common redshank (*Tringa totanus*) and Eurasian curlew (*Numenius arquata*) (Fitzpatrick and Bouchez 1998), and decrease foraging rates for migrating snowy plover (*Charadrius alexandrinus*) and sanderling (*Calidris alba*), including sanderlings on non-breeding grounds (Burger and Gochfeld 1991, Lafferty 2001a, Thomas et al. 2003). Prolonged or intense human disturbance may also cause shorebirds to expend more energy to avoid disturbances (Helmers 1992), or completely abandon a site (Furness 1973, Burger 1986, Pfister et al. 1992). Pfister et al. (1992) suggested disturbance measured by vehicle counts as a potential factor in declining numbers of southward migrating red knots and short-billed dowitchers (*Limnodromus griseus*) roosting at a stopover site in Massachusetts between 1972 and 1989.

While shorebirds reduce their foraging rates, flush more easily, and abandon areas with increased human presence (Burger 1981, Burger and Gochfeld 1991, Lafferty 2001a, Thomas et al. 2003), the degree of shorebirds' response varies with different human activities (Burger 1981, Burger 1986, Pfister et al. 1992, Lafferty 2001b). At a non-breeding site in California, stationary people along the beach disturbed shorebirds less frequently, and for fewer birds overall for each disturbance, than mobile people, and joggers disturbed twice as many shorebirds as walkers during each disturbance event (Lafferty 2001b). Similarly, fast-paced activities involving rapid movements, such as jogging, were more likely to disturb waterbirds than slow-moving activities, such as worm and clam harvesting (Burger 1981).

Despite documented changes in behavior of shorebirds exposed to human disturbance, published research establishing empirically based buffer distances to minimize disturbance to migrating shorebirds is sparse. In 2006 and 2007, we conducted experimental research on the refuge to determine flushing distances of the 11 most common migrating shorebird species. We used these empirical data to establish buffer distances that we feel minimize disturbance to migrating shorebirds (Koch and Paton in prep), and will implement these buffers in areas where shorebirds congregate and human disturbance is prevalent.

Species	Buffer Distance Range (m)
Least sandpiper	61
Semipalmated sandpiper	76
Semipalmated plover	77
Sanderling	86
Dunlin	89
Short-billed dowitcher	97
Willet	113
Red knot	124
Ruddy turnstone	125
American oystercatcher	165
Black-bellied plover	186

Indirect Impacts to Migratory Birds

As previously discussed, shellfish harvesting can alter benthic communities or reduce prey availability for shorebirds that feed on benthic organisms. Burial or mechanical (vertical) redistribution of invertebrate infauna to deeper depths in the substrate may additionally reduce the availability of invertebrate prey to predators. Many worms and crustaceans are most active and closest to the surface when the tide just covers or uncovers the sediments. For example, sediment disturbance associated with commercial harvest of bloodworms (*Glycera dibranchiata*) in the Bay of Fundy negatively impacted populations of mud snails (*Llyanassa obsolete)*, the primary prey of southward migrating semipalmated sandpipers (Shepherd and Boates 1999). Many birds and fish rely on visual cues when foraging. Turbidity due to re-suspension of intertidal sediment can significantly reduce foraging efficiency for sight-feeding predators (Vinyard and O'Brien 1976, Gradall and Swenson 1982, Gregory 1990, Servizi 1990, Peterson and Estes in press). Decreased foraging efficiency by fall migrating semipalmated sandpipers may have been related to the obstruction of visual and tactile prey cues caused by turning and loosening of the surface sediment from intensive hand-raking for baitworms (Shepherd and Boates 1999).

Observations at Monomoy Refuge in 2005 and 2006 suggested that some species of shorebirds remained farther from a standing person than from shellfish harvesters (Leavitt et al. 2010). Soft- shell clam harvesters in coastal New England typically use short hand rakes, spend most of their time bent over at the waist or on hands and knees harvesting patches of shellfish, and traverse the exposed mudflats only to move among patches (Burger 1981, Leavitt and Fraser 2004). Anecdotal observations of shorebirds congregating in recently shellfished areas at Monomoy Refuge (Leavitt et al. 2010) suggest that sediment turnover associated with softshell clam harvesting may expose additional prey that would normally be at depths unavailable to shorebirds, thereby providing a net benefit to some species of foraging shorebirds (Leavitt and Peters 2005). Our own anecdotal observations of shorebirds in 2005 and 2006 suggested that some species of shorebirds might be attracted to areas where shellfishing had recently occurred (Koch 2011). Aspinall (1992) notes that most forms of intertidal shellfish harvesting, including manual digging, provide some initial increased feeding opportunities for some birds. Other studies have also shown that discarded or injured invertebrates or shellfish are consumed by higher trophic species, including gulls, fish, crabs, echinoderms, and gastropods (Manning 1959, Caddy 1973, van der Veer et al. 1985, Eleftheriou and Robertson 1992, Hall 1994, and Kaiser and Spencer 1994). A possible immediate increase in prey availability of some species may be ephemeral (as in Ferns et al. 2000), or may be offset by negative impacts to other prey species that are subsequently buried (as in Emerson et al. 1990).

In 2007, we conducted surveys of shorebirds abundance and foraging behavior in areas that were and were not subjected to shellfish harvesting activity to determine if shellfish harvesting influenced shorebird abundance. Based on density estimates of shorebirds in the harvested and unharvested plots, shellfish harvesting activities appeared to have a positive influence on the mean density of American oystercatchers and ruddy turnstones. However, for most species of shorebirds we studied, shellfishing activity did not appear to affect the density of birds on study plots. We also did not detect any differences in the proportion of birds that were foraging in harvested and unharvested areas for all species, and generally, more than 90 percent of all birds were foraging on all plots, regardless of shellfishing activity. We did detect seven species, black-bellied plover, ruddy turnstone, semipalmated plover, sanderling, semipalmated sandpiper, dunlin, and short-billed dowitcher, actively foraging in shellfish holes or the remaining adjacent sediment piles (Koch and Paton in prep).

At Monomoy NWR, we do not anticipate any substantial direct adverse long-term impacts from nonmechanized shellfish harvesting on migratory shorebirds, species fundamental to fulfilling the refuge migratory bird purpose. Further, recent surveys of shorebird abundance and foraging behavior in harvested shellfish areas show an apparent beneficial influence on American oystercatcher and ruddy turnstone densities relative to unharvested areas. While no measureable beneficial effect was observed for any other shorebird species studied at Monomoy Refuge, shorebirds representing six additional species appear to receive short-term benefit in the form of foraging opportunities immediately following shellfish harvest disturbance, as they were observed actively foraging in shellfish holes or residual sediment piles.

Wilderness Character

North Monomoy Island and South Monomoy make up the Monomoy Wilderness. The untrammeled environment and solitude of the Monomoy Wilderness, accessible only by boat or lengthy hike along the barrier beach, make it unique among the protected areas on Cape Cod. Motorized boats operated by shellfish harvesters generally slowly approach and depart the intertidal flats through the adjoining shallows, which reduces engine noise and boat wake. Monomoy refuge has an unusually low absorption capacity for human impacts. Lack of topographic relief and low vegetation mean that intrusions, including seeing and hearing other people, are often detectable from a long distance. Shellfish harvesting on intertidal flats visible from elsewhere within the Monomoy Wilderness may result in a diminished degree of solitude for some wilderness users, but should not adversely affect the overall wilderness character of the Monomoy Wilderness.

The majority of the Monomoy Wilderness will remain essentially unvisited and virtually undisturbed by the current and expected low intensity intertidal shellfish harvesting taking place around Monomoy Refuge. Visible impacts from hand digging are temporary, generally lasting a few hours before the next tidal cycle erases most traces of digging from a harvested area. These physical disturbances are most evident near shellfish harvest sites, but are not expected to substantially compromise the perception of naturalness of the Monomoy Wilderness landscape nor impact the wilderness user's experience (Cole 2002, Hendee and Dawson 2002).

Wilderness visitors' experiences are more strongly affected by social conditions, such as other visitors and their actions, than by their perception of naturalness or ecological conditions (Hendee and Dawson 2002). The wide and expansive intertidal flats and barrier beaches where most shellfish harvest takes place afford users an unconfined experience (Hendee and Dawson 2002). With typically long sight distances across the rolling, nearly treeless, intertidal and coastal barrier landscape, too many individuals encountered or observed during visits by other Monomoy Wilderness users likely detracts from the sense of solitude experienced by wilderness users (Stankey and Schreyer 1987, Hendee and Dawson 2002). However, intertidal shellfish harvest use is still relatively dispersed across those intertidal flats open to public use.

Many shellfishers use carts to move their harvested clams to their boats. Others use large netted bags to transport their harvested clams. The use of wheeled carts in the Monomoy Wilderness is not consistent with wilderness requirements, as mechanized transport is not allowed and wheels are considered to be mechanized transport. Eliminating the use of wheeled carts in the Monomoy Wilderness will maintain wilderness characteristics and enhance visitors' wilderness experiences.

The current and anticipated level of intertidal shellfish harvest does not and is not expected to impact the preservation of the existing wilderness character—untrammeled wildness, undeveloped, natural, outstanding opportunity for solitude or primitive and unconfined type of recreation—that provides an enduring wilderness resource in the Monomoy Wilderness.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning (CCP) process for the Monomoy National Wildlife Refuge, this compatibility determination will undergo a 60-day public comment period concurrent with the release of our draft CCP/Environmental Impact Statement.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

- All intertidal subterranean shellfish harvest on refuge lands must continue to be in full compliance with all Town of Chatham Shellfish Rules and Regulations and refuge regulations and area closures. No items other than softshell clams, razor clams and quahogs, hand harvested in accord with town regulations, will be removed from the refuge.
- Only hand harvest methods will be employed on refuge intertidal lands that are open for public use.
- No carts or other mechanized equipment with wheels may be used to transport shellfish on, around, and from the flats within designated wilderness.
- Use of hydraulic pumping or other mechanized or motorized harvest methods or equipment is not permitted within designated wilderness. Hand plunging, as defined in the Town of Chatham regulations, is permitted within the Powder Hole non-wilderness area with at least 1 foot of water depth at mean low tide.

- Seasonal closures necessary to minimize human disturbance of migrating shorebirds at Monomoy Refuge will be implemented during peak migration periods if refuge staff determine they are necessary to meet our biological objective of providing high-quality stopover habitat. The necessity of these seasonal closures depends largely on the foraging quality of the intertidal flats, which is primarily determined by the natural forces of wind, tides, sediment transport patterns, erosion, and accretion. Areas that are open to this use will be evaluated on an annual, seasonal, and sometimes daily basis and will be influenced by beach geomorphology and wildlife use. Seasonal closures will vary year to year based on wildlife use and habitat conditions. Visitors will be expected to comply with closures. Updates on closures will be available at the Monomoy Headquarters and on the refuge Web site.

- Refuge staff will annually meet with the Town of Chatham Shellfish Constable to review and summarize annual shellfish harvest reports, area closures, and current and planned shellfish stewardship measures, and discuss regulations and management actions with respect to Monomoy NWR intertidal areas needed to ensure the long-term sustainability of the shellfish resource and biological integrity and ecological health of intertidal habitats.

- Refuge staff, volunteers, or researchers may engage in research designed to determine shellfish harvesting impacts to migratory birds and other species of conservation concern. Should any public use, including shellfish harvest, cause unacceptable environmental degradation or wildlife disturbance, or degrade wilderness character, we will implement appropriate limits on user numbers.

- Refuge visitor information services and products will emphasize the importance of staying out of seasonal closure areas, along with providing leave-no-trace principles.

JUSTIFICATION:

The harvest of subterranean shellfish using traditional hand raking methods on and use by migratory birds of the expansive and dynamic intertidal flats around Monomoy Refuge have coexisted for decades under joint stewardship and regulation by the Town of Chatham and the Service. Shellfish harvesting is a form of fishing, which is a priority, wildlife-dependent, public use on the refuge that provides visitors with an opportunity to experience wilderness. Based on our current knowledge about potential impacts of traditional hand harvest of shellfish on priority wildlife resources and habitats, combined with the relatively low level of use distributed across a large area of intertidal habitat, effects from this activity are similar or even less than other forms of human use in the intertidal area. We will monitor disturbance impacts of human presence (fin fishers, shellfishers, birders, photographers, and walkers) and will implement seasonal closures to protect migrating shorebirds and staging terns when necessary to ensure we accomplish the migratory bird purpose of the refuge by providing high-quality habitat to these migratory bird species. We will also include new science as it becomes available and will continually evaluate potential impacts of shellfishing on refuge resources as funding becomes available.

We have documented a positive short-term benefit to American oystercatchers and ruddy turnstones in the form of increased food availability immediately following shellfish harvest disturbance of the intertidal substrate. Allowing continuation of low intensity, nonmechanized shellfish harvest also fulfills the Service's historical commitment to permit fishing, including clamming, to continue.

Allowing intertidal shellfish harvest using hand methods at current and anticipated harvest levels, in accordance with Town of Chatham and refuge regulations and closures, requires no additional facilities. The potential disturbance to migratory birds and other species of conservation concern can be addressed and mitigated through the Town of Chatham shellfish regulations and stewardship actions, and by refuge seasonal area closures (symbolic fencing and signs with available refuge resources and a minimal administrative requirement). Potential for over-exploitation of the shellfish resource and depletion of intertidal benthic infauna, as well as potential for human-caused disturbance to wildlife species of conservation concern, are manageable and will continue to be addressed through the Town of Chatham shellfish regulations and stewardship actions, and by refuge seasonal area closures (symbolic fencing and signs.

In justifying this use, we considered the preceding evaluation of impacts to intertidal substrates and water quality, benthic intertidal communities, migratory shorebirds and other species of conservation concern, and Monomoy wilderness character. We conclude that the use will not materially interfere with, or detract from, the Refuge System mission, refuge wilderness, or migratory bird purposes, and that it contributes to the refuge purposes as follows:

- Shorebirds using the refuge were observed at higher densities in harvested areas versus unharvested areas due to the increased foraging opportunities resulting from harvesting activities.
- Low intensity harvest results in a periodic disturbance to the substrate, which under certain conditions can improve shellfish productivity and recruitment and increase prey availability for shorebirds.
- Our observations and related research indicate negligible impacts to Federal trust resources, based on past and expected harvest levels.
- We have not observed any impacts to, nor heard concerns from, any other wildlife-dependent users.
- Refuge visitors can experience wilderness in a manner that protects wilderness character by allowing only the use of hand tools and eliminating the use of wheeled carts.
- Our coordination with the Town of Chatham eliminates any undue administrative burden to refuge staff.

SIGNATURE:

Refuge Manager: ______________________ ______________________
(Signature) (Date)

CONCURRENCE:

Regional Chief: ______________________ ______________________
(Signature) (Date)

MANDATORY 15 YEAR RE-EVALUATION DATE: ______________________

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FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Monomoy National Wildlife Refuge

Use: Virtual Geocaching and Letterboxing

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ["no" to (a)], there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ["no" to (b), (c), or (d)] may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No ____.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ______ **Appropriate** ✔

Refuge Manager: ________________________ Date: ________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: ________________________ Date: ________________

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Monomoy National Wildlife Refuge

Use: Virtual Geocaching and Letterboxing

NARRATIVE:

Two of the priority public uses for national wildlife refuges–wildlife observation and interpretation–can be facilitated by geocaching. Geocaching can bring nontraditional visitors to the refuge, providing the opportunity to inform them about the mission of the U.S. Fish and Wildlife Service and the National Wildlife Refuge System. Virtual geocaching and letterboxing activities are not priority public uses; however, they can facilitate priority public uses on the refuge. When designed carefully, these activities can be used as a form of interpretation to educate the public about the Service, the Refuge System, and the refuge. Virtual geocaching involves walking or hiking, which is allowed in designated areas of the refuge. Although hiking is not a priority public use of the National Wildlife Refuge System and is classified as a non-wildlife activity, most visitors hike the refuge for the wildlands experience it provides. Hiking usually occurs on designated trails through most of the year, as would virtual geocaching. These opportunities advertised on appropriate public Web sites will build awareness of the National Wildlife Refuge System and will attract new visitors, many of whom might engage in other wildlife-dependent activities while at the refuge. Additionally, this use would encourge geocachers to stop at the visitor contact station to obtain refuge or wildlife viewing information. Letterboxing would only be allowed inside of refuge visitor contact stations and visitor centers. These activities will not materially interfere with or detract from fulfilling the National Wildlife Refuge System mission or the purpose for which the refuge was established.

These uses are anticipated to have similar impacts as other primary public uses such as interpretation and wildlife observation. Impacts of these uses will likely be minimal if conducted in accordance with refuge regulations.

For the reasons above, virtual geocaching and letterboxing is an appropriate use on Monomoy NWR.

COMPATIBILITY DETERMINATION

USE:

Virtual Geocaching and Letterboxing

REFUGE NAME:

Monomoy National Wildlife Refuge

DATE ESTABLISHED:

June 1, 1944

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Migratory Bird Conservation Act (16 U.S.C. § 715d) Public Law 91-504, 16 USC § 1132(c)

REFUGE PURPOSE(S):

"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." (16 U.S.C. § 715d).

"…wilderness areas…shall be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness. (PL 88-577 § 2(a), Wilderness Act; as referenced in P.L. 91-504 § 1(g), An Act to Designate Certain Lands as Wilderness).

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use?
Geocaching is an outdoor activity in which the participants use a global positioning system (GPS) receiver, mobile device, or other navigational technique to find hidden containers called geocaches or caches. Geocaching has been described as a game of high-tech hide-and-seek. Variations on geocaching include virtual geocaching (e.g., Earthcaching, Trail Link, and GPS Adventure) and letterboxing. A description of each of these uses follows, based on the National Wildlife Refuge System Guidance on Geocaching.

Virtual Geocaching utilizes hand-held GPS devices, but the goal of the activity is different and the activity can be enjoyed without a physical cache. Virtual caching provides GPS coordinates to existing points of interest, such as a facility, cultural feature, wayside exhibit, or object in public areas. For more information, visit *www.waymarking.com.*

Earthcaching is a type of virtual geocache. The Web site lists a number of virtual caches that are educational in purpose and judged for suitability by a team supported by the Geological Society of America. For more information, visit *www.earthcache.org.*

Trail Link is a partnership between Geocaching.com and the Rails to Trails Conservancy to collect mapping data for more than 15,000 miles of trails nationwide. Members of the Rails to Trails Conservancy are encouraged to capture GPS coordinates as they hike. The GPS coordinates can be supplemented with photos and other interpretive information about particular points along the trails. For more information about the program and its possible application to Refuge System trails, visit *www.geocaching.com/railstotrails/default.aspx.*

GPS Adventures incorporates lesson plans from a number of educational programs about geography, history, science, and technology. The program includes a GPS Adventures maze to provide students with hands-on exploration of the use of GPS technology in support of school programs. For more information, visit *http://www.gpsmaze.com/index.html.*

Letterboxing involves the placement of a cache containing a stamp and an inkpad that participants use to document that they have discovered a specific location. Participants find the location by following clues offered on the Web involving map coordinates or compass bearings. Letterboxing does not require leaving or removing caches as part of the challenge. For more information, visit *www.letterboxing.org.*

(b) Is the use a priority public use?

In their traditional form, these activities are not priority public uses. However, if these activities are designed and created under the guidance of appropriate refuge staff, they can be manipulated into forms of interpretation that are a priority public uses of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee) and the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

(c) Where would the use be conducted?

Certain areas on Monomoy NWR are seasonally closed to public access at the refuge manager's discretion to protect sensitive habitats or species of concern, minimize conflicts with other refuge activities, or respond to human health and safety concerns. All geocaching activities would be only conducted in areas that are open to the public, including the Morris Island trail system, and designated areas on Monomoy NWR. Geocaching activities would avoid sensitive areas prone to disturbance (e.g., sensitive vegetation areas) or degradation (e.g., soil compaction), and would be designed to minimize impacts to endangered species, nesting birds or other breeding, feeding, or resting wildlife. Virtual geocaching could occur in areas open to the public throughout the refuge, including in wilderness areas. Because letterboxing requires a physical cache, it would only occur inside visitor contact stations or visitor centers.

(d) When would the use be conducted?

Monomoy NWR is open to the public from ½ hour before sunrise to ½ hour after sunset. Virtual geocaching would occur during regular refuge hours any time of the year in any areas open to public access. Use of the refuge for these activities is likely to be highest in late spring, summer, and early fall. Letterboxing would only occur when visitor contact stations or visitor centers are open.

(e) How would the use be conducted?

Virtual geocaching can be used as a tool to get people to visit the refuge and the wilderness areas. The use is primarily facilitated by pedestrian walking and hiking access, commercial ferry access, or by boat. Boats are allowed to land anywhere along the refuge shoreline, with the exception of posted tern colonies and piping plover nesting areas. The presence of hazardous currents and shoals encourages visitors to land their boats in only a few designated locations. Interpretive materials associated with geocaching give the general public an opportunity to learn about the refuge, the Refuge System, and the Service. The uses are self-regulating, with geocaching coordinates and clues designed to keep visitors on designated trails or within open public areas. Some geocaches may not be available year-round, depending on staffing and seasonal wildlife related closures. Appropriate refuge staff will approve all geocaches, and all areas where geocaching would be allowed are already managed by the refuge for other wildlife-dependent recreational activities.

(f) Why is this use being proposed?
Virtual geocaching and letterboxing are not priority public uses; however, they can facilitate priority public uses on the refuge. When designed carefully, this activity can be used as a form of interpretation to educate the public about refuge management challenges and goals, refuge missions, and priority public uses. Virtual geocaching involves hiking, which is allowed in designated areas of the refuge, and although hiking is not a priority public use of the National Wildlife Refuge System and is classified as a non-wildlife-dependent activity, most visitors hike the refuge for the wildlands experience it provides. Hiking usually occurs on designated trails or in the open areas of the wilderness area through most of the year, as would geocaching. Virtual geocaching opportunities advertised on appropriate public Web sites will build awareness of the National Wildlife Refuge System and attract new visitors, who will partake in wildlife-dependent activities while at the refuge. Additionally, geocachers and people engaged in letterboxing will likely stop at the visitor center to obtain refuge or wildlife viewing information.

AVAILABILITY OF RESOURCES:

The refuge has a single trail system on Morris Island in place to support public uses. Additionally, there are many areas on Monomoy NWR that are seasonally open to public uses when not closed to protect wildlife. The estimated costs of allowing geocaching within areas open to the public are fairly low because there little infrastructure is involved. Some staff time to develop and promote the activity will be needed, as well as the procurement of materials to conduct the program. The following breakdown shows the estimated amount of funds needed to administer the program.

GS-11 Visitor Services Manager	1 staff	40 hours	$1,800
GS-11 Law Enforcement Officer	1 staff	40 hours	$1,800
Materials			$ 500
Total recurring annual costs:			**$4,100**

ANTICIPATED IMPACTS OF THE USE:

The proposed use is anticipated to have the same level of impacts as primary public uses because the access and activities are very similar. Since refuge staff will supervise these activities, the impacts of geocaching will likely be minimal if conducted in accordance with refuge regulations. Possible impacts include disruption of nesting migratory bird populations, terns, shorebirds, and other bird populations feeding and resting near the trails during certain times of the year, impacts to larval threatened northeastern beach tiger beetle populations, and disruption of local seal populations.

On Monomoy NWR, area closures are created to protect priority nesting migratory tern and shorebird species. Although these closure areas are designed to minimize human impacts, the potential exists for impacts to unobserved nesting animals. Conflicts arise when migratory birds and humans are present in the same areas (Boyle and Samson 1985). Response of wildlife to human activities includes departure from site (Owen 1973, Burger 1981, Kaiser and Fritzell 1984, Korschgen et al. 1985, Henson and Grant 1991, Kahl 1991, Klein 1993), use of sub-optimal habitat (Erwin 1980, Williams and Forbes 1980), altered behavior (Burger 1981, Korschgen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increase in energy expenditure (Morton et al. 1989, Belanger and Bedard 1990).

Numerous studies have documented that migratory birds are disturbed by human activity on beaches. Erwin (1989) documented disturbance of common terns and skimmers and recommended that human activity be restricted to a distance of 100 meters around nesting sites. Pfister et al. (1992) found that the impact of disturbance was greater on species using the heavily disturbed front side of the beach, with the abundance of the impacted species being reduced by as much as 50 percent. In studying the effects of recreational use of shorelines on nesting birds, Roberton et al. (1980) discovered that disturbance negatively impacted species composition. Piping plovers, which intensively use the refuge, are also negatively impacted by human activity. Pedestrians on beaches may crush eggs (Burger 1987, Hill 1988, Shaffer and Laporte 1992, Cape Cod National Seashore 1993, Collazo et al. 1994). Other studies have shown that if pedestrians cause incubating plovers to leave their nest, the eggs can overheat (Bergstrom 1991) or can cool to the point of embryo death (Welty 1982). Pedestrians have been found to displace unfledged chicks (Strauss 1990, Burger 1991, Hoopes et al. 1992, Loegering 1992, Goldin 1993).

Several studies have examined the effects of recreation on birds using shallow water habitats adjacent to trails and roads through wildlife refuges and coastal habitats in the eastern United States (Burger 1981, 1986, Klein 1993, Burger et al. 1995, Klein et al. 1995, Rodgers and Smith 1995, 1997, Burger and Gochfeld 1998). Overall, the existing research clearly demonstrates that disturbance from recreational activities always has at least temporary effects on the behavior and movement of birds within a habitat or localized area (Burger 1981, 1986, Klein 1993, Burger et al. 1995, Klein et al. 1995, Rodgers and Smith 1997, Burger and Gochfeld 1998). The findings that were reported in these studies are summarized as follows in terms of visitor activity and avian response to disturbance.

Presence: Birds avoided places where people were present and when visitor activity was high (Burger 1981, Klein et al. 1995, Burger and Gochfeld 1998).

Distance: Disturbance increased with decreased distance between visitors and birds (Burger 1986), though exact measurements were not reported.

Approach Angle: Visitors directly approaching birds on foot caused more disturbance than visitors driving by in vehicles, stopping vehicles near birds, and stopping vehicles and getting out without approaching birds (Klein 1993). Direct approaches may also cause greater disturbance than tangential approaches to birds (Burger and Gochfeld 1981, Burger et al. 1995, Knight and Cole 1995, Rodgers and Smith 1995, 1997).

Noise: Noise caused by visitors resulted in increased levels of disturbance (Burger 1986, Klein 1993, Burger and Gochfeld 1998), though noise was not correlated with visitor group size (Burger and Gochfeld 1998).

Trash left on the beach, particularly food or wrappers, can attract predators that prey on nesting piping plovers and least terns or roosting shorebirds. Impacts of geocaching are likely to be minimal if conducted in accordance with refuge regulations. We will manage refuge closures that restrict pedestrian access to minimize disturbance to priority avian species during critical times of the year. Closures can be expanded or contracted as needed, depending on bird activity and results of further disturbance studies. The refuge is a leave-no-trace, carry-in-carry-out facility. We encourage all outfitters and guides to pack in and pack out all food containers, bottles, wrappers, trash, and other waste and refuse. Littering, dumping, and abandoning property are prohibited by Federal regulation at 50 C.F.R. 27.93.94.

Individuals hiking to South Monomoy for geocaching activities could potentially impact the larval stage of the threatened northeastern beach tiger beetle. The recovery plan for this species describes that many of the species' habitats are threatened by human impacts such as habitat alteration and recreational activities (USFWS 1994). Larval burrows are especially susceptible to trampling, which results in excess energy expenditure and reduced time hunting for the inhabiting individual. We will continue to survey to determine the location and extent of larval beetle occurrence and habitat, and use closures and re-route trails to avoid larval habitats.

Pedestrian use also has the potential to disturb loafing seals. Gray and harbor seals haul out on the refuge year round. We will enforce the 150-foot buffer around all seals as required by the National Oceanic Atmospheric Administration to ensure compliance with the Marine Mammals Protection Act.

Only virtual geocaching will be allowed on refuge, including in wilderness areas, thereby eliminating the erection of any signs or manmade structures to assist in the pursuit of the cache. Given the difficulty in accessing the wilderness area, lower numbers of individuals are expected to engage in virtual geocaching in the wilderness. There should be no diminishment of wilderness character or impact to other wilderness visitor if virtual geocaching is allowed in the wilderness area.

Unmanaged geocaching has the potential to damage or kill plants and lead to new, unwanted, impromptu trails on the refuge that become shortcuts through more ecologically sensitive sites. Heavy use of designated, managed, or unmanaged pedestrian travel routes can ultimately lead to areas void of vegetation (McDonnell 1981, Vaske et al 1992) and potentially destabilize dunes and interdunal wetlands, which are difficult to stabilize and restore to a naturally functioning condition (Kucinski and Einsenmenger 1943, Cole 2002, Goldsmith 2002, Grady 2002, O'Connell 2008).

All of North Monomoy Island and most of South Monomoy are designated wilderness and are part of the National Wilderness Preservation System. Wilderness, in contrast with those areas where humans and their works dominate the landscape, is an area where the Earth and its community of life are untrammeled by humans, where humans are visitors who do not remain. Preserving wilderness character requires that we maintain both the visible and invisible aspects of wilderness. Aspects of wilderness character include maintaining the natural, scenic condition of the land; providing environments for native plants and animals, including those threatened or endangered; maintaining watersheds and airsheds in a healthy condition; maintaining natural night skies and soundscapes; retaining the primeval character of and influence on the land; serving as a benchmark for ecological studies; and providing opportunities for solitude, primitive and unconfined outdoor recreation, risk, adventure, education, personal growth experiences, a sense of connection with nature and values beyond one's self, a link to our American cultural heritage, and mental and spiritual restoration in the absence of urban pressures. We provide opportunities for appropriate and compatible use and enjoyment of wilderness areas in a manner that will preserve their wilderness character and "leave them unimpaired for future use and enjoyment as wilderness."

This use will not affect wilderness character. These activities do not alter the natural scenic condition of the land and will not occur at a scale large enough to diminish the environment for native plants and animals. In fact, virtual geocaching could be used to enhance a visitor's understanding and appreciation of wilderness.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning (CCP) process for the Monomoy National Wildlife Refuge, this compatibility determination will undergo a 60-day public comment period concurrent with the release of our draft CCP/Environmental Impact Statement.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

- No geocache will be created or posted on public Web sites without the permission of appropriate refuge staff.
- Geocaches will be created only in areas where there is already a designated trail or in areas that are open to the public.
- Only virtual geocaches will be allowed in the wilderness area.
- All individuals taking part in geocaching must adhere to area closures and understand that certain geocaches may not be available year-round. Areas that are open to this use will be evaluated on an annual, seasonal, and sometimes daily basis and will be influenced by beach geomorphology and wildlife use. Seasonal closures will vary year to year based on wildlife use and habitat conditions. Visitors will be expected to comply with closures. Updates on closures will be available at the Monomoy Headquarters and on the refuge Web site.
- Appropriate notification must be listed on public Web sites when a geocache is not available as a result of area closures.
- No physical item will be placed or left on the refuge.
- Letterboxing would only be allowed within visitor contact stations or visitor centers.
- Appropriate notification about the availability of letterboxes based on staffing and visitor contact station open hours will be posted on all public Web sites.

JUSTIFICATION:

The Service and the National Wildlife Refuge System maintain the goal of providing opportunities to view wildlife and engage in interpretation. Allowing the use of refuge areas that are already open to the public, including one trail system on Morris Island, to persons participating in geocaching supports this goal. Geocaching would provide visitors with the chance to view wildlife and take part in interpretation about the refuge, promoting public appreciation of the conservation of wildlife and habitats. Geocaching activities are not priority public uses; however, they facilitate priority public uses on the refuge, and in some cases can be used as a form of interpretation, which is a priority public use. Virtual geocaching and letterboxing activities would not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purpose for which the refuge was established.

In 2009, the Service developed final guidance on geocaching. This policy can be found in at *http://www.fws.gov/ridgefieldrefuges/ridgefield/pdf/Friends%202010/Recreational%20Geocaching%20Guidance.pdf*; accessed March 2012.

The Service's wilderness management policy (610 FW 2) does not prohibit the use of GPS units within refuge wilderness areas. However, managers need to make sure that wilderness character is considered when evaluating the appropriateness of GPS recreational activities. Service policy (610 FW 2, 2.31) does state that competitive public events or contests are prohibited in wilderness, such as a large organized GPS geocaching event.

SIGNATURE:

Refuge Manager: ______________________________ ______________________________
(Signature) (Date)

CONCURRENCE:

Regional Chief: ______________________________ ______________________________
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: ______________________________

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FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Monomoy National Wildlife Refuge

Use: Outdoor Events and Ceremonies

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ["no" to (a)], there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ["no" to (b), (c), or (d)] may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No __✔__.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ______ **Appropriate** __✔__

Refuge Manager: ________________________ Date: ________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: ________________________ Date: ________________

A compatibility determination is required before the use may be allowed.

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Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Monomoy National Wildlife Refuge

Use: Outdoor Events and Ceremonies

NARRATIVE:

The Service policy on Appropriate Refuge Uses (603 FW 1) states, "General public uses that are not wildlife-dependent recreational uses (as defined by the Improvement Act) and do not contribute to the fulfillment of refuge purposes or goals or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from our responsibilities to protect and manage fish, wildlife, and plants, and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System." Outdoor events and ceremonies are not considered priority public uses of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 68dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997, but this activity will not materially interfere with or detract from the mission of the National Wildlife Refuge System or purposes for which Monomoy NWR was established.

Outdoor events and ceremonies are group gatherings conducted by non-Service individuals or organizations. These uses are not outlined in an approved plan; however, there may be instances in which they can be conducted in a time, place, and manner that do not conflict with refuge goals and objectives. Although this use is not typically undertaken to promote or benefit refuge natural or cultural resources, it can expose the public to the refuge and provide an opportunity to appreciate the refuge's natural and cultural resources. Fundraising events are not allowed unless the U.S. Fish and Wildlife Service receives 100 percent of the funds raised by the event. Additionally, we will not allow events at which people receive an appearance fee or a prize of more than nominal value. Organizers may charge a slight fee to recoup the cost of the event, but may not make a profit on the event. Anything in excess of recouped costs will be given to the refuge.

Each event has different logistics, therefore, each will be evaluated for impacts to the refuge mission. A special use permit must be issued with appropriate stipulations, including limitations on the number of people attending, parking restrictions, etc. We will not allow events and ceremonies found to be detrimental to the refuge mission. A fee will be charged for each permit. When necessary, we will develop stipulations for permits to ensure that events do not create an unacceptable impact on wildlife or cultural resources, do not disrupt visitors engaged in priority wildlife-dependent public uses, do not unreasonably disrupt the atmosphere of peace and tranquility, and do not create an unsafe or unhealthy environment for visitors or employees. Events may not be held in areas closed to the public to protect wildlife, and events may not be held that result in the closure of an area that would otherwise be open to the public. Any event held within the Monomoy Wilderness will undergo a minimum requirements analysis to ensure both compliance with wilderness regulations and policies, and that impacts to wilderness character are minimal.

COMPATIBILITY DETERMINATION

USE:

Outdoor Events and Ceremonies

REFUGE NAME:

Monomoy National Wildlife Refuge

DATE ESTABLISHED:

June 1, 1944

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Migratory Bird Conservation Act (16 U.S.C. § 715d) Public Law 91-504, 16 USC § 1132(c)

REFUGE PURPOSE(S):

"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." (16 U.S.C. § 715d).

"…wilderness areas…shall be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness. (P.L. 88-577 §2(a), Wilderness Act; as referenced in P.L. 91-504 § 1(g), An Act to Designate Certain Lands as Wilderness).

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use?
The use is group gatherings at outdoor events and ceremonies conducted by non-Service individuals or organizations. Fundraising is only allowed when 100 percent of the proceeds are given to the U.S. Fish and Wildlife Service. Additionally, we will not allow events conducted at which people receive an appearance fee or a prize of more than nominal value. Organizers may charge a slight fee to recoup the cost of the event, but may not make a profit on the event. Anything in excess of recouped costs will be given to the refuge.

(b) Is the use a priority public use?
Outdoor events and ceremonies are not considered priority public uses of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997.

(c) Where would the use be conducted?
Outdoor events and ceremonies will be allowed in any area open to the public under terms specified in a special use permit. The use will not be allowed in environmentally sensitive areas such as the dunes or in any area managed for habitat conservation or wildlife protection. Activities would most likely be held on the Morris Island portion of the refuge, primarily on the beach or along the Morris Island Trail. Activities could also be held in areas of North Monomoy Island or South Monomoy that are open to the public.

(d) When would the use be conducted?
Monomoy NWR is open to the public from ½ hour before sunrise to ½ hour after sunset. Morris Island is open for fishing 24 hours a day. Outdoor events and ceremonies could occur any time of the year in any areas open to public access. Use of the refuge for these activities is likely to be highest in late spring, summer, and early fall. Pedestrian closures may prevent holding a scheduled event.

(e) How would the use be conducted?
Permission to hold an outdoor event or ceremony must be requested in writing by the organizer a minimum of 60 days in advance of the event. Each request must be submitted to the refuge manager at the Monomoy NWR headquarters in Chatham, Massachusetts. The request must provide details of who, what, where, when, why, and how the event will be conducted. Further, the request must indicate how people will travel to the part of the refuge where the event would be held (e.g., on foot or by boat). Each request has different logistics and will be evaluated for impacts to the refuge mission. A special use permit will be issued provided there are no significant negative impacts to natural resources or visitor services, and no violations of refuge regulations. The special use permit will outline the framework in which the event or ceremony can be conducted. A fee is required to pay for staff time and expenses necessary to monitor the event and ensure compliance with permit stipulations, and will be assessed on a case-by-case basis. Costs associated with processing the application may be required even if the request is subsequently denied.

(f) Why is the use being proposed?
Monomoy NWR staff receives occasional requests to conduct outdoor events or ceremonies, and other events have occurred on the refuge without notification by the organizers or permission from refuge staff. While the number of requests we anticipate receiving is low, we want to be able to review each request and issue a special use permit if we determine that we can regulate the event so it has minimal impact to refuge resources and visitors. Although outdoor events and ceremonies may not directly contribute to the achievement of the refuge purposes or the National Wildlife Refuge System mission, such events can contribute to the public's understanding and appreciation of the refuge's natural resources.

AVAILABILITY OF RESOURCES:

Permitting this use is generally within the resources of the existing staff. Staff costs are incurred to review each request, coordinate with the applicant, and process the special use permit. Refuge staff or refuge law enforcement officers will monitor the special use permit to ensure compliance with its conditions. Law enforcement staff from the refuge complex will need to be reimbursed for travel expenses and time worked.

Total initial cost of program			**$0**
Review request and process SUP	2 staff	20 hours	$2,000
Biological on-site staff	1 staff	20 hours	$1,000
Law enforcement presence	1 staff	20 hours	$1,000
Travel costs			$1,000
Total annual cost of program			**$5,000***

* Travel costs would be reimbursed by permittee; assumes two events annually.

Refuge staff time and resources are needed to ensure that delineation of bird nesting and staging areas, seal haul-out areas, and otherwise closed areas is accomplished on time and sufficiently maintained to provide maximum protection for biological resources. Refuge law enforcement will be needed to ensure permit compliance.

ANTICIPATED IMPACTS OF THE USE:

Impacts to refuge resources will be minimal if conducted in accordance with refuge regulations and conditions of the special use permit. Possible impacts include disturbing wildlife, trampling plants, littering, vandalism, and entering closed areas. Events will be structured to be held only in areas open to the public and the amount of disturbance is expected to be minimal, occasional and short-term in nature, and conducted in a manner that does not interfere with other visitors' enjoyment of the refuge or natural environment. If significant negative impacts from this use cannot be avoided, a special use permit will not be issued. Events held in wilderness areas will be managed to protect wilderness values.

Visitors engaged in outdoor events and ceremonies may impact refuge wildlife, vegetation, and soils. Pedestrian travel has the potential to impact shorebird, waterfowl, and other migratory bird populations feeding and resting near trails and on beaches during certain times of the year. Pedestrians can also impact seals resting on the beach if they get too close. Conflicts arise when migratory birds and humans are present in the same areas (Boyle and Samson 1985). Response of wildlife to human activities includes departure from site (Owen 1973, Burger 1981, Kaiser and Fritzell 1984, Korschgen et al. 1985, Henson and Grant 1991, Kahl 1991, Klein 1993), use of sub-optimal habitat (Erwin 1980, Williams and Forbes 1980), altered behavior (Burger 1981, Korschgen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increased energy expenditure (Morton et al. 1989, Belanger and Bedard 1990).

Numerous studies have documented that migratory birds are disturbed by human activity on beaches. Erwin (1989) documented disturbance of common terns and skimmers and recommended that human activity be restricted to a distance of 100 meters around nesting sites. Klein (1993) in studying waterbird response to human disturbance found that, as intensity of disturbance increased, avoidance response by the birds increased. Pfister et al. (1992) found that the impact of disturbance was greater on species using the heavily disturbed front side of the beach, with the abundance of the impacted species being reduced by as much as 50 percent. In studying the effects of recreational use of shorelines on nesting birds, Roberton et al. (1980) discovered that disturbance negatively impacted species composition. Piping plovers, which intensively use the refuge, are also impacted negatively by human activity. Pedestrians on beaches may crush eggs (Burger 1987, Hill 1988, Shaffer and Laporte 1992, Cape Cod National Seashore 1993, Collazo et al. 1994). Dogs may chase plovers (McConnaughey et al. 1990), destroy nests (Hoopes et al. 1992), and kill chicks (Cairns and McLaren 1980). Other studies have shown that if pedestrians cause incubating plovers to leave their nest, the eggs can overheat (Bergstrom 1991) or can cool to the point of embryo death (Welty 1982). Pedestrians have been found to displace unfledged chicks (Strauss 1990, Burger 1991, Hoopes et al. 1992, Loegering 1992, Goldin 1993.

The Delaware Natural Heritage Program, Division of Fish and Wildlife and the Department of Natural Resources and Environmental Control prepared a document, *The Effects of Recreation on Birds: a Literature Review*, completed in April 1999. The following information was reference from this document.

Several studies have examined the effects of recreation on birds using shallow- water habitats adjacent to trails and roads through wildlife refuges and coastal habitats in the eastern United States (Burger 1981; Burger 1986; Klein 1993; Burger et al. 1995; Klein et al. 1995; Rodgers and Smith 1995, 1997; Burger and Gochfeld 1998). Overall, the existing research clearly demonstrates that disturbance from recreation activities always has at least temporary effects on the behavior and movement of birds within a habitat or localized area (Burger 1981, 1986; Klein 1993; Burger et al. 1995; Klein et al. 1995; Rodgers and Smith 1997; Burger and Gochfeld 1998). The findings that were reported in these studies are summarized as follows in terms of visitor activity and avian response to disturbance.

Presence: Birds avoided places where people were present and when visitor activity was high (Burger 1981; Klein et al. 1995; Burger & Gochfeld 1998).

Distance: Disturbance increased with decreased distance between visitors and birds (Burger 1986), though exact measurements were not reported.

Approach Angle: Visitors directly approaching birds on foot caused more disturbance than visitors driving by in vehicles, stopping vehicles near birds, and stopping vehicles and getting out without approaching birds (Klein 1993). Direct approaches may also cause greater disturbance than tangential approaches to birds (Burger and Gochfeld 1981; Burger et al. 1995; Knight and Cole 1995a; Rodgers and Smith 1995, 1997).

Noise: Noise caused by visitors resulted in increased levels of disturbance (Burger 1986; Klein 1993; Burger and Gochfeld 1998), though noise was not correlated with visitor group size (Burger and Gochfeld 1998).

The proposed use has the potential of intermittently interrupting the feeding habits of a variety of shorebirds, gulls, and terns, but encounters between pedestrians and migratory birds will be temporary. To address pedestrian impacts listed above, we will manage refuge closures that restrict pedestrian access to minimize disturbance to priority avian species during critical times of the year. Closures can be expanded or contracted as needed, depending on bird activity and results of further disturbance studies.

Pedestrian use also has the potential to disturb loafing seals. Gray and harbor seals haul out on the refuge year-round. We will enforce the 150-foot buffer around all seals as required by the National Oceanic Atmospheric Administration to ensure compliance with the Marine Mammals Protection Act.

Heavy beach use can dry out the sand and contribute to beach erosion. Trash left on the beach, particularly food or wrappers, can attract predators that prey on nesting piping plovers and least terns or roosting shorebirds. Impacts of walking are likely to be minimal if conducted in accordance with refuge regulations. The refuge is a leave-no-trace, carry-in-carry-out facility. All food containers, bottles, and other waste and refuse must be taken out. Littering, dumping, and abandoning property are prohibited by Federal regulationat 50 C.F.R. 27.93.94.

All of North Monomoy Island and most of South Monomoy are designated wilderness and are part of the National Wilderness Preservation System. Wilderness, in contrast with those areas where humans and their works dominate the landscape, is an area where the Earth and its community of life are untrammeled by humans, where humans are visitors who do not remain. Preserving wilderness character requires that we maintain both the visible and invisible aspects of wilderness. Aspects of wilderness character include maintaining the natural, scenic condition of the land; providing environments for native plants and animals, including those threatened or endangered; maintaining watersheds and airsheds in a healthy condition; maintaining natural night skies and soundscapes; retaining the primeval character of and influence on the land; serving as a benchmark for ecological studies; and providing opportunities for solitude, primitive and unconfined outdoor recreation, risk, adventure, education, personal growth experiences, a sense of connection with nature and values beyond one's self, a link to our American cultural heritage, and mental and spiritual restoration in the absence of urban pressures. We provide opportunities for appropriate and compatible use and enjoyment of wilderness areas in a manner that will preserve their wilderness character and "leave them unimpaired for future use and enjoyment as wilderness."

Outdoor events and ceremonies are generally not consistent with the enjoyment and preservation of wilderness. However, outdoor events or ceremonies can be held to celebrate wilderness. Additionally, visitation to the wilderness parts of the refuge is low, so it is unlikely the infrequent outdoor event or ceremony that might be held on the refuge would affect the natural scenic condition of the wilderness. Attendance at these events provides opportunities for individuals to connect with nature and wildlife. We do not anticipate negative impacts on wilderness character, considering the small number of events likely to be held in the wilderness area, given the difficulties of accessing this area and the limitations on any event proposed for the refuge and within a wilderness.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning (CCP) process for the Monomoy National Wildlife Refuge, this compatibility determination will undergo a 60-day public comment period concurrent with the release of our draft CCP/Environmental Impact Statement.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

Special use permits are required for organizations wishing to hold an outdoor event or ceremony or individuals wishing to hold a ceremony on the refuge.

The refuge manager must receive a written application for a special use permit no later than 60 days before the event. The written request must provide clear and concise information about the nature of the event (who, what, where, when, why and how), including the estimated number of attendees. The refuge manager will not consider incomplete requests that do not provide full details of the event.

Each application will be evaluated for impacts to the refuge, its wildlife, and visitors. Refuge staff will use professional judgment to ascertain the proposed impacts of the event. As long as there are minimal impacts to refuge resources and visitors, a special use permit will be issued outlining the framework in which this use can be conducted.

The Service may recover from the permittee all agency costs incurred in processing the application for a special use permit and monitoring the permitted activity if the request is approved. Costs associated with processing the application may be required even if the request is subsequently denied. A fee may be charged for the special use permit, particularly if the permittee is not a conservation partner and there is a need for law enforcement presence to ensure compliance with refuge regulations and permit conditions.

Events may take place only while the refuge is open, which is one-half hour before sunrise to one-half hour after sunset. Activities may take place only in areas open to the public; refuge regulations will be posted and enforced. Beach sports, kites, and dogs are not allowed at any time. The refuge manager may impose additional restrictions.

The refuge manager will make the final decision about where and when events may be held on the refuge.

The permittee will comply with all pedestrian closures on the refuge. These may prevent holding a scheduled event.

The refuge manager may limit the number of attendees. There is only a small parking area at the refuge headquarters, and permittees may not conduct events that prevent, even inadvertently, authorized public access for priority, wildlife-dependent public use.

Events held on Morris Island may be catered, with tables, tents, and chairs. Tents must be set up in an area that avoids disturbing refuge resources and visitors. All tents must be set up and taken down the same day as the event and within regular hours the refuge is open to the public. No tents will be allowed in the wilderness area.

Alcohol may be served outdoors. Permittees will inform the refuge manager in advance if alcohol is going to be consumed, and will ensure that event and ceremony attendees are not inebriated on the refuge. Being inebriated on refuge lands is against refuge regulations (50 C.F.R. 27.81)

There will be no electric amplification of musical instruments or voices during any ceremonies or events.

All trash must be removed from site for proper disposed by the end of each day. The site must be left clean and unimpaired.

All access to events or ceremonies held in the wilderness area will be on foot only. No vehicles or over-sand vehicles will be allowed to transport people or materials needed for the event.

On Morris Island, permittees must provide portable toilets to be used by attendees of the event. The portable toilets must be delivered no earlier than 24 hours before the event and must be removed no later than 24 hours after the event. The permittee will be responsible for any cleanup associated with the use of portable toilets, including vandalism caused by a refuge visitor who was not an attendee at the permitted event.

In most cases, permittees will be required to carry commercial general liability insurance. Depending on the event, the refuge manager may require additional coverage, such as proof of automobile liability insurance or special coverage if alcohol is served.

All permittees must provide attendees with information about the refuge, our mission, and purpose. Permittees are responsible for their attendees' compliance with refuge regulations.

No permittee may create a safe or unhealthy environment for other visitors or employees.

No event may result in the closure of an area normally open to the public.

Failure to comply with refuge regulations or special use permit conditions will result in a denial of special use permits by the permittee for future events.

JUSTIFICATION:

Special outdoor events or ceremonies may not directly contribute to the achievement of the refuge purposes or the National Wildlife Refuge System mission, but can contribute to the public's understanding and appreciation of the refuge's natural resources. Therefore, a group event is compatible as long as it is conducted safely within the confines of open public use areas and does not conflict with a priority public use. It is deemed this activity will not materially interfere with or detract from the mission of the National Wildlife Refuge System or purposes for which Monomoy NWR was established.

SIGNATURE:

Refuge Manager: ______________________________ ______________________________
(Signature) (Date)

CONCURRENCE:

Regional Chief: ______________________________ ______________________________
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: ______________________________

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