3.0 AFFECTED ENVIRONMENT

3.1 Introduction

This chapter describes the existing conditions within CACO and the immediate vicinity and summarizes available information and current research relating to the impact topics. The CEQ requires that NEPA documents focus on issues that are truly significant to the action in question. With NEPA as guidance, the determination of which resources could reasonably be expected to be affected by any proposed actions related to the hunting program has been based on a combination of best available information, professional judgment, and common sense. The current conditions, relating to these resources and impact topics, are discussed below. An assessment of effects that may result from each alternative is presented in Chapter 4.

3.2 Hunting Theory and Background

When hunting substitutes for other forms of mortality, it is said to be "compensatory." In contrast, when hunting as another form of mortality adds to total mortality, it is said to be "additive." Early theories and research have shown that hunting is often compensatory in game species. The relationships among hunting regulations, hunting mortality, and population size are still not well understood, despite major research efforts spanning some 30 years (Baldassarre and Bolen 1994).

The MDFW deer management objective is to maintain the white-tailed deer population at levels compatible with human activity and habitat conditions. The target density goal is eight deer per mi^2 for the deer management zone (DMZ) encompassing CACO (DMZ 12) (MDFW 2003). The deer population is managed by predicting the adult male harvest level (from harvest trends) and then setting the appropriate harvest sex ratio (females to be harvested per 100 adult males harvested) that will increase/decrease the deer population towards the desired goal. This is accomplished by adjusting the number of antlerless deer permits.

CACO's objective is not to manage wildlife populations through hunting, but to manage hunting in a manner that is compatible with other park uses and that does not compromise natural and cultural resource conservation objectives. CACO regards MDFW as a key expert agency with the state- and region-wide perspective needed to manage hunting in a manner that maintains healthy and sustainable wildlife populations. In turn, MDFW relies on harvest theory to determine what species can be hunted and to establish seasons and bag limits for those species.

3.3 Wildlife Resources[3]

3.3.1 Species Present – Overview

Diverse and abundant vegetation within CACO supports a wide variety of fish and wildlife. A broad range of habitats is provided by the various community types, as well as by the diversity of successional stages.

At least 30 species of terrestrial mammals occur throughout the forested uplands and heathlands of CACO, including deer, rabbits, foxes, coyotes, raccoon, striped skunk, weasels (*Mustela* spp.), meadow voles (*Microtus pennsylvanicus*), bats (*Myotis* spp.), woodchucks, shrews, muskrats (*Ondatra zibethicus*),

[3] The works of Veit and Peterson, 1993, Whitaker and Hamilton, 1998, and DeGraaf and Yamasaki, 2001, were extensively consulted in compiling the information for Section 3.3.

eastern chipmunks, squirrels, mice (*Peromyscus* spp.), other rodents and small mammals, and river otter (*Lontra canadensis*).

A variety of marine mammals occur in the Cape Cod waters. The Marine Mammal Protection Act prohibits activities that cause the death or serious injury of marine mammals. Marine mammals and sea turtles are regularly stranded within CACO. CACO staff cooperates with a wide range of regional and local specialists in the recovery and rehabilitation of stranded marine mammals.

At least 368 species of migratory and resident birds have been identified within CACO, including a wide variety of waterfowl, gulls, shorebirds, wading birds, and songbirds (Griffin 2006). Many neotropical migrants use Cape Cod as a breeding site. Cape Cod is along the Atlantic Flyway, a major route for migrating birds, and many transient species appear during spring and autumn. Areas close to the beach are especially important as feeding sites for shorebirds during migration.

Due to the insular nature of Outer Cape Cod, and its glaciated past, CACO has a unique assemblage of amphibians and reptiles. There are at least 18 reptilian species and at least 13 amphibian species within CACO, including snakes, turtles, salamanders, newts, frogs, and toads.

Cape Cod is home to a number of freshwater macroinvertebrate animals, including sponges, flatworms, mollusks, insects, and crustaceans. Marine benthic macroinvertebrates such as shrimps, crabs, oligochaete and annelid, worms, mollusks, and echinoderms provide a food source for many fish, and some are fished recreationally and commercially. In addition, numerous species of dragonflies, damselflies, butterflies, moths, diptera (flies and their allies), and beetles inhabit CACO.

Inventories have been conducted for several animal species, including white-tailed deer, *Lepidoptera* (butterflies and moths), dragonflies, and tiger beetles. Monitoring of beach-nesting terns and piping plovers (*Charadrius melodus*) is conducted on an annual basis. CACO also monitors pond-breeding amphibians and estuarine nekton as part of its long-term ecosystem monitoring program. Studies have been completed that assess appropriate methods for long-term monitoring of small mammals, aquatic turtles, freshwater fish, shorebirds, and migratory waterfowl. However, such monitoring is not currently feasible given management priorities and available resources. Similar studies are underway for landbirds, snakes, and fresh and marine invertebrate assemblages. During hunting season, MDFW evaluates the sex and general age characteristics of harvested deer.

3.3.2 Natural History – Game Species-Birds

Ring-necked Pheasant

The ring-necked pheasant is one of the most successful and well-known introduced game birds in North America. This species is exceptionally popular as an upland game bird throughout much of its range. Populations are established on most mid-latitude agricultural lands throughout its range in North America. Breeding does occur in the wild; however, widespread annual releases obscure status and delineation of resident breeding populations in North America.

Range: In New England, pheasants are primarily a stocked game bird. There are low numbers of over-wintering and breeding populations along the New Hampshire coast, eastern Massachusetts, southern Connecticut, and around Narragansett Bay, Rhode Island (DeGraaf and Yamasaki 2001).

Habitat: Pheasants typically breed in open fields cultivated for grass or grain, fallow fields, brushy pastures, hedgerows by roadsides, cut-over land and open ungrazed woodlots. Agricultural land, however, provides the most suitable habitat. They are not present in mountainous regions or in forested

areas. During the winter season they inhabit areas that have dense cover, such as cat-tail swamps interspersed with thickets (DeGraaf and Yamasaki 2001). Pheasants thrive best in agricultural and early successional areas, which are limited at CACO. They require dense herbaceous cover for nesting.

Food Habits: Their staple food sources are cultivated grains and weed seeds. They also feed on soft parts of herbaceous vegetation, fleshy fruits, and insects. They typically feed in grain and weed fields bordered by hedgerows, which offer cover protection (Allen 1956).

Conservation: A study conducted by Bump (1999) found that the Cape Cod region offered only marginal habitat. Only 1.1 percent of the population survived through mid winter. Therefore, pheasants released in this area are mainly a put and take resource and have not formed any significant breeding population. Also, since they are raised in captivity, they feed very little between the time they are released and when they are harvested. As they are not present in the ecosystem for very long, pheasants are thought to have a negligible effect on the CACO ecosystem.

Abundance: Bump (1999) reviewed the history of pheasant releases on Cape Cod. Pheasants have been released on Outer Cape Cod for several decades, well before the establishment of CACO in 1961. In 1971, the NPS and MDFW began cooperative management of the pheasant release program on CACO. The MDFW stocks birds within CACO while the NPS monitors hunter numbers and activities. Pheasants are typically released at three locations on CACO: Marconi Beach WMA, Wellfleet/Truro, and Provincetown. Numbers of birds released on the Outer Cape each year between 1970 and 1997 varied between 330 and 1,166. Typically, about 800 birds have been released each year since the mid 1980s (Bump and Field 1999).

Recent Breeding Bird Survey (BBS) analyses indicate that pheasants decreased 5.4 percent per year from 1980 to 2004 statewide for Massachusetts (Sauer *et al.* 2005). While no pheasants were recorded on the BBS (47901) route within CACO (1989 to 1999), pheasants counted on the Wellfleet BBS route (47004) from 1970 to 1998 averaged 0.56 birds/count (range: 06 birds, [Sauer *et al.* 2005]). However, all pheasants on Cape Cod are assumed to be stocked birds.

Take: Kennedy (1988) reported Massachusetts statewide harvests of 70,605 and 51,468 pheasants in 1985 and 1986 hunting seasons by 43,121 and 37,613 hunters, respectively. Based on a two-season study, Bump (1999) estimated that 574 and 466 pheasant hunters used the Marconi Beach WMA in the 1996 and 1997 hunting seasons, respectively. This was lower than reported in the early 1970s, when hunter numbers ranged from 813 in 1976 to 1,150 in 1974. Of 1,595 pheasants released on CACO during 1996 and 1997, 33 percent were harvested.

Harvest management strategy: On Cape Cod, pheasants are stocked annually by the MDFW, and Bump (1999) found no evidence that released pheasants on CACO can survive through the fall and winter to establish a viable breeding population. Thus, the pheasant harvest on CACO is considered a "put and take" harvest in which all released animals are either harvested or die of natural causes. Either sex may be harvested throughout Cape Cod. Hunting constitutes a significant proportion of annual mortality for male pheasants (i.e., in most regions with self-sustaining populations, only male birds may be harvested). However, few studies have demonstrated that hunting limits population levels (Giudice and Ratti 2001).

Pheasant chicks receive a starter mash that contains the anti-biotic Amprolium during the first six-weeks of life. After six-weeks, the pheasants are fed an adult feed that does not contain antibiotics and are kept in enclosures that are large enough for the birds to fly. By the time the pheasants are released at 15 to 20 weeks old, there are only trace amounts of antibiotics in their bloodstream. The USDA and the MDFW inspect both the farms that raise and sell the pheasants and the pheasants themselves to determine that they are disease free (letter from Robert Deblinger of MDFW to Maria Burks of NPS, October 7, 2002).

Bump (1999) reported that harvest mortality in 1996-1997 on CACO accounted for a 33 percent loss, and radio-tagged pheasants experienced extreme predation from a variety of predators, including avian predators, foxes, and coyotes. All but 1 of the 53 collared birds were dead within 92 days of release.

The ecological effects of discontinuing the pheasant hunt at CACO are unknown. However, Bump (1999) concluded that the proportion of the released pheasant population not harvested (~67%) would not provide fox and coyote populations on CACO a sustained food source. Thus, the effects would probably be minimal at best.

Effects on predator/prey interactions and competition with other species: On CACO, avian predators (red-tailed hawk [*Buteo jamaicensis*] and great horned owl [*Bubo virginianus*]) accounted for 30 to 40 percent of the non-harvest mortality, followed by fox (14 – 16%), coyote (7 – 8%), and an unknown mammal (12 – 14%) (Bump and Field 1999). Furthermore, Bump and Field concluded that non-harvested pheasants provide an easy food source for predators for only a short period of time in fall each year, and the effect on the populations is short-term. There is no evidence of competitive interactions of pheasants with other species on CACO (Bump and Field 1999). Finally, the Bump and Field work concluded that released pheasants on CACO are not feeding after release; consequently they are unlikely to be numerous enough to deplete any native food source.

Northern Bobwhite Quail

Range: In New England, quail occur in southeast Massachusetts, including Cape Cod, Martha's Vineyard and Nantucket; eastern and southern Connecticut; and Rhode Island.

Habitat: Quail breed in fields, early successional habitats and open woodlands adjacent to pastures, meadows, agricultural fields with abundant weedy growth (Brennan 1999), and open pitch pines and barrens (on Cape Cod and the islands). Bobwhites avoid deep woods (DeGraaf and Yamasaki 2001).

Food Habits: Quail feed on soft parts of herbaceous vegetation, buds, seeds and fruits. The young are almost totally insectivorous. They commonly feed in agricultural fields and open areas near protective brushy cover (Brennan 1999).

Abundance: Cardoza (1993) reviewed the status of bobwhites in Massachusetts. As in DeGraff and Yamasaki (2001) bobwhites are native to Massachusetts and were common throughout southern New England. Periods of severe loss and local extirpation were reported after severe winter storms in the 1850s and 1870s. A storm in 1898 wiped out virtually all quail between Cape Cod and New Hampshire. The large, pale native New England bobwhite was extirpated by 1872. By 1952, bobwhites were restricted to five southeastern counties and the southern portion of Norfolk County. Beginning in the early 1900s, bobwhites were propagated from southern stock for release in Massachusetts. As recently as 1993, about 3,500 bobwhites were obtained from commercial sources for release on WMAs in Barnstable and Plymouth Counties (Cardoza 1993).

From 1952 to 1956, call count indices in Barnstable County ranged from 2.37 to 2.74 (quail heard/stop on route multiplied by a weighting factor) (Ripley 1958). Since 1958, biennial call counts have been conducted by MDFW. Cardoza (1993) reported an index of 1.71 for 1991 within Barnstable County. He concluded that indices in the early 1990s were less than those recorded historically. The mean index in 1999 and 2001 were 13.00 and 11.50, respectively, for Barnstable County (Cardoza 2002), up substantially from the early 1990s.

Recent BBS data indicate that bobwhites decreased 13.6 percent per year from 1980 to 2004 statewide for Massachusetts (Sauer *et al.* 2005). Similarly, bobwhites decreased 18.7 percent from 1989 to 1999 on the

BBS (47901) route within CACO and 10.2 percent from 1970 to 1998 on the Wellfleet BBS route (47004) (Sauer *et al.* 2005).

Take: There is no current information on numbers of bobwhite hunters and harvests on CACO. Kennedy (1988) reported statewide harvests of 19,100 and 9,699 bobwhites during 1985 and 1986 hunting seasons, respectively.

Harvest management strategy: Most bobwhite management focuses on habitat management via frequent vegetation disturbance (every 1 – 5 years) from prescribed fire and/or mechanical disturbances (Stoddard 1931; Landers and Mueller 1986). Hunting pressure on public lands continues to increase in some areas, despite declining populations (Brennan and Jacobson 1992). Hunting records from shooting-plantation game books from the southeastern United States show evidence that relatively stable and abundant populations can be maintained for multiple decades if proper habitat is maintained through management (Brennan *et al.* 1995b). Management of hunting pressure is also essential for effective population management (Roseberry and Klimstra 1984). However, bobwhite hunting management decisions and resultant pressure vary widely across properties, states, and regions.

Bobwhite population dynamics and susceptibility to hunting pressures: Roseberry and Klimstra (1984) reported evidence of density-dependent processes (i.e., greater reproductive success at low densities and greater mortality at high densities) and cyclic variation at 10-year intervals in southern Illinois. They suggested that pre-breeding and breeding social interactions such as intraspecific competition (for space and food resources) may also contribute to density-dependent reproduction and that over-winter survival may be related to spacing behavior among winter coveys, as well as to weather.

Two types of intrinsic factors appear to influence bobwhite populations: "one tending to promote fluctuations through momentum and the other tending to dampen fluctuations through compensatory adjustments of reproduction and mortality" (Roseberry and Klimstra 1984:166). Extrinsic factors are also potentially significant for regulating bobwhite populations. Effects of weather (both lack of rainfall and excessive rainfall, as well as winter weather severity) often overwhelm effects of management and land use (Stoddard 1931; Roseberry and Kilmstra 1989; Giuliano and Lutz 1993).

Roseberry and Klimstra (1984) observed strong evidence for synchrony between bobwhite population abundance and the nodal lunar cycle. Bobwhites show evidence of cyclic population changes (on 10-year interval) from a southern location in Illinois (38°N) that is typically characteristic of wild animals, including bobwhites (Kabat and Thompson 1963, Sinn 1978) at more northern latitudes.

Ruffed Grouse

Range: Ruffed grouse are a common species of inland New England, although less abundant along the southern coast and absent from Nantucket, Massachusetts and Block Island, Rhode Island (Veit and Petersen 1993).

Habitat: Ruffed grouse inhabit brushy, mixed-aged woodlands and early successional to mature hardwood and mixed forest, commonly with birch or aspen present. Hens and broods prefer areas with a dense understory and fairly open herbaceous ground cover. Early successional habitats (regenerating clear-cuts or old burns) are ideal. More mature woodlands, especially coniferous forests, are used in winter for cover and roosting. Birds roost in snow when it is soft and deep, or they roost on the ground or in trees (DeGraaf and Yamasaki 2001).

Food Habits: The diet of the ruffed grouse consists of seeds, insects, fruit, and leaves. During the fall and winter the buds of birch, aspen, hazel, hop hornbeam and cherry are staples (Bump *et al.* 1996). During the winter, aspen stands are favorite feeding spots (Svoboda and Gullion 1972).

Abundance and Take: There is no information on ruffed grouse abundance in CACO; however, they appear to be of numbers too small to support an abundance of hunting activity and are apparently not specifically pursued in the region. The ecological effects of hunting or not hunting ruffed grouse on CACO are unknown. Cape Cod is very poor habitat for ruffed grouse and it is likely that the number of grouse harvested in Barnstable County is very low.

American Crow

Range: The American crow is a common resident of New England and can be found throughout the region (DeGraaf and Yamasaki 2001). Northern populations are migratory, but they winter within North America (DeGraaf and Yamasaki 2001).

Habitat: Crows require open areas for foraging and are found in semi open fields and woodlands containing deciduous, coniferous and mixed forests. They also inhabit open wooded river bottoms, orchards, woodlands adjacent to agricultural fields and other open land, and parks and suburban neighborhoods. In the winter, individuals often move to lower elevations off the coast (DeGraaf and Yamasaki 2001).

Food Habits: Crows are omnivorous. Three-fourths of their diet consists of plant products such as cultivated grains, seeds, and wild and cultivated fruits and nuts. They also supplement their diet with small mammals, carrion, insects, eggs, young birds, millipedes, spiders, small crustaceans, frogs, and reptiles (DeGraaf and Yamasaki 2001).

Abundance: BBS data show significant increases in crow numbers from 1966 to 1996 in 24 of 51 states and provinces, and in 23 of 52 physiographic regions. Conversely, recent BBS data indicate that crows decreased 1.69 percent per year from 1989 to 2004 statewide for Massachusetts (Sauer *et al.* 2005). Similarly, crows decreased 4.88 percent from 1989 to 1999 on the BBS (47901) route within CACO, but increased 2.36 percent from 1970 to 1998 on the Wellfleet BBS route (47004) (Sauer *et al.* 2005).

Take: There is no current information on numbers of crow hunters and harvests on CACO or in Massachusetts.

Harvest management strategy: Although crows in the United States have been protected by the Migratory Bird Treaty Act since 1971, hunting is allowed and individual states set hunting seasons (not to exceed 124 days) that exclude the nesting season (Clapp and Banks 1993). Recreational hunting accounts for the single largest cause of death continent-wide: 1,248 crows shot among 1,831 band returns of banded crows from 1917 to 1999 (data from Bird Banding Office, Hull, Québec in Verbeek and Caffrey 2002).

Crow population dynamics and susceptibility to hunting pressures: There is no information on the effects of hunting on the population dynamics of crows. However, the effects of a variety of other control measures (lethal and non-lethal) were reported by Verbeek and Caffrey (2002). These methods included dynamiting of roosts (Kalmbach 1939, Good 1952), but this has had no noticeable effect on crow population levels or agricultural damage (Hanson 1946). Neither removal of a "traditional" roost, nor dispersal of crows from a number of roosts causes crows to leave urban areas; they instead move to other established roosts or form new ones (Gorenzel and Salmon 1993). Therefore, it appears that even

extensive population control methods have not adversely affected crow populations. As such, recreational hunting probably does not effect crow populations.

Wild Turkey

Range: Turkeys are a common resident in New England. They reside in most of Massachusetts, except for some areas to the east. Their northern limit seems to be determined by condition, depth, and duration of snow cover (Markley 1967).

Habitat: During summer months, turkeys prefer open, mature, hardwood forests containing mast-bearing trees and scattered openings such as forest clearings and agricultural land. In winter they favor mature forests with south-facing slopes, mast-bearing trees, and abundant springs and seeps. In areas to the north where snow can be deep and fluffy, turkeys use silage and waste grain as primary feeding sites (Healy 1992a).

Home Range: Size is highly variable as a result of flock segregation by sex and annual food supply. Hens with broods range over an area of 100 to 200 ha during the summer, but use smaller centers of activity within the larger range depending on habitat quality (Healy 1992a). Large movements tend to occur mostly during early spring, late summer, and fall (Healy 1992b). Pough (1951) found that in ideal conditions an average of 15 to 20 birds per mi^2 were represented.

Food Habits: The staple food of turkeys consists of acorn and beechnuts, but they also feed on fruits and seeds of trees, shrubs, and herbaceous vegetation, tubers, roots and insects (Korschgen 1967). They generally feed in mast-producing woodlands during fall and winter, and fields, pastures and woodlands with rich herbaceous ground cover during the summer (DeGraaf and Yamasaki 2001).

Conservation: The turkey population, which had been extirpated in Massachusetts and other parts of New England, rebounded as a result of the reintroduction of wild trapped birds from New York during the 1970s (DeGraaf and Yamasaki 2001). Massachusetts began transplanting wild birds into Berkshire County in 1972. From 1995 to 2003, two wild turkey transplants were made from Berkshire County to Barnstable County by MDFW. Eighteen birds were released at Camp Edwards in 1989, and 28 birds were released in 1995-1996 in the vicinity of CACO in Wellfleet (J. Cardoza, MDFW, unpubl. data).

Abundance: There is no information on wild turkey numbers specifically within CACO, but crude estimates are available at a variety of spatial scales. Populations dropped drastically during the 19th and early 20th centuries because of hunting and habitat loss. The overall population of eastern wild turkey and Florida wild turkey increased from 129,373 in the late 1940s to almost 300,000 in 1956 (Mosby 1959). By 1970, the United States population was estimated at 1,250,000 (Mosby 1973) and the species had spread beyond its ancestral range in 7 western states. It was also reestablished in two states west of the Mississippi River plus six eastern states. The United States population estimate was 5.46 million in 1999. Recent BBS analyses indicate that wild turkeys increased 11.3 percent per year survey-wide from 1980 to 2004 (Sauer *et al.* 2005). The estimated state-wide wild turkey population is 18,000 birds (MDFW unpubl. data).

Take: There is currently no wild turkey hunting season within CACO. However, estimates of annual harvests are available for Barnstable County from MDFW. The first hunting season occurred in Barnstable County in 1999, and only spring hunting seasons are permitted on Cape Cod. For the 7-year period (1999 – 2005), a total of 51 turkeys were harvested in Barnstable County, averaging 7 birds per year (range 0 – 15) (Table 10).

Table 10. Reported Spring Wild Turkey Harvest by Town in Barnstable County, 1999 – 2005[1]

Town	1999	2000	2001	2002	2003	2004	2005
Bourne	2	11	4	3	1	8	3
Chatham	0	0	1	0	0	0	0
Eastham	0	1	1	0	1	0	2
Falmouth	0	1	0	1	1	0	0
Sandwich	0	2	2	1	0	1	0
Truro	0	0	0	0	2	1	1
Total:	**2**	**15**	**8**	**5**	**5**	**10**	**6**

1. MDFW unpublished data

Harvest management strategy: In Massachusetts, restoration efforts produced a huntable population by 1980. The hunt is by permit only in order to manage hunter density. With 11 counties open for spring hunts, virtually all hunters who apply obtain a turkey hunting permit. Typically, the spring hunting season is timed to coincide with the period when the protected hens are already on their nests; thus only gobblers can be taken. During the fall, there is a limited either-sex hunting season in some areas of the state, though not on Cape Cod (MDFW 2005a).

Wild turkey population dynamics and susceptibility to hunting pressures: Wild turkeys have been studied extensively throughout their range. Roberts *et al.* (1995) suggested that annual fluctuations of northern populations of wild turkeys in mixed agricultural and forested environments rarely result from variability of annual survival, but rather from changes in annual nest success and poult survival. However, Rolley *et al.* (1998) indicated that variability of annual survival can also be important, especially regarding long-term changes in populations. Eaton (1992) summarized the limiting factors for various turkey subspecies. He reported that the main limiting factors for the eastern wild turkey are poult mortality during the first 6 weeks, loss of habitat, and hunter harvest. Factors identified as limiting turkey populations elsewhere included poult losses during the first two weeks, predators, hunting, disease, accessible surface water, land management, and fall and spring rains, which are important in recharging soil moisture for abundance of vegetation and insects.

Waterfowl Population Indices and Harvest Estimates

The following tables (Tables 11, 12, and 13) provide a summary of national waterfowl population indices, harvest estimates in Barnstable County, and a comparison of Atlantic Flyway harvests and those from Barnstable County. These summaries are further referenced within many of the species accounts that follow. Generally this information suggests that harvests from Barnstable County are relatively low and represent a very small portion of the flyway harvest.

Table 11. Waterfowl Estimated Population Indices from 1999 – 2005

Species	Estimated Population Indices by Year						
	1999	2000	2001	2002	2003	2004	2005
Brant	171,600	157,200	145,300	181,600	164,500	129,600	123,200
Black duck	1,018,000	885,009	864,009	1,174,000	976,002	1,093,000	826,500
Bufflehead	70,500	49,300	95,000	83,600	66,300	43,800	Unknown
Goldeneye	821,100	778,700	1,118,000	970,300	968,400	747,800	714,700
Canada goose breeding	77,500	93,200	146,700	164,800	156,900	174,800	162,400
Canada goose resident	999,500	1,024,500	1,017,200	966,000	1,083,200	980,400	1,064,700
Canvasback	716,000	706,800	579,800	486,600	557,600	617,200	520,600
Ring-necked	905,300	1,342,000	838,600	834,900	1,012,000	1,257,000	883,100
Gadwall	3,235,500	3,158,400	2,679,200	2,235,400	2,549,000	2,589,600	2,179,100
Pintail	3,057,900	2,907,600	3,296,000	1,789,700	2,558,200	2,184,600	2,560,500
Green-winged teal	627,600	347,900	265,900	588,800	521,100	775,700	422,900
Wigeon	2,920,100	2,733,100	2,493,500	2,334,400	2,551,400	1,981,300	2,225,100
Mallard	554,100	443,800	465,000	517,500	648,100	645,500	411,700
Lesser scaup and Greater scaup	4,411,700	4,026,300	3,694,000	3,524,100	3,734,400	3,807,200	3,386,900
Snow goose	803,400	813,900	837,400	639,300	678,000	957,600	814,600

Table 12. Waterfowl Harvested in Barnstable County 1993 – 2003

Species	Barnstable County Harvest by Year											
	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**Total**
Coot	Unk	Unk	Unk	Unk	Unk	Unk	0	0	180	40	40	270
Atlantic brant	530	140	330	0	220	160	0	220	270	510	270	2,650
Black duck	1420	1730	1360	850	900	3610	1750	3140	1440	1050	520	17,770
Bufflehead	320	230	500	100	30	2380	2140	4630	2730	350	360	13770
Goldeneye	0	30	50	0	0	310	70	0	0	0	40	500
Canada goose	1140	990	70	590	450	270	580	300	150	40	260	4,840
Canvasback	0	0	0	0	0	0	140	0	0	0	0	140
Ring-necked pheasant	0	0	0	0	0	80	0	0	220	90	0	390
Eider	840	6410	11590	5290	2100	3930	2770	0	0	0	0	32,930
Gadwall	0	0	80	0	0	80	350	0	110	0	0	620
Pintail	0	0	0	0	0	0	140	0	0	40	0	180
Green-winged teal	0	120	110	0	80	540	760	0	660	180	400	2,850
Wigeon	0	0	110	0	0	80	0	0	160	0	40	390
Long-tailed duck	0	460	150	0	0	0	140	0	0	0	0	750
Mallard	820	450	1090	910	940	460	1590	990	980	750	120	9,100
Common merganser	50	0	0	0	0	80	70	0	0	0	0	200
Red-breasted merganser	940	620	730	400	1940	2930	1310	0	230	180	40	9,320
Hooded merganser	0	0	0	0	80	230	210	0	110	90	160	880
Ruddy duck	0	0	0	0	80	0	0	0	0	0	0	80
Lesser scaup	0	60	0	0	0	230	0	0	0	310	0	600
Greater scaup	50	0	0	0	0	0	0	0	0	180	40	270
Black scoter	0	0	220	0	0	0	0	0	0	0	0	220
Surf scoter	210	0	370	0	0	0	140	0	0	0	0	720
White-winged scoter	310	190	220	0	0	0	0	0	0	0	0	720
Snow goose	0	0	0	0	80	0	0	0	0	0	0	80
Wood duck	90	60	130	0	0	150	620	170	0	0	0	1,220
Total:												

Table 13. Barnstable County Waterfowl Harvest Relative to State and Flyway Harvests

Species	Barnstable County Harvest 2003	Mass Harvest 2003	Mass Harvest 2004	Flyway Harvest 2003	Flyway Harvest 2004	2003 Harvest Barnstable County Flyway %
Coot	<50	<50	100	12,800	13,100	<0.4
Atlantic brant	270	1,600	300	44,925	18293	0.6
Black duck	520	2,711	1,809	95,108	74920	0.5
Bufflehead	360	837	2,210	54,571	52,265	0.7
Goldeneye	40	239	452	13,439	13,036	0.3
Canada goose	260	12,874	15,200	657,910	633,289	0.04
Canvasback	0	0	0	4,738	9,772	0.0
Ring-neck.	0	199	301	112,806	74,349	0.0
Eider	0	3,097	5,717	34,638	21,582	0.0
Gadwall	0	80	0	38,479	24,269	0.0
Pintail	0	40	0	18,134	10,254	0.0
Green-winged teal	400	2,033	1,156	137,155	114,969	0.3
Wigeon	40	319	50	39,598	19,374	0.1
Long-tailed duck	0	127	539	17,627	20,909	0.0
Mallard	120	7,375	9,245	427,301	422,091	0.03
Common and Red-breasted merganser	40	399	1,558	22,824	19,729	0.2
Hooded merganser	160	598	352	29,181	25,692	0.5
Ruddy duck	0	0	0	2,474	4,307	0.0
Greater scaup	40	80	0	17,344	16,837	0.2
Lesser scaup	0	0	0	60,939	54,891	0.0
All scoters	0	3,776	3,344	63,174	48,303	0.0
Snow goose	0	26	0	36,105	31,548	0.0
Wood duck	0	2,711	3,165	338,004	265,560	0.0
Totals	2300	39171	45498	2,279,274	1,989,339	0.1

Waterfowl—Dabbling Ducks:

American Black Duck

Range: The breeding range for the black duck extends from northeastern Saskatchewan to northern Labrador and Newfoundland, south to northern South Dakota, northern Illinois, and central West Virginia and on the Atlantic Coast to North Carolina. The winter range extends from southeastern Minnesota and central Wisconsin to New Brunswick and Nova Scotia, south to southern Texas, the Gulf Coast, and south-central Florida (DeGraaf and Yamasaki 2001). They winter as far north as open water and food are available. In New England they are a widespread breeder and common migrant but a declining winter resident.

Habitat: The breeding habitat of the black duck consists of a wide variety of coastal and freshwater habitats, including brackish marshes and estuaries and edges of rivers, lakes, and ponds. They also inhabit forested swamps, beaver ponds, emergent wetlands, and open boreal and mixed hardwood forests (DeGraaf and Yamasaki, 2001). Populations in Vermont have been found to occur in glacial kettle ponds surrounded by bog mats (Laughlin and Kibbe 1985). During the winter months, they are found mainly in brackish marshes bordering bays, estuaries, and agricultural marshes (DeGraaf and Yamasaki 2001).

Food Habits: The black duck diet varies greatly with habitat; in marine habitats they feed mainly on mollusks, whereas in fresh and brackish environments their diet consists mainly of plant material. They also consume seeds, acorns, berries, crustaceans, amphibians, earthworms, and small fish (DeGraaf and Yamasaki 2001). In late fall and winter, birds may leave their rest areas early in the day and just before sunset to fly to waste cornfields up to 25 miles away (Bellrose 1976).

Abundance: The longest time-series of data available to assess the status of the black duck is provided by the Midwinter Waterfowl Inventory (MWI) conducted in January in states of the Atlantic and Mississippi Flyways. The 2005 midwinter counts of black ducks (203,900 in both flyways combined) was 10 percent lower than the 2004 index (226,700), and 25 percent lower than the 10-year mean (272,600). In the Atlantic Flyway, the midwinter index of 184,100 decreased 11 percent from 206,400 in 2004, and was 18 percent below the most recent 10-year mean (225,000) (USFWS, 2004a, 2005a).

Estimates of the black duck breeding population size in the eastern survey area have varied from 826,500 to 1.174 million since 1999 (Table 11). The population estimate for 2005 was 18 percent below the 1999-2004 average (USFWS 2004a, 2005a).

Take: Estimates of annual harvests are available for Barnstable County from the USFWS Harvest Inventory Program (HIP) program. For the 1993 – 2003 11-year period, 17,770 black ducks were harvested in Barnstable County, averaging 1,615 birds per year (range 520 – 3,610) (Table 12).

In 2003 and 2004 hunting seasons, 2,711 and 1,809 black ducks were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 95,108 and 74,920 black ducks were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The average annual black duck harvest for all of Barnstable County is 1.0 percent of the black duck population in the eastern United States. Similarly, the level of harvest of black ducks in Barnstable County is insignificant compared to harvest levels in the Atlantic Flyway (0.5%) (Table 13).

The USFWS reports the numbers of mallard x black duck hybrids harvested. For the 11-year period, 1,080 mallard x black duck hybrids were harvested in Barnstable County, averaging 98 birds per year (range 0 – 210). For the Atlantic Flyway, 7,000 and 8,719 hybrids were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b).

Harvest management strategy: Black ducks have been heavily exploited in most states and provinces of eastern North America (Wright 1947). Following a 25-year decline in the abundance of black ducks as measured by the MWI, the USFWS placed restrictions on the sport harvests of black ducks in 1983, reducing the daily bag limit to one black duck in the Mississippi Flyway, and a variety of regulatory options in the Atlantic Flyway designed to reduce the harvest by 25 percent. By 1994, a 47 percent reduction in flyway harvest had been achieved. With the implementation of Annual Harvest Management (AHM) for general duck seasons in 1995, most states in the Atlantic Flyway gradually returned to the maximum season length allowable under framework regulations, although a daily bag limit of one black duck has been maintained through federal regulations. Since 1994, harvests have remained at comparable levels. Black duck harvest in Canada has declined at an average rate of 3 percent per year since keeping records began in 1968, in part due to regulatory restrictions, but probably more as a result of their dramatic long-term decline in hunter numbers (Johnson and Conroy 2005).

Johnson and Conroy (2005) developed an assessment framework for black duck harvest management in the United States. This framework is intended to help the USFWS assess the biological implications of any proposed changes to hunting regulations, as well as to complement the ongoing effort to develop an AHM program for black ducks.

Black duck population dynamics and susceptibility to hunting pressures: Conroy *et al.* (2002) reviewed the variety of factors proposed to explain the black duck decline, including reduction in quantity and quality of: (1) breeding habitat; (2) wintering habitat; (3) effects of harvest; and (4) interactions with mallards. They concluded that there is circumstantial evidence linking all of these factors with the black duck decline. However, several studies suggested that the long-term population decline in black ducks was related mostly to excessive hunting (Blandin 1982, Grandy 1983, Francis *et al.* 1998), and not to interactions with mallards (Ankney *et al.* 1987, Longcore *et al.* 1998, McAuley *et al.* 1998; Longcore *et al.* 2000). Further, with the harvest restrictions implemented since 1983, there have been increasing numbers of black ducks recorded on the MWI (Longcore *et al.* 1998) and in Canada (Boyd 1988). The numbers of breeding black duck pairs has also increased in eastern Canada since the 1990s (Longcore *et al.* 2000).

The ecological effects of discontinuing the black duck hunt are unknown. However, mean survival rates, based on recoveries of banded ducks, increased when hunting was reduced (Francis *et al.* 1998). Survival rates were higher in areas where mean numbers of direct band recoveries (i.e., within same year banded) were lower. At four study sites in Québec, Nova Scotia, and Vermont during 1990-1991, survival of black ducks in the fall was ≥ 80 percent when losses from hunting were excluded (Longcore *et al.* 2000).

Gadwall (*Anas strepera*), ***Northern Pintail*** (*A. acuta*), ***Green-winged Teal*** (*A. crecca*), and ***American Wigeon*** (*A. americana*)

Range: The winter range of the gadwall, pintail, green-winged teal, and wigeon in New England includes sections of Massachusetts (eastern coast, Plum Island, Salem, Plymouth and Berkshire counties), south along the coast to Rhode Island and Connecticut (Veit and Petersen 1993). All four are uncommon in winter and during the breeding season in New England (DeGraaf and Yamasaki 2001).

Habitat: During the winter, gadwalls reside in coastal bays and freshwater marshes that remain free of ice, but they can be found in most bodies of open water (DeGraaf and Yamasaki 2001). Pintail winter habitat includes shallow inland fresh and brackish wetlands, flooded agricultural fields, tidal wetlands, mudflats along rivers, and sounds and bays (DeGraaf and Yamasaki 2001). During the winter green-winged teal remain on fresh and brackish marshes, lakes, ponds, shallow streams, sloughs, forested wetlands, brackish estuaries, and flooded agricultural fields. They will also use mud banks. During winter wigeons use shallow, fresh and brackish ponds; wet meadows; coastal marshes; and bays (DeGraaf and Yamasaki 2001).

Food Habits: Gadwalls feed mainly on submerged aquatic plants (seeds or soft parts), pondweeds, naiads, wigeon grass, eelgrass, filamentous algae, etc. in shallow water (DeGraaf and Yamasaki 2001).

The pintail mainly feeds on seeds, especially those of pond weeds, sedges, grasses, smartweeds and cultivated grains. They will also consume aquatic insects, crustaceans and snails (Austin and Miller, 1995). Their preferred feeding habitat is shallow waters of marshes, ponds, meadows, and grain fields (DeGraaf and Yamasaki 2001).

Seeds of wetland plants comprise the staple of the green-winged teal diet, especially millets, smartweed, and nutgrasses. They also feed on insects, crustaceans, and mollusks. Teals generally forage in flooded or dry grain fields and woodlands in the spring and fall, but their preferred feeding habitat is mudflats (Johnson 1995).

The wigeon is almost wholly vegetarian, eating leaves, stems and buds of pondweed, wigeon grass, and wild celery. It also eats tender shoots of grasses and occasionally snails, beetle, and crickets (DeGraaf and Yamasaki 2001).

Abundance: There is no information on gadwall numbers specifically within CACO. Estimates of the gadwall breeding population size in the traditional North American survey area have varied from 2.179 to 3.235 million since 1999 (Table 11) and are 30 percent above the 1955 – 2004 long-term average (USFWS 2005a).

There is no information on pintail numbers specifically within CACO. Estimates of the pintail breeding population size in the traditional North American survey area have varied from 1.79 to 3.3 million since 1999 (Table 11) and are 38 percent below the 1955 – 2004 long-term average (USFWS 2005a).

There is no information on green-winged teal numbers specifically within CACO. Estimates of the green-winged teal breeding population size in the eastern survey area (survey strata 51-72) have varied from 422,900 to 775,700 since 1999 (Table 11). The population estimate for 2005 was 19 percent below the 1999 – 2004 average (USFWS 2005a). Estimates of the green-winged teal breeding population size in the traditional North American survey area have varied from 2.16 to 3.19 million since 1999, and are 16 percent above the 1955 – 2004 long-term average (USFWS 2005a).

There is no information on wigeon numbers specifically within CACO. Estimates of the wigeon breeding population size in the traditional North American survey area have varied from 1.98 to 2.92 million since 1999 (Table 11), and are 15 percent below the 1955 – 2004 long-term average (USFWS 2005a).

Take: There is no information on numbers of these four species harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program.

For the 11-year period (1993 – 2003), 620 gadwalls were harvested in Barnstable County, averaging 56 birds per year (range 0 – 350); 180 pintails were harvested, averaging 16 birds per year (range 0 – 140) 2,850 green-winged teals were harvested, averaging 259 birds/year (range 0 – 760); and 390 wigeons were harvested in Barnstable County, averaging 35 birds/year (range 0 – 110) (Table 12).

In 2003 and 2004 hunting seasons, 80 and 0 gadwalls were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 38,479 and 24,269 gadwalls were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 harvest of gadwalls for Barnstable County accounts for <0.1 percent of the flyway harvest (Table 13).

In 2003 and 2004 hunting seasons, 40 and 0 pintails were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 18,134 and 10,254 pintails were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 Barnstable County harvest represents <0.1percent of the flyway harvest (Table 13).

In 2003 and 2004 hunting seasons, 2,033 and 1,156 green-winged teals were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 137,155 and 114,969 green-winged teals were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 harvest of green-winged teal for Barnstable County accounts for about 0.3 percent of the flyway harvest (Table 13).

In 2003 and 2004 hunting seasons, 319 and 50 wigeons were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 39,598 and 19,374 wigeons were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 wigeon harvest in Barnstable County represents approximately 0.1 percent of the flyway harvest (Table 13).

Harvest management strategy: Gadwalls are the third most harvested waterfowl species in the United States; however, less than 4 percent of the total United States harvest comes from the Atlantic Flyway (LeSchack *et al.* 1997). There is no specific AHM protocol developed for the gadwall. Thus, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for gadwalls in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for gadwalls in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway gadwalls since 1996.

Pintails have shown a substantial population decline in the past 30 years, presumably due to anthropogenic changes to the landscape on the breeding grounds (Miller and Duncan 1999). Prior to this decline, pintails were an important component of the United States harvest. In recognition of the poor status of pintails, the USFWS developed a special harvest strategy in 1997 (referred to as the "Interim Pintail Harvest Strategy") that remains in effect. In the 2002 and 2003 hunting seasons, the USFWS set pintail regulations that deviated from the provisions of the interim strategy, referred to as "season-within-a-season" regulations. For the 2004 hunting season, the USFWS formally incorporated seasons-within-a-season as a component of the pintail strategy. Runge and Boomer (2005) provided a draft interim report reviewing pintail demographic and harvest information and suggesting technical modifications to the pintail harvest strategy.

There is no specific AHM protocol developed for the pintail. However, since 1997 the USFWS has depended on their "Interim Pintail Harvest Strategy" instead of exclusively using the status of eastern mallards for setting the harvest level for pintails in the Atlantic Flyway. Under this interim strategy, the USFWS has generally based their harvest regulations on the estimated breeding population size for pintail in the traditional survey area and their projected fall flight.

Typically, green-winged teals are the second most hunted duck species in the United States after mallards; however, on average <10 percent of the total United States green-winged teal harvest comes from the Atlantic Flyway (USFWS 2005b). Although there is no early hunting season for green-winged teals in Massachusetts, six states in the Atlantic Flyway had special teal seasons in September 2003 and 2004 with total harvests of 3,186 and 2,331, respectively (USFWS 2005b). There is no specific AHM protocol developed for the green-winged teal. Thus, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for green-winged teals in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for green-winged teals in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway green-winged teals since 1996.

Less than 4 percent of the total United States wigeon harvest comes from the Atlantic Flyway (Mowbray 1999). There is no specific AHM protocol developed for the wigeon. Thus, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for wigeons in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for wigeons in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway wigeons since 1997.

Population dynamics and susceptibility to hunting pressures: From 1986 to 1996, gadwalls had the largest population increase of any other waterfowl species (LeSchack *et al.* 1997). There are several factors contributing to this increase. First, gadwalls typically nest later than other dabbling ducks, and this decreases nest-site competition and predation. Second, gadwalls prefer to nest on island habitat, which further reduces mammalian predation. Finally, increases in their breeding numbers are also

attributed to increased nesting habitat due to unusually wet conditions since 1996 (Caithamer and Dubovsky 1996).

Information is very limited on the effects of hunting on gadwalls. However, the species is the third most harvested waterfowl species in the United States. Although the gadwall populations were at record highs in the mid 1990s (Dubovsky *et al.* 1995), population numbers have declined since then (Wilkins *et al.* 2005). However, hunting pressure and associated human activity affect this bird's ability to accumulate lipid reserves (Fredrickson and Drobney 1979, Gaston 1991). This is probably a result of reduced feeding time and increased energy requirements.

The ecological effects of discontinuing the gadwall hunt on CACO are unknown; however, the harvest is typically so small or completely absent in Barnstable County that no ecological effects would be expected.

Overall, the continental pintail population has been declining since the mid 1950s when surveys were first initiated. In 2005, populations were 38 percent below their 1955—2004 long-term average (USFWS 2005a). The continental population is influenced by variations in recruitment rates, annual and winter survival rates, and harvest rates (Austin and Miller 1995). High populations are associated with abundant shallow wetlands in the Prairie Pothole Region during wet periods. Low populations are associated with prairie drought (Bellrose 1980). Consequently, sustaining a large continental population seems dependent on prairie production. However, regions of Alaska, northern Canada, and the intermountain western United States also support the population base. Continued wetland drainage and cultivation of preferred upland nest sites in grassland (Krapu 1977), intense predation on nesting hens (Sargeant *et al.* 1984), agricultural operations that destroy nests in stubble fields (Krapu 1977, Klett *et al.* 1988, Greenwood *et al.* 1995), and other agricultural effects on wetlands and upland nest sites (Turner *et al.* 1987) result in poor nest success (Greenwood *et al.* 1995) and recruitment in prairies. Runge and Boomer (2005) report that the pintail population is settling, on average, about 2.4° of latitude farther north now than it did prior to 1975. They believe that this more northern distribution has resulted in lower reproduction, a 30 to 45 percent decrease in carrying capacity and a 40 to 65 percent decrease in sustainable harvest potential.

Information on the effects of hunting on pintails is very limited. Based upon band recoveries, Runge and Boomer (2005) reported that annual survival rates from 1960 to 2002 were highly dynamic across all pintail sex and age classes. In contrast, the recovery rate estimates suggested a common pattern of decreasing recovery rates from the 1970s through the 1990s with large increases in recovery rates throughout the period of liberalization associated with the AHM program. Further, there was a consistent reduction during the restrictive seasons in 2002 and 2003.
The ecological effects of discontinuing the pintail hunt at CACO are unknown; however, the harvest is typically so small in Barnstable County that no ecological effects would be expected.

Although green-winged teal populations have been declining since the late 1990s, populations are 16 percent above the 1955—2004 long-term average (USFWS 2005a). These higher population numbers may result from a lack of breeding habitat disturbance, because most individuals breed north of major agricultural areas (Bellrose 1980; Johnson 1995). Factors that regulate green-winged teal populations are unknown. Potential factors (i.e., those factors important in other species) include predation, wetland habitat availability, weather, hunting, and food availability (Johnson *et al.* 2002).

Information on the effects of hunting on green-winged teals is very limited. On protected reserves in Louisiana, numbers of individuals on the reserve were not correlated with hunting season (Tamisier 1976). Thus, it did not appear that green-winged teal were moving to areas free of hunting pressure.

The ecological effects of discontinuing the green-winged teal hunt at CACO are unknown; however, the harvest is typically so small in Barnstable County that no ecological effects would be expected.

Wigeon populations have been declining since the late 1990s and are below the 1955—2004 long-term average (Wilkins *et al.* 2005). Weather and land use patterns and their effects on nest site availability are the major factors affecting wigeon populations (Mowbray 1999). Additionally, long-term climate change and associated wetlands loss in the Canadian Prairie-Parklands also have significant effects on duck abundance (Bethke and Nudds 1995).

Information on the effects of hunting on wigeons is very limited. Hunting pressure and associated human activities affect wigeon feeding patterns during fall migration and winters. During fall hunting season, birds feed largely at night and leave the fields and marshes at daybreak for sheltered areas on larger bodies of water. In southwestern British Columbia during fall and winter hunting seasons, wigeons feeding during the day prefer large open agricultural fields with standing water to smaller fields with adjacent vegetative cover (Hirst and Easthope 1981).

The ecological effects of discontinuing the wigeon hunt at CACO are unknown; however the harvest is typically so small or completely absent in Barnstable County that no ecological effects would be expected.

Mallard

Range: Mallards are the most widely dispersed duck in the northern hemisphere. In New England the mallard is a common resident and migrant. They are found throughout the region during the breeding season and primarily in Massachusetts, Rhode Island, Connecticut, southern Vermont, southern New Hampshire, and southern of Maine during the winter months (DeGraaf and Yamasaki 2001).

Habitat: During the winter months, mallards are found mainly inland on ponds and rivers with open water and less commonly in coastal marshes (DeGraaf and Yamasaki 2001).

Food Habits: Mallards feed primarily on the seeds of sedges, grasses and smartweed, but they will also eat leaves, stems, and seeds of other marsh plants; waste grain; snails; insects; tadpoles; fishes; and fish eggs (DeGraaf and Yamasaki 2001).

Conservation: The mallard is the most common and widely distributed duck in North America and is ubiquitous throughout southern New England. The introduction of feral mallards has resulted in much hybridization with black ducks and various domestic waterfowl, particularly Muscovy (*Cairina moschata*) and Peking (*Anas platyrhynchos*) ducks (Veit and Petersen 1993).

Abundance: There is no information on mallard numbers specifically within CACO. However, mallards in Massachusetts are considered part of the eastern mallard population that is defined as those breeding in southern Ontario and Québec and in the northeastern United States Estimates of the eastern mallard population size in the eastern survey area (survey strata 51-72) have varied from 411,700 to 648,100 since 1999, with the majority of the population accounted for in the northeastern United States (Table 11). The population estimate for 2005 was 25 percent below the 1999 – 2004 average (USFWS 2005a). Estimates of the mallard breeding population size in the traditional North American survey area have varied from 6.75 to 10.81 million since 1999, and are 10 percent below the 1955 – 2004 long-term average (USFWS 2005a).

Take: There is no information on numbers of mallard harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the

11-year period (1993 – 2003), 9,100 mallards were harvested in Barnstable County, averaging 827 birds/year (range 120 – 1,590) (Table 12).

During the 2003 and 2004 hunting seasons, 7,375 and 9,245 mallards were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 427,301 and 422,091 mallards were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 take in Barnstable County represents 0.03 percent of the flyway harvest for that year.

Harvest management strategy: The biology of eastern mallards appears to differ from that of mid-continent mallards (Johnson *et al.* 2002). The eastern breeding population, although much smaller than the mid-continent population, appears to be more productive and has been growing since the mid-1960s. Because of these differences and the high degree of spatial separation of the mid-continent and eastern mallard populations during the hunting season, the USFWS implemented separate AHM protocols for the Atlantic Flyway regulations for mallards beginning in 2000-2001.

For purposes of AHM, the estimates of eastern mallard population size differ from those reported in the USFWS annual waterfowl trend and status reports (USFWS 2005a). This is because the annual survey includes composite estimates based on more fixed-wing strata in eastern Canada and helicopter surveys conducted by the Canadian Wildlife Service (CWS). For the AHM, the eastern mallard population has varied from 856,000 to 1.1 million since 1990.

Based largely upon these estimated population sizes as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for mallards in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway mallards since 1996. Between 1996 and 2004, the estimated harvest rate ranged from 0.13 to 0.16 (USFWS 2005c).

Mallard population dynamics and susceptibility to hunting pressures: Mallards are highly adaptable, migratory ducks with a high reproductive potential. Females breed at one year of age and lay 9 to 12 eggs. This species is the most heavily hunted waterfowl species in North America. The effects of harvest on mallards have been studied in detail since the 1960s. Early work by several researchers (Geis 1963, 1972a, 1972b; Martinson *et al.* 1968; Geis and Crissey 1969) suggested that hunting represented additive[4] mortality to waterfowl. In contrast, an analysis of nearly 700,000 band recoveries from mallards by Anderson and Burnham (1976) concluded that hunting mortality was compensatory at least up to a threshold. Rogers *et al.* (1979) also concluded that hunting represented compensatory mortality from examining mallard survival rates. Nichols *et al.* (1984) summarized several other studies and concluded that the bulk of evidence for mallards supported the compensatory hypothesis, especially for males. In contrast, Caswell *et al.* (1985) determined that the survival rates of adult mallards increased during years of restrictive harvests compared to liberal harvests. Additional studies (Nichols and Hines 1983, Burham and Anderson 1984, Trost 1987) have not produced consistent results on the effects of hunting. Smith and Reynolds (1992) thoroughly rejected the influence of compensatory mortality in mallard populations. Thus, many questions remain about the effects of hunting on annual survival rates of mallards. In the 1995-1996 hunting season, the AHM framework was implemented by the USFWS for setting the waterfowl harvests levels. This approach has provided managers with a structural testing process for developing a quantitative link between waterfowl population data and hunting regulations. By 2001, the AHM process has consistently selected the model for additive mortality and strong density dependence, thereby suggesting that hunting mortality is additive to natural (non-hunting) mortality (USFWS 2005c).

[4] Hunting mortality is considered to be additive when natural mortality is not reduced in assication with hunting mortality. Essentially the two types of mortality are additive for total mortality of that species.

The ecological effects of discontinuing the mallard hunt at CACO are unknown. If hunting mortality is additive, this suggests that more restrictive hunting would result in larger mallard populations. However, many factors affect annual mortality, especially habitat conditions. The effects of population size on non-hunting mortality are unknown. If it is density dependent, the mortality rate may increase with population size. Mallard populations may also experience density-dependent natality. Kaminski and Gluesing (1987) reported that the mallard recruitment rate was correlated negatively with the population size in May. Recruitment rate was also correlated positively to mean numbers of May and July ponds, suggesting that the habitat conditions in breeding areas were more important to mallard recruitment than winter habitat conditions. Baldassarre and Bolen (1994) conclude that hunting does not appear to have reduced populations of mallards "most of the time, for most places, and with most populations." However, they believe hunting may have reduced mallard populations "at some times, and in some places and with some populations." They conclude that more research is needed and that the question is so complex that biologists may never be able to arrive at a highly refined answer to the effects of hunting.

Wood Duck

Range: The breeding range of the wood duck in eastern North America encompasses east-central Saskatchewan, east to Prince Edward Island and Nova Scotia, and south to central and southeast Texas and the Gulf Coast. Wood ducks winter primarily in the southern part of their breeding range. They are fairly common and are a widespread breeder and migrant in the New England region (DeGraaf and Yamasaki 2001).

Habitat: The wood duck inhabits woodlands near shallow, quiet inland lakes, ponds, streams, marshes, beaver impoundments, forested wetlands, and river bottomlands where nest sites are available and there is an abundant plant and invertebrate food sources. They also use scrub-shrub wetlands with woody shrubs (buttonbush, willow, alder) and an overhead cover of downed trees (Hepp and Hair 1977). Stable water levels are important for successful brood rearing; stream channels may provide travel lanes for ducklings moving among wetlands (Hepp and Bellrose 1995). Wood ducks are probably not abundant on CACO during the waterfowl hunting season due to the lack of suitable habitat in areas open to hunting. Wood ducks generally do not use estuarine habitats and would likely be restricted to freshwater streams and small ponds.

Food Habits: Wood ducks feed primarily on aquatic and terrestrial insects, fleshy fruits, acorns, hickory nuts, and waste grains. Often, lack of wetland foods will drive wood ducks into uplands, groves, orchards, or fields, where they seek acorns, nuts and grains (Bellrose and Holm 1994).

Abundance: Wood duck populations are not monitored using aerial surveys, and there are few estimates of wood duck populations (Heusmann and Sauer 2000). Trends in wood duck populations are monitored by the North American BBS (USFWS 2005a). Wood ducks are encountered with low frequency along BBS routes, limiting the amount and quality of available information for analysis (Sauer and Droege 1990). However, the BBS provides the only long-term indices of this species' regional populations. Trend analysis suggests that wood duck numbers in the Atlantic Flyway increased 4.8 percent annually over the long-term, with a 2.4 percent annual increase over the intermediate-term (1985 – 2004).

Take: Because wood ducks are not abundant on CACO, they are not specifically pursued and those taken would likely be incidental to other hunting efforts. Estimates of annual harvests for Barnstable County from the USFWS HIP program indicate a total of 1,220 wood ducks were harvested in Barnstable County, averaging 111 birds per year (range 0 – 620) for the 11-year period (1993 – 2003) (Table 12).

In the 2003 and 2004 hunting seasons, 2,711 and 3,165 wood ducks were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway,

338,004 and 265,560 wood ducks were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The average take in Barnstable County represents about 4 percent of the statewide harvest and only 0.04 percent of the flyway harvest.

Harvest management strategy: After mallards, wood ducks are the second most hunted duck species in the Atlantic Flyway. Approximately 25 percent of the total United States wood duck harvest comes from the Atlantic Flyway (USFWS 2005b). There is no specific AHM protocol developed for the wood duck. Thus, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for wood ducks in the Atlantic Flyway (Heusmann and McDonald 2002). Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for wood ducks in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway wood ducks since 1997.

*Wood duck population dynamics and susceptibility to hunting pressur*es: Hunting was the most important factor limiting wood duck populations from the late 1890s up to 1918, and recovery took almost 70 years (Bellrose and Holm 1994). Low availability of nest sites may limit production and population growth (Nichols and Johnson 1990, Soulliere 1990). Several studies indicated that wood duck numbers are higher after addition of nest boxes (Nichols and Johnson 1990). Where food resources are good and nest sites inadequate, nest boxes might be used to increase local populations. Predation may limit production locally (Bellrose 1976). Further, increased productivity from increased nest success in predator-resistant nest boxes often results in increased population density leading to intraspecific competition that intermittently reduces local populations (Bellrose and Holm 1994).

Populations seem to be responsive to changes in hunting mortality. Increased harvest rates resulted in lower estimated annual survival (Sauer *et al.* 1990, Trost 1990, and Johnson *et al.* 1986). Heusmann and McDonald (2002) analyzed wood duck population and harvest data from the Atlantic and Mississippi flyways. They concluded that total wood duck harvests increased in both flyways during the liberal 60-day hunting seasons. Further, they evaluated the BBS and other breeding surveys and concluded that the long-term (1966 – 2000) and short-term (1980 – 2000) data indicated maintenance or growth of wood duck populations in Atlantic and Pacific flyways. However, they suggested the liberal seasons from 1997-2002 may have resulted in "population leveling" or even a reversal of the population trend.

The ecological effects of discontinuing the wood duck hunt at CACO are unknown; however, the harvest is typically so small in Barnstable County relative to state-wide harvest totals that no ecological effects would be expected.

Waterfowl—Diving Ducks and Coots

American Coot *(Fulica Americana)*

Range: In New England, coots breed along the southern Maine coast, the northern Champlain Lowlands in Vermont (Kibbe 1985), and in northeastern Massachusetts (Veit and Petersen 1993). Coots are considered a rare and local breeder in New England and occasionally an abundant fall migrant and uncommon winter resident in southern New England (DeGraaf and Rappole 1995).

Habitat: Coots inhabit marshes, ponds, lakes, reservoirs, sewage lagoons, sloughs, wet meadows and marshy borders of creeks and rivers. They typically require shallow, freshwater wetlands with water about 3-feet deep and emergent vegetation interspersed with areas of open water (Fredrickson *et al.* 1977).

Food Habits: Underwater plants are staples for coots as well as algae, grass shoots, grains, and aquatic insects, but they will also take fish, tadpoles, worms, and crustaceans in shallow water (DeGraaf and Yamasaki 2001).

Abundance: Continental numbers (1999) are estimated at around 3 million individuals in the major breeding strata of the United States and Canada, based on aerial surveys (Brisbin *et al.* 2002). This estimate is similar to that projected by the 1999 BBS with estimates of just fewer than 3 million for all areas included in the BBS (Sauer *et al.* 1997). MWIs for the United States and Mexico, which tend to underestimate numbers by at least 1.6 percent (Boyd *et al.* 1982), indicate about 2.5 to 3.0 million wintering coots. States where annual winter densities average >100,000 coots include California, Florida, Louisiana, and Texas, as well as Sonora, Mexico (Arnold 1994).

BBS data indicate significant increases in the Midwest between 1966 and 1999 (7 – 13%), and in the entire United States (6.6%). Populations for the survey-wide area of the United States and Canada increased slightly (1.2%), but not significantly (Sauer *et al.* 1997).

Take: Estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 5-year period (1999 – 2003), a total of 270 coots were harvested in Barnstable County, averaging 54 birds per year (range 0 – 180) (Table 12).

In the 2003 and 2004 hunting seasons, <50 and 100 coots were harvested statewide in Massachusetts by 100 and <50 hunters, respectively (USFWS 2005a). For the Atlantic Flyway, 12,800 and 13,100 coots were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005a). Generally the harvest in Barnstable County, based on the above figures, only accounts for <0.4 percent of the flyway harvest.

Harvest management strategy: Annual coot harvests in the United States vary greatly (e.g., 88,000 in 2003 and 181,300 in 2004). During these 2 years, 7 to 14 percent of the United States harvest came from the Atlantic Flyway (USFWS 2005a). There is no specific AHM protocol developed for the coot.

Coot population dynamics and susceptibility to hunting pressures: There is little information on the population dynamics of coots (Brisbin *et al.* 2002). The major factor limiting coot populations appears to be availability of habitat as demonstrated by declines in reproductive output and abundance during drought conditions. In wet years, increased availability of wetlands, coupled with stable water levels through brood-rearing, results in increased breeding densities, improved breeding success, and greater numbers of coots. There is no information on the susceptibility of coots to modern recreational hunting.

Bufflehead (*Bucephala albeola*) ***and Common Goldeneye*** (*B. clangula*)

Range: During the winter months bufflehead and goldeneye are abundant migrants and common residents in eastern Massachusetts, Rhode Island, and southern Connecticut and also along the coasts of Maine and New Hampshire (DeGraaf and Yamasaki 2001).

Habitat: Both species inhabit saltwater habitats consisting of sheltered coves, harbors, bays, and estuaries. Their inland habitat encompasses rivers, ponds, lakes and reservoirs (Gauthier 1993).

Food Habits: Aquatic invertebrates such as crustaceans and mollusks account for 90 percent of the bufflehead and goldeneye diet. This is supplemented with fish and seeds of pond weeds, widgeon grass, and bulrush. Both species prefer feeding in shallow (4 to 15 feet deep) water over tidal flats and in large open bodies of water (DeGraaf and Yamasaki 2001).

Conservation: The winter populations of the bufflehead have increased greatly over the past 50 years (Veit and Petersen 1993). It is one of the few species of ducks whose numbers have increased markedly since the 1950s (Gauthier 1993).

Abundance: There is no information on bufflehead numbers specifically within CACO. However, estimates of bufflehead numbers for the eastern survey area (survey strata 51-72 as discussed in USFWS 2005a) varied from 43,800 to 95,000 between 1999 to 2004 (Table 11) and were 27 percent below the 1996 – 2003 long-term average (USFWS 2004).

There is no information on goldeneye numbers specifically within CACO. Estimates of the goldeneye (Barrow's [*Bucephala islandica*] and common) breeding population size in the eastern survey area (survey strata 51-72) have varied from 714,700 to 1.12 million since 1999 (Table 11), and are 21 percent below the 1955 – 2004 long-term average (USFWS 2005a).

Take: There is no information on the numbers of buffleheads harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 13,770 buffleheads were harvested in Barnstable County, averaging 1,252 birds/year (Table 12).

In 2003 and 2004 hunting seasons, 837 and 2,210 buffleheads were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 54,571 and 52,265 buffleheads were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 harvest in Barnstable County represents 0.7 percent of the flyway harvest (Table 13).

There is no information on the numbers of goldeneyes harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 500 goldeneyes were harvested in Barnstable County, averaging 45 birds/year (range 0 – 310) (Table 12).

In 2003 and 2004 hunting seasons, 239 and 452 goldeneyes were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 13,439 and 13,036 goldeneyes were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 harvest in Barnstable County represents 0.3 percent of the flyway harvest (Table 13).

Harvest management strategy: Typically, about 30 percent of the total United States bufflehead harvest and about 15 percent of the total United States goldeneye harvest comes from the Atlantic Flyway (USFWS 2005b). There is no specific AHM protocol developed for buffleheads and goldeneyes. Thus, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for each species in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for buffleheads and goldeneyes in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway buffleheads and goldeneyes since 1996.

Bufflehead and goldeneye population dynamics and susceptibility to hunting pressures: Erskine (1972) suggested that nest sites (either because of the absence of trees or lack of suitable cavities) may limit bufflehead distribution and probably density in many parts of the species' range. Eadie *et al.* (1995) reported that the most important factor limiting goldeneye populations is probably nest-cavity availability, particularly in recently or historically logged regions.

The role of hunting in population regulation of both species is unknown, largely due to poor population estimates. Eadie *et al.* (1995) concluded that the relatively stable goldeneye population numbers from the 1950s to the early 1990s, in combination with the decline in numbers harvested over that same period, indicated that the effect of hunting on goldeneyes may be small. A comparable scenario may apply to buffleheads.

The ecological effects of discontinuing the goldeneye hunt on CACO are unknown; however, the average annual harvest is typically so small (x = 45), or completely absent in many years, in Barnstable County that no ecological effects would be expected. For buffleheads, the annual harvest is only 0.7 percent of the flyway harvest and as such discontinuing the hunt would have no ecological effects.

Canvasback (*Aythya valisineria*) and ***Ring-necked duck*** (*A. collaris*)

Range: The canvasback winter range encompasses the Pacific Coast from the central Aleutians and southern coastal Alaska, south to Baja California, from Arizona and New Mexico to the Great Lakes, and on the Atlantic Coast from New England south to the Gulf Coast and into Mexico (DeGraaf and Yamasaki 2001). In New England, they are present during the winter months in Massachusetts along Cape Cod, the Islands, and Cambridge (Veit and Petersen 1993).

In New England, the ring-necked duck breeds throughout Maine, western to northern and central New Hampshire, and the Northeast Highlands in Vermont. It winters along the coast of Connecticut, Rhode Island, and mid Cape Cod and the islands (DeGraaf and Yamasaki 2001).

Habitat: In the winter months canvasbacks prefer estuaries, sheltered bays, and inland lakes that contain wild celery and pondweeds and that are free from ice. They also require stretches of open water for taking off and landing (DeGraaf and Yamasaki 2001). Ring-necked duck use similar habitats, such as fresh or brackish marshes, lakes, rivers, and estuaries; they seldom use strictly saline water (DeGraaf and Yamasaki 2001).

Food Habits: The canvasback and ring-necked duck diets consists of seeds, vegetative parts of aquatic plants such as wild celery and pondweeds, aquatic invertebrates, small fishes, and some small mollusks (Noyes and Jarvis 1985, Bellrose 1980).

Conservation: Overall, canvasback populations have declined in the United States, possibly due to loss of breeding habitat as a result of drainage and drought (Hohman *et al.* 1990). However, in Massachusetts, the population has varied greatly over the years. Although they were scarce before the 1900s, the canvasback population on Cape Cod and surrounding islands rebounded somewhat between 1910 and 1950 (Veit and Petersen 1993).

Abundance: Estimates of the canvasback breeding population size in the traditional North American survey area have varied from 486,600 to 716,000 since 1999 (Table 11) and are 8 percent below the 1955-2004 long-term average (USFWS 2005a).

Estimates of the ring-necked duck breeding population size in the eastern survey area (survey strata 51-72) have varied from 834,900 to 1.34 million since 1999 (Table 11) and are 14 percent below the 1955 – 2004 long-term average (USFWS 2005a).

Take: Estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), a total of 140 canvasbacks were harvested in Barnstable County; however, all of these canvasbacks were harvested in one year (1999) (Table 12).

In 2003 and 2004 hunting seasons, no canvasbacks were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 4,738 and 9,772 canvasbacks were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b).

There is no information on numbers of ring-necked ducks harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 390 ring-necked ducks were harvested in Barnstable County, averaging 35 birds/year (range 0 – 220) (Table 12).

During the 2003 and 2004 hunting seasons, 199 and 301 ring-necked ducks were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 112,806 and 74,349 ring-necked ducks were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b).

Harvest management strategy: Since 1955, there has been considerable fluctuation in continental breeding populations of canvasbacks. Much of this variation is attributed to changes in moisture levels and perhaps hunting regulations (Mowbray 2002). In response to fluctuations in population size, harvest limits have varied considerably during the past three decades, with total annual harvest in the United States ranging from a high of 219,242 (1966) to a low of 1,003 (1988), with complete bans on hunting during some years in some regions. In 2003 and 2004, 14 percent and 22 percent, respectively, of the total United States canvasback harvest came from the Atlantic Flyway (USFWS 2005b).

Typically, ring-necked ducks are the most hunted diving duck species in the United States; up to 25 percent of the total United States ring-necked duck harvest comes from the Atlantic Flyway (USFWS 2005b).

There is no specific AHM protocol developed for either species. Thus, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for canvasback and ring-necked ducks in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for canvasback and ring-necked ducks in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway for both species since 1997.

Canvasback and ring-necked ducks population dynamics and susceptibility to hunting pressures: On a continental basis, land-use patterns and weather are key factors regulating canvasback populations. Nest-site availability may also limit breeding opportunities in some areas (Mowbray 2002). Increased availability of wetlands results in increased breeding densities, improved nest success, and a greater number of canvasbacks is noted during wet years (Leitch and Kaminski 1985; Anderson *et al.* 2001). Patterson (1999) suggested that canvasback populations are density dependent; thus, they are less productive when their numbers are high. Stoudt (1971) reported a decline in number of clutches/pairs with higher canvasback density in Saskatchewan. In contrast, studies at Manitoba reported that density-dependent factors do not affect the size of canvasback populations (Serie *et al.* 1992; Arnold *et al.* 1995; Leonard *et al.* 1996; Anderson *et al.* 1997, 2001). Temporal fluctuations in Minnedosa populations appeared to result from differences in natality and/or mortality.

Hunting is a major mortality factor for canvasbacks (Mowbray 2002). Canvasbacks have lower survival during years of liberal harvest, suggesting harvest is additive or that kill exceeds the threshold for compensation (Anderson *et al.* 1997, 2001). Illegal hunting was a major source of mortality during fall migration on the upper Mississippi River (Korschgen *et al.* 1996) and the single largest source of mortality in hatch-year females.

The ecological effects of discontinuing the canvasback hunt on CACO are unknown; however, the harvest is typically absent or so small in Barnstable County that no ecological effects would be expected.

There is little information on ring-necked duck population dynamics, but Hohman and Eberhardt (1998) suggested that human-related activities may be the primary sources of population regulation in the United States. Further, the relationship between hunting and non-hunting mortality is poorly understood because of limited banding information and low reporting rates. Survival rates of adult male and female ring-necked ducks banded in the southern Mississippi Flyway were negatively correlated with recovery rates of birds banded in north-central North America, but there was no correlation between survival rates and recovery rates of banded birds in other regions (Conroy and Eberhardt 1983). Prevalence of embedded shot in spring-migrating diving ducks killed by oil pollution in southeast Minnesota in March through April of 1963 was 2 to 3 times greater in ring-necked ducks than in lesser scaup (*Aythya affinis*) (Jessen *et al.* 1968). Harvest rates estimated on basis of prevalence of embedded shot were 30 to 35 percent for immature females and 60 to 70 percent for immature males (Jessen *et al.* 1968). In spring 1985 and 1986 5 of 16 fluoroscoped ring-necked ducks had embedded shot at Keokuk Pool, Mississippi River, (Havera *et al.*, 1992). Spring trapping of muskrats was also an important source of mortality for ring-necked ducks in Maine (Mendall 1958), presumably due to capture in traps.

The ecological effects of discontinuing the ring-necked duck hunt at CACO are unknown; however, the average annual harvest is typically so small (x = 24), or completely absent in many years, in Barnstable County that no ecological effects would be expected.

Ruddy Duck (*Oxyura jamaicensis*)

Range: The winter range of the ruddy duck encompasses North America from British Columbia along the west coast, and to a limited extent inland through the western United States and south to Mexico and Central America. They are present along the Atlantic Coast from Massachusetts to Florida, the West Indies, and the Gulf Coast (Johnsgard 1975).

Habitat: The wintering grounds of the ruddy duck are primarily brackish to slightly brackish estuaries or coastal lagoons of shallow depth. They often contain an abundance of submerged plants, small mollusks and crustaceans (Johnsgard 1975).

Food Habits: A majority of the diet of these birds consists of plant material, with pondweeds and sedges being the most common. A variety of insects are also consumed, such as the larvae of midges and horseflies (Johnsgard 1975). For a diving duck mollusks comprise an unusually small portion of their diet. Although they regularly dive for food in water 2 to 10 feet in depth, they will also feed on the surface or submerge their heads to reach plants slightly below the surface. This species more commonly feeds in smaller bodies of water than scaups or canvasbacks typically use (Bellrose 1980).

Abundance: There is no information on ruddy duck numbers specifically within CACO, and estimates of the breeding population size in the traditional survey area are not reported in the 2005 Waterfowl Population Status report (USFWS 2005a). Brua (2001) reports that an estimate of continental and prairie-pothole-region breeding populations appear to be stable to increasing, although highly variable between years. The majority (87%) of breeding population is located within the Prairie Pothole Region of North America (Batt *et al.* 1989), with roughly a 50/50 split between Canadian and United States prairies. Long-term (1955 – 2000) population average estimated from May breeding waterfowl population surveys is 409,783, with a high of 947,872 in 1982 and a low of 170,712 in 1958 (USFWS and Canada Wildlife Service unpublished in Brua 2001). From 1955 to 1979, the population of ruddy ducks wintering in Chesapeake Bay declined significantly, with a long-term average of 29,552 birds. There is little information about wintering populations.

Take: There is no information on the numbers of ruddy ducks harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 80 ruddy ducks were harvested in Barnstable County, averaging 7 birds per year (range 0 – 80) (Table 12).

In 2003 and 2004 hunting seasons, no ruddy ducks were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 2,474 and 4,307 ruddy ducks were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b).

Harvest management strategy: Typically, 12 to 24 percent of the total United States ruddy duck harvest comes from the Atlantic Flyway (USFWS, 2005b). The ruddy duck is generally not considered to be a desirable game bird by many hunters. There is no specific AHM protocol developed for the ruddy duck. Thus, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for ruddy ducks in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for ruddy ducks in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway ruddy ducks since 1997.

Ruddy duck population dynamics and susceptibility to hunting pressures: There is little information on ruddy duck population dynamics. The size of breeding population correlates positively with wetland abundance on breeding grounds (Batt *et al.* 1989). Current hunting pressure is low relative to other waterfowl. The role of hunting in population regulation is unknown. Further, the ecological effects of discontinuing the ruddy duck hunt on CACO are unknown.

Lesser Scaup and Greater Scaup (*Aythya marila*)

Range: The lesser scaup winters along the west coast from British Columbia into Mexico and Central America, along the southern United States and the Gulf Coast, into the Prairie Pothole Region and along the Atlantic Coast to southeastern Massachusetts (Austin *et al.* 1998). In Massachusetts, it is a common to abundant migrant and winter resident (Veit and Petersen 1993). Greater scaup winter on the Great Lakes, the Finger Lakes in New York, and the St. Lawrence River during mild winters and where heated water discharge occurs, as well as along the Atlantic Coast from southern Newfoundland and Nova Scotia south to northern Florida (Kessel *et al.* 2002).

Habitat: During the winter, both species are found along shores of lakes reservoirs and fresh to brackish coastal bays and estuaries (Chasbreck *et al.* 1989). During severe winters, they may move to more saline waters often close to freshwater sources. Wintering greater scaup are found almost exclusively in marine habitats, usually on extensive, shallow, salt-water bays and brackish river inlets that provide protection from cold winds. Large freshwater lakes that remain ice-free are used by wintering greater scaup in the eastern United States.

Food Habits: Both scaup species are expert divers and can swim rapidly underwater. They feed mainly in depths of 5 to 6 feet. Their diet is almost equally divided between plant and animal matter. They feed on the seeds of pondweeds, widgeon grass, wild rice, sedges, and bulrushes. They also consume snails and other mollusks, small shrimp like crustaceans, and aquatic insects. They feed along the coast and in the open-water zone of shallow wetlands and lakes (Terres 1980).

Abundance: Lesser scaup are the most abundant diving duck in North America. This species cannot be distinguished from greater scaups from aerial surveys, thus the two species are combined in the May

Breeding Waterfowl Population Survey (USFWS 2005a) and flyway midwinter waterfowl estimates (USFWS 2005b).

Estimates of the scaup breeding population size in the traditional North American survey area have varied from 4.0 to 4.4 million since 1999 (Table 11), and are 35 percent below the 1955-2004 long-term average (USFWS 2005a).

Take: Estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 600 lesser scaups were harvested in Barnstable County, averaging 54 birds per year (range 0 – 310) (Table 12). Unlike population estimates of breeding and wintering birds, species-specific harvest estimates are derived from hunter-reported kills and from wings analyzed from the Waterfowl Parts Survey (USFWS 2005b) (Table 13).

In the 2003 and 2004 hunting seasons, no lesser scaups were harvested in Barnstable County or statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 60,939 and 54,891 lesser scaups were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b).

In 2003 and 2004 hunting seasons, 80 and 0 greater scaup were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 17,344 and 16,837 greater scaup were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b) (Table 13). The 2003 harvest represents 0.2 percent of the Atlantic Flyway 2003 harvest (Table 13).

Harvest management strategy: Lesser scaup are the second most harvested diving duck species in the United States, and about 20 percent of the total United States harvest comes from the Atlantic Flyway (USFWS 2005b). Annual United States greater scaup harvests declined significantly from 1961 through 1997 (Allen *et al.* 1999). The largest harvests generally occurred during special scaup seasons (1966 – 1988), with a high of 132,475 birds in 1977. In 2003 and 2004, 36 percent and 24 percent of harvested greater scaups came from the Atlantic Flyway (USFWS 2005b), down from 51 percent from the 1961-1989 period.

With the continental decline of scaup populations since the mid 1980s, the USFWS implemented restrictive hunting seasons for scaups between 1988 and 1994 (Austin *et al.* 1998). Boomer and Johnson (2005) reported that the productive capacity and the harvest potential of the scaup population decreased since the historical high scaup population levels observed prior to the mid 1980s. Further, this decline has coincided with a period of harvest liberalization associated with the AHM program. In the absence of an AHM protocol for scaup, Boomer and Johnson (2005) concluded that there are no objective criteria that prescribe when scaup regulations should be modified in response to changes in population status or harvest potential. They recommend that a continental-wide scaup harvest strategy be developed that accounts for system changes and key sources of uncertainty relative to scaup population dynamics and responses to exploitation.

Considering there is no specific AHM protocol developed for scaup, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for scaup in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards, as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for scaup in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway scaup since 1997.

Scaup population dynamics and susceptibility to hunting pressures: Information is very limited on the effects of hunting on scaups. However, the species is typically the second most harvested diving duck

species in the United States. Boomer and Johnson (2005) reported that the productive capacity and the harvest potential of the scaup population decreased since the historical high scaup population levels observed prior to the mid 1980s. Additionally, their analyses indicated that the harvest levels in 1997 and 1998 may not have been sustainable, and that contemporary scaup harvest levels may be approaching values close to the maximum sustained yield; yet, the breeding population estimate continues to decrease. Further, they suggest that the harvest of scaup has increased post AHM with increasing levels of hunter effort.

However, the harvest is typically so small or completely absent in Barnstable County; no ecological effects of discontinuing the scaup hunt would be expected.

Waterfowl—Sea Ducks

Common Eider (*Somateria mollissima*)

Range: Eiders winter in coastal areas of the Pacific from Alaska south to Washington and along the Atlantic coast from Newfoundland south to the Mid-Atlantic States, with casual occurrences inland (Johnsgard 1975). In Massachusetts they are very abundant migrants and winter residents off Cape Cod and the Islands. They are also common to abundant along the rest of the New England Coast (Veit and Petersen 1993).

Habitat: Common eiders are mainly marine birds, remaining well off shore during the winter season (Johnsgard 1975).

Food habits: Most of the diet of the eider consists of animal matter, such as bivalves (blue mussels [*Mytilus edulis*], clams), gastropods (whelks), starfish, sea urchins, and crustaceans. However, the blue mussel, which grows in dense beds on rocky or pebbly substrates, is their staple food source. They prefer feeding in fairly shallow waters around submerged ledges and reefs of rocky shores (Terres 1980). They are expert divers and can go down to depths of 35 to 60 feet (Bent 1925).

Abundance: Bourget *et al.* (1986) assembled the best available information from Newfoundland southward to estimate wintering populations of approximately 155,000 eiders in the Gulf of St. Lawrence, 157,000 in Newfoundland and the Maritime Provinces, and 181,000 from Maine to Massachusetts. The total winter population of common eiders for North America is probably 600,000 to 750,000 individuals, of which approximately 500,000 to 600,000 are breeding adults.

Take: Estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 32,930 common eiders were harvested in Barnstable County, averaging 2,994 birds/ per year (range 0 – 11,590) (Table 12).

In the 2003 and 2004 hunting seasons, 3,097 and 5,717 common eiders were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 34,638 and 21,585 common eiders were harvested during the 2003 and 2004 hunting seasons.

Harvest management strategy: Typically, the total United States common eider harvest comes from the Atlantic Flyway (USFWS 2005b). The species is important subsistence game for humans in northern regions, especially in the spring (Litvinenko 1993). The effect of this harvest of adults in spring may be increasingly significant in some areas with the advent of better mobility and firearms (Cooch 1986). In North America, interest in the sport hunting of sea ducks has increased dramatically, perhaps due to declining opportunities for other "sport" ducks and the promotion of sea ducks as an abundant waterfowl group with liberal hunting regulations (Gillelan 1988). Harvests of common eiders have been increasing

dramatically in eastern North America in recent years, and may exceed sustainable levels (Goudie *et al.* 1994, Bédard 1995). Newfoundland and Labrador support a traditional hunt that has extended from late fall to March 10, with high bag limits and little enforcement.

There is no specific AHM protocol developed for common eiders. Thus, the USFWS depends exclusively on the status of eastern mallards to set the harvest level for common eiders in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for common eiders in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway common eiders since 1997.

Common eider population dynamics and susceptibility to hunting pressures: Hunting is an important source of mortality. Eiders are a key component of native subsistence hunts in the north and coastal sport hunting farther south. In the past, some populations were almost totally extirpated due to over-hunting by humans (Townsend 1914, Doughty 1979, Goudie *et al.* 1994). Goudie (1989) and Goudie *et al.* (1994) concluded that traditional harvests in Newfoundland and Labrador are excessive, based on available population information. Krementz *et al.* (1996) reported high survival rates for eiders in eastern North America using recovery data from 1930 to 1994. Commercial netting in littoral zone for species such as lumpfish (*Cyclopterus lumpus*; coastal Newfoundland) can overlap considerably with near-shore haunts of eiders; large numbers are caught and drowned (Palmer 1976b). The ecological effects of discontinuing the common eider duck hunt on CACO are unknown.

Long-tailed Duck (*Clangula hyemalis*)

Range: Long-tailed ducks in New England are abundant migrants, especially off Nantucket Island, and are winter residents, although rarely inland. Populations are scarce during the summer months, mostly occurring in Massachusetts, on Cape Cod, and the Islands (Veit and Petersen 1993).

Habitat: During the winter, long-tailed ducks inhabit open water, coastal bays, salt estuarine bays and some brackish estuarine bays (Johnsgard 1975). They also occupy the Great Lakes in greater numbers than any other sea duck (Bellrose 1980).

Food Habits: The diet of the long-tailed duck consists of amphipods, shrimps, crabs, and other crustaceans. They can dive depths up to 200 feet below the surface, but tend to dive in water of moderate depths to retrieve blue mussels and other mollusks (Terres 1980).

Abundance: Robertson and Savard (2002) reviewed the breeding population status of the species. Various population estimates in Alaska and the Canadian northwest combine for a 1.4 percent overall annual increase for the 1996-2000 period (CWS Waterfowl Committee 2000). Midwinter inventories on the east coast of the United States indicate a 1.15 percent decline/year during 1976-1997.

Take: Estimates of annual harvest are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 750 long-tailed ducks were harvested in Barnstable County, averaging 68 birds per year (range 0 – 460) (Table 12).

In the 2003 and 2004 hunting seasons, 127 and 539 long-tailed ducks were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 17,627 and 20,909 long-tailed ducks were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The harvest levels in Massachusetts are a very small portion of the Flyway harvest, 0.7 to 2.6 percent (Table 13).

Harvest management strategy: Typically, 80 percent of the total United States long-tailed duck harvest comes from the Atlantic Flyway (USFWS 2005b). However, this species is not a large component of the waterfowl harvest in North America (Robertson and Savard 2002). The long-tailed duck is not considered a desirable game bird by many hunters. There is no specific AHM protocol developed for the long-tailed duck, therefore the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for long-tailed ducks in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for long-tailed ducks in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway long-tailed ducks since 1997.

Long-tailed duck population dynamics and susceptibility to hunting pressures: As with all sea ducks, population growth rates are most sensitive to changes in adult survival (Goudie *et al.* 1994); factors such as hunting or fishing by-catch that decrease adult survival probably have the greatest effect on populations. Historically, by-catch in fishing nets has been large. It is estimated that in the winter of 1951-1952, 15,539 were killed; in 1952-1953, 19,562 were killed in Lake Michigan alone (Ellarson 1956). This is possibly still an important source of mortality on some coastal wintering areas, but no data are available.

Like most sea ducks, long-tailed ducks have a limited capacity to compensate for hunting mortality, and it is likely this mortality is completely additive (Caithamer *et al.* 2000). On the east coast of North America, special seasons were established for sea ducks; while restrictions were put in place for scoters (bag of 4 ducks/day) in 1993. This was not done for long-tailed ducks, which remained at 7 ducks per day. Harvest increased under liberal regulations and stabilized under restrictive ones, indicating that changes in regulations could be an effective tool (Caithamer *et al.* 2000) in controlling harvest. The ecological effects of discontinuing the long-tailed duck hunt at CACO are unknown.

Black Scoter (*Melanitta nigra*), ***Surf Scoter*** (*M. perspicillata*), ***and White-winged Scoter*** (*M. fusca deglandi*)

Range: The wintering range of the three scoter species extends from Newfoundland along the Atlantic Coast to South Carolina and the Great Lakes (Johnsgard 1975). These three species are abundant migrants and uncommon to fairly common winter residents in New England (Veit and Petersen 1993). Their major wintering areas on the east coast are Maine, Massachusetts, and Rhode Island (Bordage and Savard 1995).

Habitat: Stewart (1962) found that scoters often inhabit the littoral zone of the ocean, usually within a mile of the shore, and occasionally in coastal bays or their salt and brackish estuaries. They also are common in areas where water depths do not exceed 25 feet and large quantities of mussels can be found (Cottam 1939, Goudie *et al.* 1994, and Grosz and Yocom 1972).

Food Habits: The majority of food (90%) consumed by scoters is animal matter, and mollusks are the main food source, with blue mussels the most common (Bellrose 1980), followed by short razor clams (*Tagelus californianus*). Plant material such as muskgrass and other algae, pondweeds, and widgeon grass comprised the remaining 10 percent (Cottam 1939).

Abundance: There is no information on black scoter numbers specifically within CACO, and estimates of the black scoter breeding population size in the traditional survey area are not reported in the 2005 Waterfowl Population Status report (USFWS 2005a). Bordage and Savard (1995) reviewed the population status of the species; however, they noted that surveys in Alaska combine all 3 scoter species (Conant and Groves 1992), as do most wintering-ground surveys (Serie 1993; Bartonek 1994). USFWS

Midwinter Surveys (1973 – 1992) provided no evidence for trends in wintering populations of scoters in the United States portions of the Atlantic Flyway. At Manomet Point, Massachusetts (west Cape Cod Bay), October counts of migrants flying along the coast showed no discernible trend from 1967 to 1976: 10,915 in 1967; 2,112 in 1968; 8,900 in 1975; and 2,524 in 1976 (Veit and Petersen 1993). Winter counts in southeast Massachusetts, however, dropped from 100,000 to 15,000 from 1960 to mid-1970s (Veit and Petersen 1993).

Take: There is no information on numbers of scoters harvested within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 220 black scoters, 720 surf scoters, and 720 white-winged scoters were harvested in Barnstable County, all in 1995 (Table 12).

In the 2003 and 2004 hunting seasons, 3,776 and 3,344 scoters (all species combined) were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 63,174 and 48,303 scoters were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b) (Table 13).

Harvest management strategy: Typically, over 80 percent of the total scoter harvest comes from the Atlantic Flyway (USFWS 2005b). Harvest numbers have increased greatly since 1961 to 1993 when approximately 18,000 were killed annually in the United States (Bartonek 1994). There is no specific AHM protocol developed for black scoters. Thus, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for black scoters in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for black scoters in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway black scoters since 1997.

Scoter population dynamics and susceptibility to hunting pressures: Population dynamics of scoter populations are poorly known. Scoters are long-lived and have low reproductive output (Goudie *et al.* 1994, Krementz *et al.* 1997). Reproductive success is highly variable, but generally low (Savard and Lamothe 1991; Morrier *et al.* 1997). Populations are highly sensitive to adult mortality, so hunting and accidental deaths due to fishing nets or oiling can have a significant effect on the population. Further, there is a large non-breeding segment in the population because this species does not breed until 2 or 3 years of age.

Common Merganser (*Mergus merganser*), ***Red-breasted Merganser*** (*M. serrator*), ***and Hooded Merganser***

Range: During the winter, the range of the common and red-breasted mergansers encompasses the Aleutian Islands and south-coastal Alaska, east across to southern Canada to Newfoundland and south to southern California, and the Gulf Coast to Central Florida (DeGraaf and Yamasaki 2001). They are found throughout southern New England and along the coast of Maine and New Hampshire (DeGraaf and Yamasaki 2001). In New England, the hooded merganser breeding range encompasses Maine, New Hampshire, Vermont, and most of Massachusetts, but they are absent from Cape Cod and the Islands (Veit and Petersen 1993). During the winter, their range includes Massachusetts, with regular presence on Cape Cod and the Islands, but they are uncommon throughout the rest of the state (Veit and Petersen 1993). Hooded mergansers also occasionally inhabit parts of New Hampshire and areas of open water in Vermont (Laughlin and Kibbe 1985).

Habitat: During the winter, common and red-breasted merganser species prefer fresh and brackish waters of lakes, rivers, ponds, and estuaries (DeGraaf and Yamasaki 2001). Hooded merganser breeding habitat

consists of freshwater forested wetlands, forested margins of rivers, streams, small lakes, ponds, reservoirs, and emergent marshes. They prefer clear freshwater habitats, especially those with sandy, gravelly, or cobbled bottoms and abundant small fish (DeGraaf and Yamasaki 2001). They tend to avoid areas of human activity and roost on exposed rocks, and logs and unvegetated sandbars (Beard 1964).

Food Habits: For each merganser species, fish is the staple of their diet, but they also supplement it with the roots and stems of aquatic plants, leeches, frogs, aquatic salamanders, worms, and aquatic insects (Johnsgard 1975, Palmer 1976b, and DeGraaf and Yamasaki 2001). During the winter they will often consume mollusks (Timken and Anderson 1969). Their preferred feeding habitat is calm shallow water (Johnsgard 1975).

Abundance: There is no information on merganser species specifically within CACO. Continental population size for common mergansers has been estimated at 641,000 birds by Bellrose (1980). Data from the USFWS and the Canadian Waterfowl Survey May Aerial Waterfowl Population Surveys during 1970-1979 suggested a combined population of roughly 1.5 million for all three merganser species found in North America; using the Audubon Christmas bird census proportion of mergansers that are common mergansers (73%, Bellrose 1980), this gives an estimate of 10.9 million birds. Winter population is estimated at 165,000 birds (USFWS 1998), which is undoubtedly an underestimate, as single concentrations of 35,000 birds have been seen in Minnesota (Janssen 1987).

In the 1970s, Bellrose (1980) recorded wintering populations for red-breasted mergansers of 38,000 in the Atlantic Flyway, 14,000 in the Mississippi Flyway, 1,100 in the Central Flyway, and 6,000 in the Pacific Flyway. From 1966 to 1989, BBS data show 4.6 percent decline in the continental population. For Canada alone, the trend is similar: overall, a 7 percent decline estimated from 1966 to 1994, with a 6.6 percent decline in the Boreal Shield, which comprises boreal regions of Newfoundland, Québec, Ontario, Manitoba, and Saskatchewan (Downes and Collins 1996). Christmas Bird Counts compared between 1959 and 1988 indicate local decreases of wintering populations in Maryland, North Carolina, and Oregon and increases in Colorado, Georgia, Indiana, Maine, Massachusetts, Nova Scotia, Ontario, Ohio, Pennsylvania, Texas, and Wisconsin.

There is no information on hooded merganser numbers specifically within CACO. Further, estimates of the hooded merganser breeding population size in the traditional survey area are not reported in the 2005 Waterfowl Population Status report (USFWS 2005a). Further, estimating population sizes is difficult because of the secretive behavior of hooded mergansers and their preference for wooded habitats (Dugger *et al.* 1994). Additionally, the May and mid-winter surveys conducted by USFWS and CWS group all merganser species together. Dugger *et al.* (1994) reviewed the population status of the species. Bellrose (1980) estimated continental populations at 76,000 individuals, but this estimate is much too low given that hunters harvest 70,000 to 100,000 birds each year (U.S. Dept. Interior 1988). Little is known about long-term population trends nationwide. In central Ontario, however, populations increased significantly from 1985 to 1989 (Dugger *et al.* 1994), and populations in Minnesota and locally in south east Missouri and western Tennessee also seem to be increasing (Dugger *et al.* 1994). These observations, plus the increased hunter harvest throughout the continent from 1961 to 1988 (USDOI 1988), suggest populations are currently stable and possibly increasing over much of the range.

Take: There is no information on numbers of common mergansers harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program (Table 12). Unlike population estimates of breeding and wintering birds, species-specific harvest estimates are derived from hunter reported kills and from wings analyzed from the Waterfowl Parts Survey (USFWS 2005b).

In 2003 and 2004 hunting seasons, 399 and 1,558 mergansers (excluding hooded mergansers) were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 22,824 and 19,729 mergansers were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 1998 combined harvest of common and red-breasted mergansers represents 15.2 percent of the flyway harvest.

There is no information on numbers of hooded mergansers harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 880 hooded mergansers were harvested in Barnstable County, averaging 80 birds per year (range 0 – 230) (Table 12).

In 2003 and 2004 hunting seasons, 598 and 352 hooded mergansers were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 29,181 and 25,692 mergansers were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 Barnstable County harvest represents 0.5 percent of the flyway harvest (Table 13).

The combined harvest of the three merganser species in Barnstable County during 2003 represents 0.2 percent of the flyway harvest.

Harvest management strategy: Common and red-breasted mergansers are not considered a prized game species (Mallory and Metz 1999) and are often shot by mistake or shot but not retrieved (Wick and Jeffrey 1966). Nonetheless, around 40,000 mergansers (excluding hooded) are shot annually in the United States and about 13,000 in Canada (USFWS 2005b). In 2003 and 2004, about 50 percent of harvested mergansers came from the Atlantic Flyway (USFWS 2005b).

Although over-hunting was common at the turn of this century (Phillips 1926), hooded mergansers are also not considered a prized game species (Dugger *et al.* 1994). Nonetheless, 80,000 to 90,000 hooded mergansers are shot annually in the United States and about 8,000 in Canada (USFWS 2005b). In 2003 and 2004, about 31 percent of harvested hooded mergansers came from the Atlantic Flyway (USFWS 2005b).

Considering there is no specific AHM protocol developed for hooded mergansers, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for mergansers in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for hooded mergansers in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway hooded mergansers since 1997.

Merganser population dynamics and susceptibility to hunting pressures: The most important factor limiting common merganser populations is probably nest cavity availability, particularly in recently or historically logged regions. The role of hunting in common and red-breasted merganser population regulation appears to be small, although the exact effect is unknown because of poor population estimates. Most data indicate that populations vary regionally, but overall are presently stable or increasing (Mallory and Metz 1999).

In many areas, lack of nest cavities due to logging probably limits hooded merganser breeding in once suitable areas. Increasing local populations associated with nest box programs in Missouri, Maine, Iowa, and Oregon support this conclusion (Morse *et al.* 1969, Allen *et al.* 1990). Non-human related factors limiting populations remain largely unknown, but probably vary across the species range. Cavity densities probably play a role in population regulation, but understanding of this resource is limited.

More localized factors may include nest site competition with common goldeneyes in the north and wood ducks in the south. Inter-specifically territorial goldeneyes may also exclude mergansers from suitable habitat in some areas. Competition with fish for invertebrate resources also may play a role in more oligotrophic habitats. In the south, annual variation in river floodplain hydrology creates apparent high variability among years in habitat availability and food abundance, which may regulate densities in these systems. The current effect of hunting on populations of this species is unknown (Dugger *et al.* 1994).

The ecological effects of discontinuing hunting of the three merganser species on CACO are unknown; however, the harvest is relatively small or completely absent in Barnstable County and no ecological effects would be expected.

Waterfowl— Atlantic Brant, Canada Goose, and Snow Goose

Atlantic Brant (Branta bernicla hrota)

Range: During the winter months, brant (referring to the Atlantic flyway population) migrate to wintering grounds along the Atlantic Coast from Massachusetts to South Carolina. They are most abundant along the coast of New York and New Jersey (Bellrose 1980). In New England, they are locally abundant migrants and winter residents (Veit and Petersen 1993).

Habitat: Brant inhabit intertidal mudflats during the winter, in well-protected, shallow marine waters behind barrier beaches or sheltered estuaries, where eelgrass or other green algae are abundant. This type of habitat is prevalent along the coasts of Long Island and New Jersey, where extensive cordgrass marshes in upper intertidal areas and beds of eelgrass and sea lettuce occur (Reed, Ward *et al.* 1998).

Food Habits: Sea lettuce is the staple food source of this bird, followed by eelgrass, green algae and salt marsh grasses (Bellrose 1980). In its artic habitat the brant will also graze on algae, mosses and artic plants (Terres 1980).

Abundance: Estimates of the brant populations are made from the MWI, typically conducted in January of each year. Brant have been assessed annually during midwinter (January) aerial and ground surveys for over 50 years. However, these inventories lack precision because they are usually single counts and do not account for variations in weather or seasonal phenology (Kirby and Obrecht 1982; Sedinger *et al.* 1994).

The 2005 MWI conducted by the USFWS estimated 123, 200 brants in the Atlantic Flyway, which was 5 percent lower than the 2004 estimate (Table 11) (USFWS 2005a). However, these estimates have increased an average of 1 percent per year for the most recent 11-year period. The 2005 MWI estimate of brants in the Pacific Flyway and Mexico was 101,400, 15 percent fewer than in 2004. These estimates have decreased an average of 3 percent per year during 1996 to 2005 (USFWS 2005a).

Take: Estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 2,650 brants were harvested in Barnstable County, averaging 241 birds per year (range 0 – 530) (USFWS, 2005b) (Table 12).

In 2003 and 2004 hunting seasons, 1,600 and 300 brants were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 44,925 and 18,293 brants were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). Based on the 2003 estimates, the brant harvest in Barnstable County is approximately 0.6 percent of the Atlantic flyway harvest (Table 13).

Harvest management strategy: In North America, most brant deaths are caused by hunting, except for Eastern High-Arctic brants, which benefit from closed seasons on staging areas in Iceland and wintering areas in Ireland (Reed, Ward *et al.* 1998). Hunting mortality of brants occurs in 2 main areas: (1) along the United States Atlantic Coast from Massachusetts to North Carolina; and (2) in eastern James Bay (Québec), by Cree subsistence hunters. Brant hunting seasons were closed along the Atlantic Coast in 1972/1973-1974/1975 and 1976/1977-1980/1981. Typically, 3 states—New Jersey, New York, and Virginia—accounted for >85 percent of birds shot during 1973-1979, when comparable estimates of recreational and subsistence harvest were available. United States recreational hunters were calculated to have taken 73 percent, Québec Cree 22 percent, and other Canadians (recreational hunters and other native groups) the remaining 5 percent of the harvest (Reed 1991). Because brants overfly the populated southern portion of eastern Canada in the fall, only small numbers are shot by Canadian sport hunters.

Considering there is no specific AHM protocol developed for brant, the USFWS depends exclusively on the status of eastern mallards for setting the harvest level for brants in the Atlantic Flyway. Based largely upon the estimated population size for eastern mallards as well as the objective to maximize long-term cumulative harvests, the USFWS determined that the liberal harvest option was the optimal regulatory strategy for brants in the Atlantic Flyway in 2005 (USFWS 2005c). This has been the management option selected for Atlantic Flyway brants since 1997.

Brant population dynamics and susceptibility to hunting pressures: Hunting has been one of the most important factors regulating population size (Reed, Ward *et al.* 1998). Reductions in the brant population in the 1970s were caused in part by overshooting on the United States Atlantic Coast (Kirby *et al.* 1985). Although harvest levels have been relatively low (<12% of total winter population size) on Atlantic and black brant (*Branta bernicla nigricans*) since 1985, hunting may have greater effect on breeding population than in other waterfowl because adults generally constitute greater proportion of the bag than juveniles (Kirby *et al.* 1985; Subcommittee on Pacific Brant 1992) and spring subsistence harvest differentially takes breeding pairs (Sedinger *et al.* 1994).

The ecological effects of discontinuing the brant hunt on CACO are unknown; however, the harvest is typically so small relative to the Atlantic Flyway harvest that no ecological effects would be expected.

***Canada Goose* (*Branta canadensis*)**

Range: The winter range of the Canada goose extends from the southern coast of Alaska through British Columbia, southern Alberta to the Atlantic Coast of Newfoundland, and south to Mexico, the Gulf Coast and Florida (Bellrose 1980). They are a common resident throughout the New England Region and sometimes cause damage to golf courses and small ponds (DeGraaf and Yamasaki 2001).

Habitat: During the winter, Canada geese remain on coastal marshes, inland ice-free lakes and rivers, agricultural land, and flooded fields (DeGraaf and Yamasaki 2001).

Food Habits: Canada geese graze on tender shoots of grass, sedges and other marsh plants, submerged vegetation, and agricultural crops. Also, they consume small quantities of insects; larvae; seeds; mollusks; and small crustaceans in mud flats, agricultural fields, flooded meadows, salt marshes, and shallow water with submergent vegetation (DeGraaf and Yamasaki 2001).

Abundance: Flyway and continental population estimates for geese are derived from a variety of surveys, including the MWI, conducted each January in wintering areas, the Waterfowl Breeding Population and Habitat Survey (WBPHS), surveys specifically designed for various populations, and others. These estimates are reported in the Waterfowl Status Report each year (USFWS 2005a).

In the Atlantic Flyway, a mixture of *B. c. canadensis* from boreal areas of Atlantic Canada, *B. c. interior* from arctic and boreal Québec and Greenland, and resident Canada geese, *B. c. maxima*, declined from 775,200 to 569,200 between 1970 and 1993 (Rusch *et al.* 1995), prompting studies of the status of contributing subspecies to overall numbers of Canada geese in the flyway (Trost and Malecki 1985; Hindman and Ferrigno 1990). Subsequently, it was determined that resident Canada geese increased from 400,000 in 1989 to >1 million in 2001. This increase, coupled with the overall decline in the Atlantic Flyway, created uncertainty about the status of migrant stocks (*B. c. canadensis* and *B. c. interior*). Harvest restrictions were imposed, and subsequent surveys of populations on the breeding grounds indicated that the decline was of the *B. c. interior* population of northern Québec, which recovered, increasing from <50,000 pairs in 1994 to 147,000 pairs in 2001 (Harvey and Rodrigue 2001).

Three Canada goose populations comprise most of the geese that occur in the Atlantic Flyway. The Atlantic Population (AP) of Canada geese nest throughout much of Québec, especially along Ungava Bay, the eastern shore of Hudson Bay, and on the Ungava Peninsula. The AP winters from New England to South Carolina, but the largest concentrations occur on the Delmarva Peninsula. Spring surveys in 2005 yielded an estimate of 162,400 breeding pairs (+/- 24,700), 7 percent fewer than in 2004. Breeding pair estimates have increased an average of 17 percent per year during 1996-2005. The estimated total spring population of 1.14 million geese in 2005 was 12 percent higher than that of last year.

The Atlantic Flyway Resident Population (AFRP) inhabits southern Québec, the southern Maritime Provinces, and all states of the Atlantic Flyway. Surveys during spring 2005 estimated 1.06 million AFRP Canada geese in this population (+/- 189,000), about 9 percent more than in 2004. These estimates have increased an average of 1 percent per year over the last 10 years.

The North Atlantic Population (NAP) of Canada geese principally nest in Newfoundland and Labrador. They generally commingle during winter with other Atlantic Flyway Canada geese, although NAP geese have a more coastal distribution than other populations. During the 2005 WBPHS, biologists estimated 51,300 (+/- 23,100) indicated pairs (singles plus pairs) within NAP range (strata 66 and 67), 24 percent fewer than in 2004. Indicated pair estimates have declined an average of 4 percent per year since surveys were initiated in 1996. The 2005 estimate of 129,900 (+/- 62,800) total Canada geese was 34 percent lower than last year's estimate. Total goose estimates have declined an average of 3 percent per year from 1996 to 2005.

Take: Estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), 4,840 Canada geese were harvested in Barnstable County, averaging 440 birds/year (range 40 – 1,140) (USFWS, 2005b) (Table 12).

In 2003 and 2004 hunting seasons, 12,874 and 15,200 Canada geese were harvested statewide in Massachusetts by 3,300 and 3,100 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 657,910 and 633,289 Canada geese were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The 2003 harvest in Barnstable County represents only 0.04 percent of the Atlantic Flyway harvest (Table 13).

Harvest management strategy: Mowbray *et al.* (2002) reviewed the harvest strategy for Canada geese in North America. Currently, about 2 million Canada geese are harvested annually in the United States, and approximately 600,000 in Canada (Trost and Drut 2001; Peterson 2001). Annual harvest has been increasing steadily since the 1970s, making this goose one of the top two or three species of waterfowl harvested in North America (exceeded only by mallards and in some years green-winged teal). Thus, harvest constitutes an important recreational and economic influence on all aspects of Canada goose management. Harvest regulations vary widely in different geographic areas of the United States, with

different management programs attempting to target specific recognized populations. A similar approach is used in Canada, and efforts are made to coordinate harvest management between the two countries.

Subsistence hunters in Alaska and northern Canada also take a number of Canada geese each year (Klein 1966; Bromley 1996). Although exact numbers are not known, harvest by aboriginal people in Canada estimated to be about 200,000 per year, or 25 percent of 600,000 sport harvest (Mowbray *et al.* 2002) and less of regulated harvest in Alaska. Thus, subsistence harvest overall is not a major factor for most recognized Canada goose populations (e.g., Bromley 1996), but for some it has been identified as a local concern (e.g., *B. c. minima* on Yukon-Kuskokwim Delta, AK; Raveling 1984).

The USFWS is striving to apply the principles and tools of AHM to improve decision-making for the AP of Canada geese whose numbers declined significantly in the 1980s and early 1990s (USFWS 2005a). Sport-hunting seasons for this population were closed in the United States from the fall of 1995 to the winter of 1999. Hunting seasons have been reinstated, but are currently at restrictive to moderate levels in the United States. Continuation of sport harvest for Canada geese and maintenance of the population within desired bounds is contingent upon effective harvest management and monitoring programs. Effective management will need to incorporate multiple objectives and must be accomplished with incomplete knowledge of the system and in the presence of various types of uncertainty, including environmental variation, partial system control, model uncertainty, and partial system observability.

Canada geese population dynamics and their susceptibility to hunting pressures: Hunting has been one of the most important factors regulating population size for many Canada goose populations. Canada goose populations have significant age structure as a result of relatively high survival rates and age-dependent productivity. Previous studies have shown that optimal harvest management of age-structured populations is conditional on the age-structure of the population and on age-specific differences in vulnerability of harvest (USFWS 2005c). The prototype AHM strategy for the AP recognizes that the critical components governing the dynamics of the population, unlike those governing ducks, are generally density-independent over the range of population sizes that likely characterize management objectives. Thus, harvest represents an imposed regulatory mechanism on the dynamics of the population. This requires specification of a desired range for the population size. At one end of the population spectrum is the maximum tolerable population size that is linked with what the various stakeholders are willing to accept, given the potential for negative effects of overabundant goose populations. Similarly, the minimum tolerable population size is that population below which the hunting season would be closed considering stakeholder concerns. Thus, the management objective is to maintain the population in the range between the maximum and minimum values, while simultaneously maximizing opportunity for sport harvest (USFWS 2005c).

The ecological effects of discontinuing the Canada geese hunt on CACO are unknown. However, special Canada goose hunting seasons have occurred in Massachusetts and many other states, with the first in 1988 in Massachusetts. One of the major objectives of special Canada goose hunting seasons is to reduce the numbers of resident Canada geese. Heusmann (1997) reported on the various problems associated with over-abundant resident goose populations in Massachusetts, including complaints received about fecal deposition/contamination on golf courses, gardens, shellfish beds, lawns, cranberry bogs, alfalfa fields, beaches and reservoirs. Without the harvest of these increasing numbers of resident geese, the frequency of these complaints from the public would be expected to increase (Heusmann 1997). Yet, relatively low numbers of geese are harvested from Barnstable County each year.

Snow Goose (Anser caerulescens)

Range: In winter, the eastern snow goose population is dispersed along Atlantic Coast from Massachusetts (Veit and Petersen 1993, CBC data) to South Carolina, with main concentrations in New

Jersey, southeast Pennsylvania, Delaware, Maryland and Virginia, and North Carolina. Highest concentrations are found along the shore of Delaware Bay (Reed, Giroux *et al.* 1998).

Habitat: In winter in coastal areas, snow geese inhabit estuarine marshes, marine inlets and bays, shallow tidal waters and coastal freshwater and brackish marshes. Inland, they inhabit wet grasslands, freshwater marshes, coastal prairies, and cultivated fields (Palmer 1976b). Along the Atlantic Coast, snow geese frequent saltwater-cordgrass tidal marshes, freshwater ponds, and agricultural fields.

Food Habits: In winter and during migration, the snow goose diet is comprised of seeds, stems, leaves, rhizomes, stolons, tubers, and roots of grasses, sedges, rushes, and other aquatic plants; grains and young leafy stems of various agricultural crops; stems of horsetails (*Equisetum* spp.); and a variety of berries (Palmer 1976b, Bellrose 1980). During the breeding season, they eat the leafy parts of grasses, sedges, rushes, willows, and other aquatic plants, along with rhizomes, tubers, and roots of grasses, rushes, sedges, forbs, and tundra shrubs. Brooding goslings may also feed on fruits and flowers, the shoots of horsetails, and Chironomid (Diptera) larvae (Palmer 1976b, Bellrose 1980).

Abundance: There is no information on snow geese numbers specifically within CACO. Flyway and continental population estimates for geese are derived from a variety of surveys, including the MWI, the WBPHS, surveys specifically designed for various populations, and others. These estimates are reported in the Waterfowl Status Report each year (USFWS 2005a). Most snow goose populations are currently increasing and causing considerable management concern. In most parts of their range, the population is expanding, and any current estimate of size is soon likely to be superseded and thus of limited use. Aerial photo inventories in 1997 put the total number of breeding snow geese at around 5 million individuals; adding 30 percent for nonbreeding adults (1- and 2-year-olds), the total becomes 6.7 million (Cooke *et al.* 2000).

Midwinter inventories and counts of Mississippi and Central Flyways made by USFWS personnel provide an annual index from which trends can be calculated. These counts underestimate numbers by at least a factor of 1.6 (Boyd *et al.* 1982), increasingly so as the population has risen (Cooke *et al.* 2000). Current midwinter counts by this method, including immature birds (Sharp and Moser 1998), indicate about 3 million birds, clearly well below values derived from the breeding ground estimates.

Take: There is no information on numbers of snow geese harvested specifically within CACO. However, estimates of annual harvests are available for Barnstable County from the USFWS HIP program. For the 11-year period (1993 – 2003), a total of 80 snow geese were harvested in Barnstable County, and all of these geese were taken in 1997 (USFWS 2005b) (Table 12).

In the 2003 and 2004 hunting seasons, 26 and 0 snow geese were harvested statewide in Massachusetts by 2,400 and 2,400 hunters, respectively (USFWS 2005b). For the Atlantic Flyway, 36,105 and 31,548 snow geese were harvested during the 2003 and 2004 hunting seasons, respectively (USFWS 2005b). The harvest of snow geese during 2003 in Barnstable County represents <0.01 percent of the flyway harvest (Table 13).

Harvest management strategy: Mowbray *et al.* (2000) reviewed the harvest strategy for snow geese in North America. Harvest estimates for the mid-continent population from 1975 (first year when data were available from Central and Mississippi Flyways of United States and Canada) to 1992 declined gradually from 597,000 to 258,000. Declines in the United States sector of flyways were evident for an even longer period (Abraham and Jefferies 1997). This decline occurred despite large increases in the goose population and increases in the bag limit/hunter, suggesting that the number of hunters of snow geese declined during this period. Between 1992 and 1997, the harvest increased to 721,000, and perhaps to >1 million in 1999 (Cooke *et al.* 2000). This increase may have been due to increased publicity associated

with concerns about overpopulation (Batt 1998). Even with these increases in harvest, there is no evidence that the population growth of the species has declined.

Snow geese population dynamics and susceptibility to hunting pressures: It appears that hunting mortality is additive to natural mortality for snow geese (Francis *et al.* 1992), but hunting mortality, despite liberal bag limits, has to date failed to curtail the 5 percent or more annual population growth rate of most populations. Mortality due to hunting will decline as snow goose populations increase, unless there is a corresponding increase in hunting pressure. Indeed, Francis *et al.* (1992) and Kerbes *et al.* (1999) showed declines in hunting and total adult mortality during the period 1970-1987, as total population numbers increased. As adult survival increased from 78 to 88 percent, recovery rates (a measure of hunting mortality) decreased 2 to 3 fold at 3 major colonies. Whereas hunting accounted for 66 percent of total adult mortality in 1970, it accounted for <50 percent in 1997 (Cooke *et al.* 2000).

The ecological effects of discontinuing the hunting of snow geese on CACO are unknown; however, relatively few snow geese are harvested from Barnstable County each year.

3.3.3 Natural History – Game Species-Mammals

White-tailed Deer

Range: White-tailed deer are widespread throughout New England. Their range extends across southern Canada to central British Columbia and throughout the United States into South America (Hesselton and Hesselton 1982).

Habitat: Deer utilize forest edges, swamp boarders, areas interspersed with fields, and woodland openings. During the winter they require dense cover for shelter and adequate browse. When snow depths exceed 16 inches, they will yard in conifer stands creating a central resting area with trails (DeGraaf and Yamasaki 2001). Deer are mostly active in the early evening and early morning and seasonally browse on a variety of deciduous and coniferous growth. This consists of twigs, bark, dried red maple (*Acer rubrum*) leaves, and twig litter from hemlock (*Tsuga canadensis*) and white cedar (Crawford 1982). Spring and summer food consists of forbs, ferns, leaves, grasses and sedges. During the fall they supplement this with gilled mushrooms, beechnuts, and acorns (Pruss and Perkins 1992).

For non-migratory deer, home ranges can vary from 146 to 1,285 acres (i.e., densities of 0.2 – 2.0 deer/ mi^2). Areas used seasonally tend to not exceed a one-mile radius (Marchinton and Hirth 1984). In agricultural woodland and suburban areas, densities can reach 30 deer/mi^2. For densely forested areas, density can range up to 15 deer/mi^2 (Baker 1984).

Deer Abundance in Massachusetts: A survey of deer on CACO was completed during November 2003 using nocturnal spotlight surveys. This effort resulted in estimates of 0.80 and 0.56 deer/kilomter^2 (2.08 and 1.45 deer/mi^2) depending on the calculation method (Underwood, H. B. 2004 unpublished data). While these results are consistent with reported values in the literature, they are substantially lower than the MDFW estimates for deer densities in DMZ 12, which comprises the 15 towns of Cape Cod and therefore includes CACO within its boundaries. In recent years, deer densities for DMZ 12 have been estimated at 15 to 17 deer/mi^2. Although this is higher than the density goal set by MDFW (8 deer/mi^2), agency managers consider both the deer densities and hunter densities to be stable and satisfactory.

Porter *et al.* (1994) conducted research at CACO beginning in 1988. This study described the age distribution, physical condition, reproductive performance, and mortality rates of deer on CACO; evaluated principal factors contributing to the limitation of deer abundance on Cape Cod; and recommended methods for long-term monitoring of the deer populations at CACO. This study concluded

that: (1) deer populations on CACO appear to be in good physical condition; (2) deer populations appear to be stable or increasing slowly and are well below the ecological carrying capacity; and (3) that the limit to deer population abundance is probably set by annual harvest rather than habitat or weather.

Harvest: Each harvested deer in Massachusetts is required to be checked at a deer check station. Data collected at these check stations include date of kill, location of kill by DMZ, and sex of deer. Prior to 2003, MDFW did not record numbers of deer harvested specifically within CACO. CACO-specific data for deer harvest were collected in 2003, but have not yet been processed by MDFW. Therefore, estimates of total deer harvest within CACO must be derived from the harvest totals for the five towns encompassing CACO (Provincetown, Truro, Eastham, Wellfleet, and Orleans).

There are no specific counts of the deer harvest at CACO as deer can be checked in at any deer checking station. Therefore, some deer taken at CACO may be checked at stations other than those in the immediate area. Harvest counts are available by town for those towns that provide deer hunting opportunities that fall within the CACO boundaries. For the period between 1999 and 2004 harvest counts ranged from 42 to 74, with an average of 53 deer (data supplied by MDFW). Furthermore deer population estimates are not made at CACO but, in general, population densities are estimated in southeast Massachusetts. The MDFW estimates that the region has 10 to 20 deer per mi^2.

In the late 1980s, a 4-year deer study was conducted at CACO (Seybold 1994). This work suggested that CACO deer population trends, age structure data and physical condition indices were not limited by nutrition or weather. Anthropogenic data indicated that habitat loss probably was not limiting deer population sizes. The deer demographic analyses identified population characteristics typical of heavily exploited herds, and the study concluded that deer populations on CACO may be smaller and less problematic than in other eastern National Parks because they are hunted and subject to intense human disturbance.

Deer population dynamics and their susceptibility to hunting pressures: Deer populations have the potential for rapid growth. Under normal circumstances, yearling does produce single fawns and does two years or older produce twins annually. In very good habitat conditions, adult does can produce triplets. Thus, in the absence of predation or hunting, a deer herd can nearly double in size in one year. The deer population in George Reserve in southern Michigan grew from 10 deer in 1975 to 212 in 1980 (McCullough 1984). This is an average growth rate exceeding 80 percent per year.

However, there are natural limits to the number of deer that a given area can support. The high potential rates of increase of deer populations are limited by reproductive rates and fawn survival (McCullough 1984, Fuller 1990), which in turn is affected by the quantity and quality of deer forage and/or the availability of good winter habitat. If deer populations grow beyond the capacity of an area's vegetation to support them, deer starvation rates increase and vegetative destruction caused by deer feeding becomes problematic (Behrend *et al.* 1970, Deblinger *et al.* 1993). Deer densities greater than $20/mi^2$ have typically reduced forest regeneration and plant species diversity (MacDonald *et al.* 1998).

Most studies of white-tailed deer survival have concluded that hunting is the major source of mortality in exploited populations (Nelson and Mech 1986, Fuller 1990, Patterson and Power 2002, Patterson *et al.* 2002). In the Northeast, in several areas where deer densities had reached high levels, controlled hunts were used to reduce the densities to within biological carrying capacity (e.g., Deblinger *et al.* 1993, Decker *et al.* 2004, Winchcombe 1993, and MacDonald *et al.* 1998).

For example, at the 6,000-acre (9.4 mi^2) Great Swamp National Wildlife Refuge in New Jersey, deer densities in the mid 1970s reached 60 to 70 deer/mi^2. Starting in 1974, controlled hunts were used to reduce the herd and to stabilize population numbers. As a result of the hunt, MacDonald *et al.* (1998)

reported that no winter starvation mortalities were recorded after 1974, deer body condition improved and parasite loads in deer stomachs were reduced (an indicator of herd health).

Management of the deer population at Gettysburg National Military Park and Eisenhower National Historic Site consists of direct reduction (authorized personnel shooting deer in the Parks) and cooperative management (increasing public hunting outside the Parks by cooperative efforts of private landowners, the Pennsylvania Game Commission, and the NPS) (NPS 1995). These methods are used annually to maintain the deer population at a predetermined density.

At the Crane Wildlife Refuge in coastal Massachusetts, deer densities estimated at 100 deer/mi^2 were reduced by setting a harvest quota of 40 percent of the pre-hunting season population (1985 – 1990). Beginning in 1991, the harvest rate was set at 25 percent, maintaining the population at or below its biological carrying capacity (Moen 1984, Deblinger *et al.* 1993). Over the period of the study, body condition improved, winter starvation was eliminated, and vegetative overgrazing was reduced. In addition, researchers noted a decrease in the abundance of ticks that cause Lyme disease.

Effects on predator/prey interactions and competition with other species: Predation can be a major source of mortality for deer, especially along the northern extent of their geographic range (Nelson and Mech 1986). However, Patterson (1999) reported in Nova Scotia that the proportion of deer removed by coyotes decreased with increasing deer densities; thus coyote predation is likely to destabilize rather than regulate deer densities.

Eastern cottontail and New England cottontail

Range: Eastern cottontails can be found in the United States east of the Rocky Mountains and in southern Canada, eastern Mexico, and parts of Central America (Chapman *et al.* 1980). They were introduced into New England in the early twentieth century and have now extended their range to include Vermont, southern Hew Hampshire, and southern New England (Probert and Litvaitis 1996).

New England Cottontails were historically found throughout southern and central New England, eastern Pennsylvania, New Jersey, and along the southern Appalachian Mountains to Alabama (Chapman 1975). Their range has been greatly reduced in New England as a result of suburbanization and forest maturation. New England cottontails have not been documented on outermost Cape Cod since the mid-1900s and were only recently detected in Orleans (Boland and Litvaitis 2007). They now inhabit isolated patches of early successional habitat in Maine, New Hampshire, Massachusetts, and Rhode Island (Litvaitis and Litvaitis 1996). In many areas they are vulnerable to regional extirpation and are considered a species of special concern in New Hampshire, Maine, Vermont, and Rhode Island (DeGraaf and Yamasaki 2001). This species is a candidate for federal listing as a threatened or endangered species.

Habitat: Eastern cottontail habitat consists of farmland, pastures, barren farmland, open woodland, forest edges, marshes and suburban areas. They require stone walls, piles of brush, dens, or burrows (e.g., abandoned woodchuck [*Marmota monax*] holes) for protection from cold weather or storms. They avoid dense cover, but must have occasional pockets of shrubby or herbaceous cover (Allen 1984).

New England cottontails inhabit brushy areas, open woodlands, swamps, and mountains (Fay and Chandler 1955). They are also found in patches of clear-cut forest, shrublands, or grasslands but also require closely spaced patches of dense cover and coniferous shrubs seedlings and saplings (Chapman *et al.* 1982). They occur more frequently in suitable habitats $\geq$25 acres (Litvaitis and Litvaitis 1996).

The home range of the Eastern cottontail is from 0.5 to 40 acres (larger for males, especially during spring and summer, than females) and 0.5 to 1.8 acres for New England cottontail (Godin 1977). In favorable

habitat, the population density of Eastern cottontail can be up to three rabbits/acre (over 2,000 rabbits/mi^2) (Kurta 1995). The densities for New England cottontail average 5.7 females per acre and 1.2 males per acre (Dalke 1942).

Both cottontail species are active mostly during the early evening and early morning. They are primarily nocturnal feeders with summer food consisting of grasses and herbs; winter food is comprised of seedlings, bark, twigs, and buds, especially from maples and oaks (DeGraaf and Yamasaki 2001).

There are many predators, including coyote, fox, bobcats (*Lynx rufus*), hawks, owls and domestic dogs and cats (Chapman *et al.* 1980). Foxes are thought to have some influence over rabbit populations (Banks 2000, Banks *et al.* 1998). Because of dark pelage, predation can be high where snow cover is persistent and escape cover is insufficient (Keith and Bloomer, 1993).

Loss of early successional habitat (reduction in understory cover) is believed to be a major problem for New England cottontail, thereby increasing predation rates by coyote and fox. Further, New England cottontails require patches of greater than 10 hectares to sustain viable populations (Litvaitis and Villafuerte 1996).

Abundance: There is little information on the abundance of cottontail species on CACO. While Eastern cottontails are known to occur throughout Cape Cod, the extent of New England cottontail distribution on Cape Cod is not fully known. In 2004, CACO initiated studies to investigate the presence and distribution of both species and the effects that hunting may have on them. These studies involved collection of fecal pellets for DNA analysis at 161 locations across the Outer Cape over a three year period, with the majority of the collections taken from CACO. Cottontails were also trapped at five locations within CACO in 2005, and at six locations in 2006. The only New England cottontails detected were from a single site in the northwest portion of Orleans (Boland and Litvaitis 2007). Prior to that time, New England cottontails had not been documented on outermost Cape Cod (Orleans to Provincetown) since the mid-1900s (as summarized in Boland *et al.* 2005).

Harvest: Eastern cottontail is a common game species that is often hunted with hounds. Incidental take of New England cottontail can occur as a result of eastern cottontail harvest when the two species are found in the same area. Both species can withstand high hunting pressure due to high reproductive rates.

In Montana, Raucher (1999) surveyed 1,408 hunters and found that only 6 percent (85 individuals) hunted or harvested rabbits. Most stated they were hunting other game in combination with rabbit hunting (51%). while 41 percent were hunting specifically for rabbits. Successful hunters generally harvested less than three rabbits (61%).

However, Kennedy (1988) found that statewide in Massachusetts in 1985/6 and 1986/7, cottontail was the fourth most popular species (as measured by total hunter-days). His estimated statewide harvest (with a large standard of error, since it was computed from a 1% sample of hunters) was 20,096 cottontails for 1985/86 and 19,163 for 1986/87. Given the methods used in this study, there is no reliable way to estimate what proportion of this take occurs at a county or town level.

Species susceptibility to hunting pressures: According to Lord (1963), harvest of eastern cottontail was once greater than for any other game species in the United States. Nonetheless a minimal amount of research is available regarding hunting pressure on cottontails. In Mississippi, Bond (1999) reported that in areas of the wildlife refuge that were not hunted during the late season (i.e., to the end of February), the number of cottontails harvested tripled the following year relative to the harvested areas. Hence, eliminating late season hunting increased harvest the following year.

In Virginia, Payne (1964) reported that intense fall hunting of cottontail (with dense cover conditions) was not a depressing factor to cottontail populations. Removal of different percentages of cottontail populations indicated that with a 75 percent reduction of the fall population, a breeding population was able to produce comparable numbers the following year. Both of these studies suggest that the timing of the hunt is an important factor in determining whether hunting effects are additive or compensatory.

Murphy *et al.* (1996) examined the effect of beagle chasing (training beagles to chase cottontails) on a cottontail population in an enclosure that excluded most predators. There were concerns that chasing activity may lead to increased nest destruction, inhibit rabbit reproduction, and limit fall rabbit abundance. The study concluded that even with intensive beagle chasing activity (more than 200 days per year), cottontail densities in the enclosed area were high and that the almost daily chasing by dogs did not preclude rabbit abundance within the enclosure.

To assess the effects of hunting on cottontail population dynamics at CACO, Boland and Litvaitis (2007) compared cause-specific mortality rates of radio-collared cottontails in hunted and non-hunted areas of CACO. In period 1 (December 2004 through April 2005), 78 rabbits were radio-collared from two hunting and two non-hunting areas, and in period 2 (December 2005 through April 2006), 98 rabbits were radio-collared in six hunting and three non-hunting areas. The fates of 16 and 14 collared rabbits, respectively, were undetermined. Of the 52 cottontail deaths recorded during period 1, 2 were from hunting, 42 were killed by predators, and 8 died of non-hunting anthropogenic or unknown causes. This period was marked by an unusually severe winter with large snowfall for Cape Cod. Of the 46 rabbit deaths recorded in period 2, 8 were from hunting, 28 were killed by predators, and 10 died of non-hunting anthropogenic or unknown causes. The investigators found a lower overall survival rate at the hunted sites compared to the non-hunted sites during period 1; however, during period 2, no overall differences in survival was noted for hunting and non-hunting sites, although hunting represented 17 percent of mortality for that period. The authors concluded that higher mortality rates associated with the harsh winter during period 1 may have reduced cottontail populations below the capacity of their environment, and that under such conditions, hunting mortality may have been additive. Under the more normal winter conditions of period 2, the authors believe hunting is likely operating as a form of compensatory mortality.

Gray Squirrel

Range: Gray squirrels range over the eastern United States to just west of the Mississippi River and north to Canada. Introductions have occurred in many of the western states. They are found throughout New England and are very common in Massachusetts.

Habitat: Mast-bearing hardwood trees (acorns, beechnuts, and hickory nuts) are the most important element of squirrel habitat. Other important tree and shrub species provide flowers, buds, fruit, cones and samaras (fruit of maple trees) in season. Den trees are essential to squirrels for winter shelter, escape cover, and rearing of young. Natural den cavities begin to appear in 40 to 50 year old stands. Although leaf nests are also used, the survival rate of young is 40 percent lower in leaf nests compared to cavities. Frequently, squirrels will claim two or three dens at the same time. Moderate to dense ground cover near den trees is preferred for cover and concealment. Optimal habitat has 2 to 3 suitable cavities per acre (Flyger and Gates 1982).

The home range of gray squirrels varies from 1.5 to 8 acres and is usually smaller where populations are high. Populations develop social hierarchies or "pecking orders" influenced by age and sex of the animals. Dominant animals usually have larger home ranges.

Gray squirrels normally feed twice a day, usually feeding on one or two types of food at a time. They will also bury nuts and acorns in the fall and then dig them up and eat them in the winter and spring. Important food sources include hickory, oak, beech, maple, fungi, animal matter, and corn.

Abundance: There are no squirrel abundance data specific to Cape Cod or to CACO.

Harvest: There is no information on the number of hunters pursuing squirrels or the total squirrel harvest within CACO. Studies that have examined the harvest of squirrel populations in other places vary widely in hunting pressure: In Mississippi, Bowman *et al.* (1999) found a density of hunters averaging 1 hunter per 54 acres on an 8.9 mi^2 WMA; in Ohio, Nixon *et al.* (1974) documented harvest density on a fox squirrel (*Sciurus niger*) population in a 1.9 mi^2 area, with 1 hunter per 3.4 to 13.5 acres.

Reported squirrel harvests from public forests have varied from lows of 13 percent to 15 percent of the population (Uhlig 1955; Kidd and Soileau 1965) to highs of 45 percent (Nixon and McClean 1969), 46 percent (Chapman 1941), and 58 percent (Peterle and Fouch 1959; Nixon *et al.* 1974 as referenced in Nixon *et al.* 1975, p1).

In the 1980s, gray squirrels were consistently the fifth or sixth most hunted species statewide in Massachusetts and in the top three in terms of statewide harvest (Kennedy 1988). Statewide, this study estimated that 10,800 and 14,100 hunters sought gray squirrels statewide in Massachusetts in the 1985/6 and 1986/7 hunting seasons, respectively. Further, Kennedy reported an average season total harvest of 4.6 to 5.1 squirrels per hunter per season. To place Kennedy's findings about number of squirrel hunters in perspective, Nixon *et al.* (1975) reported a low success rate for squirrel hunters in an Ohio study: over a 10 year period, nearly 63 percent of 3,466 hunters killed no squirrels, 23 percent shot only 1 squirrel, and 14 percent shot 2 or more. Only 82 hunters out of the 3,466 shot the bag limit of 4 squirrels.

Using the data from this study (Kennedy 1988), an approximate estimate of the squirrel harvest in CACO can be calculated[5]. There are several assumptions that must be considered. First, it is assumed that hunting pressure is not evenly distributed across the state since hunting on Cape Cod represents only 2 percent of the hunters in the state; whereas the Cape represents 5.1 percent of the state's surface area (Cape Cod represents 400 mi^2 of the 7,840 mi^2 of the state). This estimate is assumed based on discussion with CACO rangers who have indicated that squirrel hunting is limited on CACO and that gray squirrel habitat is better in other areas of the state. It is likely that squirrel hunting is much more popular in the central and western portions of the state. Secondly, it is assumed that 75 percent of all squirrel hunting on Cape Cod takes place within CACO. Based on these assumptions, the acreage available for squirrel hunting, and the data in Kennedy (1988), it is estimated that a total of 162 people hunt squirrels each year in CACO. The average squirrel harvest per hunter per year is likely one-half of the statewide average harvest (4.6 to 5.1 squirrels/hunter) or 2.5 squirrels per hunter per year. This estimate yields harvest of perhaps 405 squirrels per year on CACO.

There are approximately 12,188 acres of forested upland and wetlands available for squirrel hunting. This would amount to a hunter density of approximately 1 hunter per 57 acres. This calculated hunter density for CACO is considerably lower than the 1 hunter per 54 acres reported by Bowman *et al.* (1999) in Mississippi. Furthermore, this represents a take of 1 squirrel per 22 acres. Assuming an average density of 0.3 squirrels per acre (one-half of the density reported by Nixon *et al.* 1975), or 3,657 squirrels in the hunted woodlands, a typical harvest is an estimated 14.5 percent of the population.

[5] Hunter and harvest estimates were calculated by Woodlot Alternatives, Inc. based on data from Kennedy (1988) as follows: 10,800 hunters statewide * 2% of the hunters hunt on Cape Cod * 75% of the Cape Cod hunters hunt on CACO yields 162 hunters that may hunt squirrels on CACO.

Species susceptibility to hunting pressures: Early research suggested that harvest was not detrimental to gray squirrel populations, even at harvest levels of 50 to 60 percent of the fall populations (Uhlig, 1955; Madson 1964, quoted in Bowman *et al.* 1999). Squirrel populations, however, have been shown to be sensitive to food availability. Allen (1942) reported that squirrel populations were affected more by mast availability than by harvest, except in bottomland forests. Nixon *et al.* (1975) documented that the combination of poor mast crop years and harvest adversely affected squirrel populations in an upland area of Ohio. In contrast, Mosby (1969) reported "little or no measurable effect" of poor mast crop on gray squirrel populations.

Mosby (1969) demonstrated experimentally that 37 percent of the fall gray squirrel population could be harvested without affecting the average annual mortality rate compared with the rate on an adjacent un-hunted area. Additionally, Mosby *et al.* (1977) described a "law of diminishing returns" for hunters, since they found that hunter effort could be positively correlated to squirrel densities. This means that as population densities drop, squirrels are correspondingly more difficult to find and to hunt. Thus, they believed that hunters would cease harvest before populations were impacted negatively.

Shugars (1986) reported a 7 to 9 percent annual mortality attributed to harvest in Maryland with a total annual mortality rate of 48 to 54 percent. Similar mortality rates were documented in an unexploited gray squirrel population in North Carolina (Barkalow *et al.* 1970).

Bowman *et al.* (1999) documented the effect of hunting in two study areas following an 11-year period in which one of the study areas had not been hunted. They found that gray squirrel harvest per hunter day decreased in the first two years of the study, but then stabilized for the remaining five years of the study. There were no changes in age ratio, sex ratio, or color following exploitation. Similarly, Mosby (1969) documented no difference in sex ratio between exploited and unexploited populations.

Harvest is often considered compensatory for small mammals like squirrels (Caughley 1985). Bowman *et al.* (1999) reported reproductive compensation for exploitation in fox squirrel, but not in gray squirrel. They hypothesized that partial compensation in gray squirrel population occurred in natural mortality, but their data were not sufficient to demonstrate this effect. Although they had no data on gray squirrel abundance in their study area, the harvest per unit effort stabilized after two or three years following the beginning of harvest, suggesting that exploitation was sustainable at that harvest pressure of 1 hunter per 54 acres.

Nixon *et al.* (1975) observed that the size of the adult kill in one fall hunting season appeared to influence the population density the following year (but not the size of the sub adult kill). However, when both harvest and seed crop were combined in a correlation analysis, the density of squirrels was significantly influenced only by the size of the seed crop the previous fall. In other words, effects of food availability substantially outweighed the effect of harvest on the fluctuating population numbers.

Mosby *et al.* (1977) reviewed several hunting studies and concluded that a harvest rate of 30 percent of pre-season fall population can occur without detrimental effects to the population. They generalized their results to say that squirrel populations in extensively forested areas can usually withstand "much greater utilization than [they] are currently receiving."

Coyote

Range: Coyotes, which first appeared in Maine in the 1930s, are now present throughout New England. Their range also includes North and Central America south of the tundra region (Parker 1995). Their distribution can be limited by certain factors, including snow depth, prey size, and competition with larger predators such as the wolf or the mountain lion (Voigt and Berg 1987).

Habitat: Coyotes are primarily found in a variety of forest and field habitats. They use edge habitat, especially second-growth forests, bare agricultural land, forest openings, exposed scrub-brush fields and many urbanized areas (Voigt and Berg 1987). They tend to remain in low-lying areas, which contain substantial populations of deer and snowshoe hare, especially during the winter (Ozoga and Harger 1966). They also require areas that contain well-drained and secluded den sites, which are generally abandoned by foxes and porcupines. These include rocky caves, hollow logs, or excavated burrows (Parker 1995).

Northeast ranges are generally larger due to limited food availability and distribution (Harrison 1992). In Maine, they average 12,800 acres for males and 11,800 acres for females (Caturano 1983). Seasonal range changes do occur often during breeding, pregnancy, nursing and winter foraging (Major and Sherburne 1987). Young will disperse at 1 to 1.5 years of age, traveling an average distance of 70 miles (males) and 58 miles (females) (Harrison 1992). Some coyotes form packs and develop well-defined territories, whereas those traveling in pairs or solitary do not (Bekoff 1980).

Coyotes are often considered a keystone predator, one with much influence on the local ecosystems. Because of this, they frequently shape the faunal community around them; this is more evident in the western states (Henke and Bryant 1999). They are an opportunistic species and prey on a variety of small to medium-sized mammals. Their most common prey species are snowshoe hare, deer fawns, beaver, muskrat, and small mammals such as mice and voles (Parker 1995). The availability of food is often a major influence in the type of social system (pack vs. pair) (Harrison 1992).

The diet and food habits of coyotes in Ohio's Cuyahoga Valley National Park were analyzed by Cepek (2004). Cuyahoga Valley National Park is surrounded by residential communities, located between Cleveland and Akron, Ohio, and is experiencing pressures of increased urbanization. The coyote is the top predator at Cuyahoga. Meadow vole (*Microtus pennsylvanicus*) was the predominant food item found, followed by eastern cottontail, white-tailed deer, and raccoon. A variety of insects, small birds, and plant materials comprised the remainder of the diet. It is important to note that though white-tailed deer occurred frequently in coyote diet, further investigation indicates that they are mainly scavenged as carrion.

Under natural circumstances, coyote abundance is controlled greatly by resource availability and competition with other predators, such as wolves (Bekoff and Gese 2003).

Human-caused mortality also occurs. Studies indicate that coyote populations are able to maintain themselves under considerable human-induced mortality through behavioral adaptations and biological compensatory mechanisms such as increased rates of reproduction, survival, and immigration (Knowlton 1972). Coyote population densities that have been reduced result in increased resource availability and less competition. Lower densities also reduce the transmission of disease. Pregnancy rates tend to increase while natural mortality tends to decrease. Connolly and Longhurst (1975) estimated that coyotes can withstand 70 percent annual control level and that 3 coyotes would need to be killed for every animal present at breeding time to hold the density below 50 percent of the pre-control level. In most areas, coyote population numbers are controlled by competition for limited resources such as food and by social stress, disease, and parasites.

Effects of control, sport hunting, and trapping are not well known. However, there have been some observations that suggest that coyotes may be adapting to exploitation through learning or heredity (e.g., trap aversion) (Andelt 1987).

Interspecific competition: Coyotes may not tolerate the presence of red foxes in their range unless there is an abundant food supply (Gese, Ruff, and Crabtree. 1996). They will often kill small canids such as gray fox if food supplies and territory areas overlap. In many areas, coyotes control the abundance and

distribution of smaller predators. For example, Crooks and Soulé (1999) reported that in southern California areas where coyote are absent, the population density of smaller predators (i.e., foxes and feral cats) increases. This can also have detrimental effects on the avifaunal community (Soulé *et al.* 1988).

It has also been found that coyote predation has little effect on deer population. When coyotes are absent, deer populations increase, causing less resource availability, which results in a decrease in population. They have the largest effect on rabbit populations when those populations are already in decline because of other factors (Andelt 1987).

Hunting data/information - Abundance: Coyotes are relatively 'new' to Cape Cod, documented first in the late 1970s (Way *et al.* 2002a). Way (2001) and Way *et al.* (2002b) documented that Cape Cod coyotes are territorial, with average territory sizes of 11 mi^2 and with average pack sizes of 3 resident animals per territory. A crude estimate of population size for coyote in CACO's 69 mi^2 area is therefore around 20 resident animals. Coyotes are highly efficient dispersers (Way *et al.* 2004) and have litter sizes of approximately five pups. This suggests that there could be as many transient animals as residents (i.e., 20) and thus perhaps as many as 40 individuals in total within CACO at a given time.

Harvest: MDFW maintains a database of all sealed pelts from 1981/82 to the present. Prior to the ban on trapping in 1996, the database lists eleven coyotes harvested in 7 Cape Cod towns[6] (all in the 4-year period from 1989 – 1993). In the eight years following the banning of traps, only two coyotes were reported harvested on Cape Cod, both in the town of Chatham.

The statewide harvest estimate prepared by Kennedy (1988) is considerably higher than the number of sealed pelts in the full statewide MDFW database. Using the low-end estimate of the statewide harvest (Kennedy 1988), the total coyote harvest is still approximately five times the number of sealed pelts. This data would suggest that the actual Cape Cod harvest may be several times higher than the pelt data show, but probably not more than 5 to 10 coyote a year from within CACO. Anecdotal information suggests the number may be higher than this; possibly up to 20 per year (Way *et al.* 2004). However, because coyote disperse rapidly into vacant territories and because of the large number of transient coyote on Cape Cod, the harvest is unlikely to have a major ecological impact on this species.

Coyote susceptibility to hunting pressures: In addition to the territory size data from Way *et al.* (2004), other studies have reported densities ranging from ~0.12 coyote/247 acres (Henke and Bryant 1999, mixed grassland and shrubland habitat, western Texas) to more than 2 coyotes/247 acres (Knowlton 1972, also in Texas).

The major factor regulating coyote populations is food abundance, especially in winter (Gese, Stotts, and Grothe 1996.), but human activities (hunting, trapping, and vehicle collisions) can cause a high proportion of coyote deaths (Tzilkowski 1980, Windberg *et al.* 1985, Windberg 1995).

Exploitation of coyote was shown to affect the demographic structure of populations. (Knowlton *et al.* 1999). Unexploited populations have older age structures, high adult survival rates, low reproductive rates (especially among yearlings), and low recruitment into the adult population. These populations may have larger packs or social units depending on available food. Heavily exploited populations have younger age structures, lower adult survival rates, increased percentages of yearlings reproducing, increased litter size, and relatively smaller packs.

[6] Provincetown, Truro, Orleans, Harwich (all with zero harvest from 1981-2003), Wellfleet (1 coyote in 89/90), Eastham (2 in 1990/91, 3 in 1991/92, and 5 in 1992/93, i.e., all prior to the trap ban), and Chatham (1 in 1998/99 and 1 in 2001/02, i.e., after the trap ban).

Much of the literature on coyote is related to managing their populations because of livestock depredation, which is not relevant to CACO. Knowlton *et al.* (1999) provides a good overview of this topic.

Effects on predator/prey interactions and competition with other species: Coyotes have been suggested as being keystone predators in a variety of ecosystems, including chaparral (Soule *et al.* 1988), grassland (Vickery *et al.* 1992), wetland (Sovada *et al.* 1995), and shortgrass prairie (Henke and Bryant 1999, Crooks and Soule 1999).

Henke and Bryant (1999) showed that reducing coyote density had little effect on desert cottontail rabbit population, but did have a regulatory effect on black-tailed jackrabbit (*Lepus californicus*). Similarly, Wagner and Stoddard (1972) also showed a strong cross-linkage in the food web between jackrabbit and coyote in Utah. Wagner (1988) speculated that a sustained reduction of coyote numbers would result in a jackrabbit increase, which in turn could lead to overuse of vegetation and greater competition with livestock for available forage. Lingle (2000) reported on coyote predation of mule deer (*Odocoileus hemionus*) and white-tailed deer (open prairie and mixed grassland habitat in Alberta, Canada) and found that between 47 and 85 percent of the mortality on fawns was caused by coyotes (n=19).

Interspecific killing seems to be common in carnivore communities (Peterson 1995). Coyotes may not tolerate red foxes in some areas (Sargeant *et al.* 1987) and can apparently control the abundance and distribution of smaller predators like feral cats (Crooks and Soule 1999).

Red Fox and Gray Fox

Range: The red fox occurs over most of North America from Baffin Island, Canada, and Alaska to the southern United States, except for coastal western Canada, Oregon and California, the Great Plains, the southwestern desert and the extreme southeastern United States. Kamler and Ballard (2002) point out that red fox occurs both as native and non-native species in North America. They refer to the introduction of red fox by colonists in the mid 1700s and show how the non-native red foxes expanded westward. Since native red foxes are generally found at high elevations, it seems possible (although uncertain) that red fox at CACO may be an introduced species that has become naturalized.

The gray fox occurs from extreme southern Canada throughout the United States, except in Montana, Idaho, Wyoming, and most of Washington. It ranges into Mexico and Central America.

Habitat: Home range size varies considerably for both red and gray foxes (Cypher 2003). In Maine, Harrison *et al.* (1989) and Major and Sherburne (1987) reported mean home range sizes for red fox of 5.8 to 7.7 mi^2. In Minnesota, Sargeant (1972) observed home range size of 2.7 mi^2. Griffin *et al.* (1989) documented fox home range sizes at CACO for three radio-tagged foxes over an eight month period (June – January). Monthly home range size averaged 0.3 mi^2 for the two tagged females and 0.4 mi^2 for the tagged male. The three tagged foxes spent 70 percent of their time in upland habitats (fields and woods) and 30 percent of their time in beach habitats.

Foxes are important predators of prolific prey species like mice and rabbits. Griffin *et al.* (1989) reported that foxes were a significant predator of piping plover and roseate tern (*Sterna dougallii*) eggs.

Abundance: There are no fox abundance data specific to Cape Cod or to CACO. In Scotland, England, Hewson (1986) found average densities of red fox dens ranging from 3.8 mi^2 per den (in agricultural land) to 12.4 mi^2/den (in forested land). Lindstrom (1982) reported higher densities of dens in Sweden (2.7 mi^2/den). Hewson (1986) estimated that red fox densities in an area with high control of fox numbers through culling were less than 0.3 fox per 0.39 mi^2, whereas other studies in areas with no control had fox

densities ranging from 1 to 3 foxes per 0.39 mi^2. If these figures are extrapolated to CACO, they suggest a red fox population of between 35 and 300. However, since red fox typically avoid coyote territories (Gosselink 1999 and Harrison *et al.* 1989), it seems likely that the fox numbers are at low end of this range.

Harvest: The MDFW maintains a database for all sealed fox pelts that extends back to the 1989/90 hunting season. In the period prior to 1996 when leg-hold traps were banned, the database lists only one red fox harvested in all of the seven Cape Cod towns[7] (from Orleans in 2000/01), and no reported gray fox harvest from 1989-2003.

A statewide estimate of fox harvest prepared by Kennedy (1988) is considerably higher than the number of sealed fox pelts in the full statewide MDFW database. Following the methodology established for coyote pelts (see above), even if a crude estimate of take on the low end of Kennedy's range, the total fox harvest appears to be more than five times the number of sealed pelts. This suggests that the actual Cape Cod harvest may be four or five foxes per year from within CACO.

Fox susceptibility to hunting pressures: Allen and Sargeant. (1993) suggested that annual harvests in localized areas for one or more years would likely have little effect on population size in subsequent years, because red fox are efficient dispersers. Weston and Brisbin (2003) compared age structure, sex ratio, and reproductive output for unharvested and harvested populations of gray fox with the same parameters for harvested populations. They found significant differences in age structure, although this may have been partly attributable to habitat and not only to hunting. Further, there was a high percentage of foxes older than 34 months, and the authors concluded that the lack of harvest pressure on this population led to more individuals surviving to 3+ years of age. The sex ratio of unharvested gray fox showed higher proportions of females (1.27:1 f:m) than is generally found in exploited populations (typically 1:1).

Effects on predator/prey interactions and competition with other species: Foxes and coyotes have extensive dietary overlap, given that they are generalist carnivores-omnivores occupying the same habitat. Lavin *et al.* (2003) reported in a range of urban and rural landscapes of Illinois that coyotes inhibit fox foraging, possibly by spatial displacement or by direct scramble competition. Foxes typically avoid coyote territories (Gosselink 1999 and Harrison *et al.* 1989).

Raccoon (Procyon lotor)

Range: Raccoons are found throughout most of southern Canada and the United States. They are not present in the deserts of the Southwest or high elevations in the Rocky Mountains (Sanderson 1987). They are very common throughout New England.

Habitat: Raccoons are commonly found in wooded areas containing fields and wetland habitat, especially near human habitation. They tend to avoid upland areas and dense forest (Kaufman 1982). Raccoons will also make use of edge habitat and agricultural landscapes, traveling along the periphery (Pedlar *et al.* 1997). Den sites consist of abandoned woodchuck burrows and hollow trees; culverts are used when tree dens aren't available (Leham 1984). Sites are generally located 10 feet above ground in trees that are near water (Sanderson 1987).

[7] Chatham, Harwich, Provincetown, Truro and Wellfleet all have zero reported harvest for both red and gray fox from 1981-2003. In 2000/2001, there is one red fox in the dataset (i.e., after the trap ban of 1996).

Most raccoons reach sexual maturity by their first fall. Breeding season is late February to June, peaking in February (Fritzell 1978). Gestation is approximately 63 days and the young are born in late April to early May. They have only 1 litter per year, with litter sizes ranging from 2 to 7 cubs (Sanderson 1987).

The size of raccoon home ranges varies greatly, from less than 12 acres (reported in an Ohio suburb) to nearly 12,355 acres (reported in North Dakota), and is affected by weather and by food availability. Typical home range size is between 99 acres and 247 acres (Sanderson 1987). Juvenile dispersal generally occurs in fall or early winter following birth (Lotze and Anderson 1979).

Raccoons are omnivorous and opportunistic. In the spring and early summer, their diet consists mainly of animal matter such as crayfish, worms, insects, carrion, mollusks, turtle and bird eggs (significant predation), and garbage. In the summer, fall, and winter, fruits, grains, nuts, seeds, buds and shoots comprise most of their diet (Sanderson 1987). Winter dormancy lasts from late November to March, during this time they live off fat accumulated during late summer (Godin 1977).

Their primary source of mortality is a result of human activities such as harvest, vehicle collisions, and nuisance control (Lotze and Anderson 1979). Another major source of mortality is disease, such as canine distemper and rabies. Major predators include coyotes, red fox, bobcats, and owls (Kaufman 1982).

Historically, raccoons have been an economically important mammal in North America (Sanderson 1987). However, during the late 1980s and early 1990s their economic importance shifted to economic costliness as carriers of disease and damage in residential areas (Bluett 2000). There is little or no evidence that harvesting raccoons has had any lasting detrimental effect on raccoon populations.

Abundance: There is no information on raccoon population levels within CACO. Studies in rural areas of Ontario, Minnesota, Wisconsin, and Tennessee report densities averaging 2 to 10 raccoons per $0.39mi^2$. In urban areas in Ohio and Toronto, population densities exceed 50 raccoons per $0.39mi^2$ (see Table 1 in Rosatte 1998 for specific references). Assuming population densities typical of rural areas, this would suggest a raccoon population at CACO of between 350 and 1,750 animals.

Harvest: Because raccoon pelts do not need to be sealed in Massachusetts, no specific information exists on harvest levels within CACO. Of the nine species assessed in Kennedy (1988), raccoon hunting had the lowest hunter demand and was one of the least harvested species statewide (although estimates of raccoon harvest did fluctuate considerably for the years reported in this study).

Raccoon susceptibility to hunting pressures: Two studies in Iowa (Glueck *et al.* 1988) and Mississippi (Chamberlain *et al.* 1999) both cite human activity (hunting and trapping, vehicle collisions) as a substantial cause of raccoon mortality. Peak exploitation of raccoon populations usually occurs during fall-winter trapping and hunting seasons (Clark *et al.* 1989). In Washington D.C., road-kills accounted for 46 percent of the raccoon mortalities (Hadidian and Riley 1990), and in Toronto Rosatte and MacInnes (1989) reported road-kill mortality of raccoons to be 17 percent.

Raccoons are capable of withstanding substantial hunting pressures (Rosatte 1998). Sanderson (1987) claims that there is no evidence that harvesting raccoons has any lasting detrimental effect on their populations; even if the local population declines, the overall effect is negligible. Hasbrouck *et al.* (1992) suggests that harvest be considered an additive mortality factor only when more than 40 percent of the population is harvested; in other cases it is probably compensatory. Similarly, Clark (1990) reported that increasing raccoon harvest beyond 40 percent of the fall population level appears to have an additive effect, but that harvest levels between 20 percent and 40 percent permitted compensation.

It has been suggested that hunting might alter movement patterns of raccoon and increase their energy expenditure, particularly for a summer hunting season. Roseberry (1980) and Hodges *et al.* (2000) showed that summer hunting had a minimal effect on movement and home range size (and therefore on energetics and population dynamics). In a direct study of summer hunting, Chamberlain *et al.* (1999) found that hunting with reasonably conservative bag limits (three raccoons) did not affect annual survival of raccoon. In CACO there is no summer hunting season.

Opossum

Range: Opossums, which were not present in New England before 1900, can now be found throughout the region. They have extended their range to southern Maine, through central New Hampshire, and up to northwestern Vermont (DeGraff and Yamasaki 2001). Their northern distribution is probably limited by lack of foraging as a result of subfreezing temperatures. Over the years, their range has expanded due to warming trends and their reliance on human activity to provide food and shelter (Gardner and Sunquest 2003).

Habitat: Opossums are found in dry to wet wooded areas, often near rivers and swamps; they require access to a water source. They are not commonly found in uplands or cultivated areas, yet are becoming increasingly common near more residential areas as they are being attracted by the availability of human food waste (DeGraff and Yamasaki 2001). Since opossums do not dig their own burrows, they must rely on dens provided by other animals such as woodchucks, raccoons, and cottontail rabbits. These dens are then often reused by other animals such as red fox, skunk, woodchuck, raccoon, and cottontail rabbits (Gardner and Sunquest 2003).

Maturity is reached at 8 to 12 months and breeding occurs in late June to early July. The young are born from February to July, after a 13-day gestation period. Opossums give birth to young in an underdeveloped stage, after which the offspring spend the next 60 days in the mother's pouch. They are typically weaned 96 to 106 days later. In the northern United States, they tend to have 1 litter per year with an average of 8 young (DeGraff and Yamasaki 2001).

Two telemetry studies on opossum movements (Allen *et al.* 1985, Hossler *et al.* 1994) indicated that opossums, especially females, regularly use areas for food gathering and caring for young. Allen *et al.* (1985) reported home range sizes for seven radio-tagged animals, and Hossler *et al.* (1994) reported high den fidelity, especially during weaning periods. Male ranges average 270 acres and often encompass home ranges of several females, which tend to be smaller (127 acres). When the young reach 80 to 100 days, they begin to gradually extend their range away from the den. Males will make gradual shifts in their ranges as opposed to females who will often demonstrate sudden dispersal movements (DeGraff and Yamasaki 2001).

Opossums are omnivorous and are extensive scavengers; they will eat the food source that is most abundant. This includes most vegetable or animal food, insects, invertebrates, fruit, and mushrooms from beneath the snow. They are not thought to be a serious predator (Gardner and Sunquest 2003).

In the past, hunting and trapping of opossum was extensive, but has recently been decreasing (Gardner and Sunquest 2003). Urbanization, which results in habitat reduction and increased motor vehicle collisions, is thought to be the major source of mortality (DeGraff and Yamasaki 2001). Other factors include winter severity and resource availability. Natural predators such as dogs, coyotes, foxes, raccoons, and raptors seem to have little effect on the population (Gardner and Sunquest 2003).

Management: Population trends are often difficult to predict. They vary greatly with changing environmental conditions. These fluctuations result in a change in carrying capacity for a given area.

This change affects the number of young produced. Since there is little time lag between the change in animal numbers and the change in environmental conditions affecting carrying capacity, estimating current and future populations is very difficult. For this reason, harvest data are a good indicator of survivorship and environmental conditions for the reproductive season preceding harvest, but not a good prediction of future trends. The most effective management option is to restrict harvest until after the breeding season and to protect areas providing favorable environmental conditions, especially during environmental extremes (Seidensticker *et al.* 1987).

Abundance: There is no information on the abundance of opossum in CACO, and no literature was found for this species on which estimates could be made based on typical population densities.

Harvest: There is no information on the size of opossum harvest in Massachusetts or within CACO. Similarly, no references were found in the scientific or management literature related to the effects of hunting on opossum.

3.3.4 Non-native Species

Non-native or exotic species are defined as species that occupy or could occupy Park lands directly or indirectly as a result of deliberate or accidental human activities. Because an exotic species did not evolve in concert with the species native to the place, the exotic species is not a natural component of the natural ecosystem (NPS 2006a). Highest priority is given to the control of exotic species that have a potential to have a substantial impact on Park resources and that can reasonably be expected to be successfully controlled. Lower priority is given to the control of exotic species that have almost no impact on Park resources or that probably cannot be successfully controlled.

Since European settlement, numerous non-native wildlife species have been introduced to the Outer Cape, including brown-tailed moths (*Euproctis chrysorrola*) and gypsy moths (*Lymantria dispar*). Many brown-tailed moth surveys and control efforts have been conducted within CACO over the last 30 years. However, very little quantitative data exist to indicate trends in their distribution or abundance on the Outer Cape. Some gypsy moth monitoring has also been conducted.

Ring-necked pheasants are a non-native species introduced within CACO by MDFW specifically for a stocked hunt. The annual release of ring-necked pheasants has not resulted in an established population and this species does not appear to cause any adverse effects towards other wildlife species (Bump and Field 1999). Pheasants appear to represent what are termed innocuous species and by definition are exotic species that do not significantly harm Park resources and do not require management efforts (NPS 1991).

3.3.5 Wildlife Species That Are Endangered, Threatened, or of Special Concern

USFWS and National Marine Fisheries Service list 15 species found within CACO as threatened or endangered. Eleven of these species are marine mammals or marine turtles. The Massachusetts Natural Heritage Endangered Species Program lists 42 species occurring in CACO as threatened, endangered, or of special concern. Nine species found within CACO are also protected by the Marine Mammal Protection Act. Migratory birds are protected under the Migratory Bird Treaty Act.

CACO implements an intensive monitoring and management program for the state and federally listed threatened piping plover (*Charadrius melodus*). State listed terns are also monitored and protected as part of this program. CACO implements periodic road closures to protect state threatened Eastern spadefoot toads (*Scaphiopus holbrookii*), and is conducting research to better understand toad movements and inform management to reduce road mortality. CACO does not actively manage other state or federally

listed species. However, these species receive varying levels of monitoring, and all park activities and projects are managed to avoid impacts.

3.4 Hunting Activity at CACO

A detailed discussion examining the economic aspects of hunting is presented in Section 3.8.4, while this section provides a brief synopsis of the level of hunting activity at CACO. Much of the discussion is based on the recently completed CACO Hunting Survey (Kuentzel 2006).

Responses from hunters using CACO provide the basis for documenting hunting activity on CACO. Hunters using CACO most commonly target deer, waterfowl, pheasant, and rabbit. Over 70 percent of hunters consider deer to be their preferred species (Kuentzel 2006), which is consistent with hunter preferences on a statewide and nationwide basis (USFWS 2004). The most heavily hunted areas of CACO include the Marconi and the Collins Road/kettle pond area. However, hunting occurs in all areas of CACO that are open to hunting. In general, CACO is used by a limited set of local hunters who hunt extensively. On average, they hunt at CACO 32 days out of the year. This exceeds the average hunting days for Massachusetts hunters of 17.5 days per year by a large margin (USFWS 2002). Most CACO hunters are Massachusetts residents: 70.2 percent Cape Cod residents; 24.4 percent Massachusetts "off Cape Cod" residents; and 3.3 percent from out-of-state (NPS 2005b). Approximately 43 percent of the hunters licensed in Barnstable County hunted within the previous 12 months and 24 percent have hunted at CACO (Kuentzel 2006). Hunting activity peaks in October, with pheasant (prior to when the pheasant stocking was enjoined), rabbit, and waterfowl hunting seasons opening (Table 14). Hunting activity remains relatively steady through December, with deer, waterfowl, and rabbit hunting seasons all occurring within this month. There are some notable differences between a visitor and resident survey conducted in the early 1990s (Manning 1994) and the Kuentzel (2006) study (Table 14). While the earlier study shows a peak in hunting activity during September and October, the more recent study shows hunting activity more focused on deer and to a lesser extent waterfowl and rabbits. DLW

Table 14. Estimate of CACO Hunting Days

	Sept	Oct	Nov	Dec	Jan	Feb	TOTAL
Estimated Hunting Days (1993-1994 season) (Manning 1994)	2,273 23.4%	3,456 35.6%	1,533 15.8%	1,131 11.7%	641 6.6%	661 6.8%	9,694 100%
Kuentzel (2006)	3.5%	19.8%	28.6%	27.4%	12.7%	8.0%	100%

3.5 Hunting Violations of Regulations, Safety

3.5.1 Hunting Related Violations

***Hunting Program*:** The legislation establishing CACO allows hunting under the jurisdiction of the MDFW and the NPS. White-tailed deer hunting is a popular hunting activity; waterfowl and small upland game are also harvested. The state sets harvest quotas and hunting season dates. The state stocks ring-necked pheasants in three locations in CACO (the Marconi Area, the area near Bound Brook Island, and in the Province Lands) for a six-week sport-hunting season. Refer to Section 1.2.1 of this Final EIS for a more detailed summary of the hunting program at CACO.

***Hunting Related Violations and Warnings*[8]:** The following provides a summary of hunting regulation enforcement. The full staff of CACO rangers enforces hunting regulations. There is no seasonal or extra assistance needed by the NPS for enforcement duties. According to information from the NPS, there have not been any hunting related fatalities or injuries since CACO was established. Violations and warnings issued by CACO rangers are relatively few, particularly in comparison to other activities at CACO (Tables 15 and 16). During 2001, 11 of the 16 violations were specific to waterfowl hunting enforcement in the Nauset Marsh/Nauset Beach area. From 1997 to 2001, based upon the type of warning and/or the location of the violation and/or the date, none were related specifically to pheasant hunting. During 2001, no hunting related warnings were issued. There have been no hunting related injuries or fatalities to hunters or non-hunters at CACO since its inception.

Over the last 10 years, annual visitation to CACO has remained steady at an average of just under 5 million with the last few years showing some decline to a low of 4.1 million in 2004. According to statistics compiled by the Cape Cod Commission (Cape Cod Commission 2000), the year-round population for the lower six Cape Cod towns (Provincetown, Truro, Wellfleet, Eastham, Orleans, and Chatham) has increased by an average of 23 percent between 1990 and 2000. Similarly, the Commission reports that the average summer population has increased by almost 10 percent for the same period. In spite of this significant increase in the numbers of people living and recreating in and around CACO, there have been no injuries or fatalities to hunters or non-hunters at CACO since its inception. Each year, a few violation notices and warnings are issued to hunters (primarily rabbit) for being within 500 feet of a building with a loaded weapon. Most of the contacts come as a result of ranger-initiated patrols rather than complaints since the majority of the buildings (cottages) are unoccupied during this time of year. On occasion, a resident inside CACO will phone in a complaint concerning hunters walking through their property with weapons (loaded or unloaded) and a ranger will respond. More often than not, the hunter is no longer in the area when the ranger arrives. During the public scoping process, individuals related situations of near misses or shot flying over visitors. However, none of these incidents were reported to CACO rangers at the time.

Non-hunting-related violations (Table 17) exceed hunting related ones (Tables 15 and 16) by a factor of some 35 to 265 times for violations and 56 to 107 times for warnings, with some years having no hunting related warnings. In comparing the numbers of hunting-related violations and warnings to non-hunting-related violations and warnings each year, it should be noted that hunters represent a small percentage of annual users overall and may receive violations and warnings at a higher per capita frequency than other user groups. The difference in the ratio of Resource and Visitor Protection Rangers to the number of participants in various user groups may also influence violation and warning rates. A summary of the types of violations is provided in Table 17. Injuries relating to non-hunting activities occur annually at CACO, averaging 30 accident-related injuries per year from 1998 to 2005 (Unpublished CACO data). Approximately one-half of these injuries are from bicycle accidents. Non-hunting accident-related fatalities at CACO are rare, with only one bicycle fatality occurring between 2001 and 2004.

[8] Data was provided by CACO.

Table 15. Hunting-Related Violation Notices, 1997 – 2004

Violation	1997	1998	1999	2000	2001	2002	2003	2004
Possible loaded weapon within 500' of building	6	1	7	2	2	4	6	13
Permanent tree stand	0	0	0	0	0	2	0	0
Loaded weapon on bike trail	1	4	0	0	0	0	0	0
Hunting with more than six dogs	3	0	0	0	2	0	0	1
Hunting on posted land	0	0	1	0	0	0	0	0
Taking waterfowl out of season	0	0	0	0	2	0	0	0
Unplugged shotgun	0	0	0	0	5	0	0	0
Invalid license	0	0	0	0	1	0	0	0
Hunting waterfowl without stamp	0	0	0	0	3	2	0	0
Closure	1				1	0	0	1
Failure to tag deer	0	0	0	0	0	0	0	1
Total Hunting Violations	**11**	**5**	**8**	**2**	**16**	**8**	**6**	**16**
Total Violations for all Activities	382	433	383	531	628	831	754	688

Table 16. Hunting Related Warning Notices, 1997 – 2004

Violation	1997	1998	1999	2000	2001	2002	2003	2004
Possible loaded weapon within 500' of building	1	4	1	0	0	0	0	2
Hunting hours	2	0	0	0	0	0	0	0
Failure to display	0	0	1	0	0	0	0	0
Hunting with more than six dogs	3	0	3	0	0	0	0	0
No orange hat	3	1	0	0	0	0	0	0
Orange hat in wildlife area	2	0	0	0	0	0	0	0
Duplicate license	1	0	0	0	0	0	0	0
No FID in possession	0	1	0	0	0	0	0	0
Illegal taking of wildlife	0	1	0	0	0	0	0	1
Closed season	0	0	1	1	0	0	0	1
Total Hunting Warnings	**12**	**7**	**6**	**1**	**0**	**0**	**0**	**4**
Total Warnings for the Year for all Activities	668	393	251	107	100	202	121	389

Table 17. CACO Non-Hunting Related Violation Notices, 2001 – 2004

Violation	2001	2002	2003	2004
Motor vehicle related (parking, speed, off route, registration, etc.)	359	328	401	301
Alcohol/controlled substance related	86	123	84	108
Nudity/disorderly conduct/lewd/interfering with agency function	41	148	97	92
Pets off-leash/prohibited area	9	15	27	35
Illegal activities (fire, camping, metal detector, sanitation, aircraft, etc.)	33	84	73	81
B&E/vandalism/theft	1	2	6	3
Trespass/closed area	27	47	39	19
Permit violations	54	65	12	25
Fishing violations	1	7	8	2
Preservation/destruction natural resources	1	4	1	6
Hunting violations	16	8	6	16
Total Violations for the Year for all Activities	628	831	754	688

3.5.2 Hunting Related Injuries

Hunting Injuries in Massachusetts[9]: There were no fatal hunting accidents in Massachusetts from 1995 through 2005. The last hunting related fatality occurred in 1992. Twenty-nine hunting-related accidents occurred from 1995 to 2005, of which 25 involved 2 parties and 4 were self-inflicted. All accidents occurred among shooters and victims that were hunters. There were no accidents involving non-hunters.

Hunting Injuries and Injuries to Non-participants in a Nationwide Context: Virtually all hunting-related accidents occur between the victim and a member of his or her party. The most common type of hunting accident is associated with the victim not being seen by the shooter. Vision or hunter judgment related accidents comprise about 55 percent of hunting-related injuries and fatalities, based on 10 years of data from the National Safety Council. Generally, these type of injuries fall into four categories:

- the victim moved into the shooter's line of fire;
- the victim was covered by the shooter who was swinging on game;
- the victim was out of sight of the shooter; or
- the victim was mistaken for game.

Skill and aptitude deficiencies or errors comprise about 54 percent of the hunting related injuries and fatalities and fall into categories such as:

- getting the trigger caught while loading/unloading the gun;
- careless handling of a firearm, such as dropping it; or
- falling from a tree stand.

Self-inflicted injuries are typically caused by improperly handling a loaded firearm. Almost 34 percent of all hunting accidents are self-inflicted.

Based on data from the United States National Safety Council, hunting ranks very low for the number of injuries requiring hospital emergency room treatment per 100,000 participants when compared to several other recreations[10] (Table 18). Furthermore the mortality rate for hunters involved in a hunting-related accident is very low (Table 19) relative to all other types of accidents and outdoor recreational activities (Table 20). For example, activities such as bowling, golf, and fishing have higher injury rates than in hunting. Statistics indicate that only 1 non-hunting person in 100 million could die from a hunting-related accident. On average, a hunter injures only 1 non-hunter for every 12 million recreation days of hunting. Essentially, a non-hunter has a higher probability of dying from a lightning strike (40 times more likely) or an insect bite (20 times more likely) than from a hunting related incident (Table 19). Hunting has become a very safe sport relative to other common outdoor activities. The probability of being killed or injured in a hunting accident is lower than many other activities, including those within the home. Compared to other activities, hunting has one of the lowest accident rates per 100,000 people. Firearms are involved in approximately 0.8 percent of all accidental fatalities in the United States.

[9] Information provided by the MDFW

[10] The National Safety Council stopped recording accidents by activity after 2001; therefore, this data is the most current available. Fatality data from the 1990s is also the most current available.

Table 18. Annual Rates of Recreation-Related Injuries Requiring Hospital Emergency Room Treatment in the United States[1]

Recreation	Injuries per 100,000 participants
Football	2,369.2
Basketball	2,326.2
Wrestling	1,536.9
Bicycle Riding	1,400.6
Soccer	1,262.4
Baseball	1,167.4
Skateboarding	1,088.0
Softball	963.4
Ice Hockey	766.1
Boxing	676.8
Volleyball	482.7
Horseback Riding[2]	464.6
Martial Arts	461.9
Roller Skating	441.1
Weight Lifting	352.2
Ice Skating[2]	334.9
Snowmobiling	333.3
Swimming	319.0
Racquetball	130.4
Mountain Climbing	256.6
Tennis	228.3
Fishing	178.8
Golf	173.3
Archery	86.0
Bowling	56.9
Hunting	4.2

[1] U.S. National Safety Council Data 2001
[2] U.S. National Safety Council Data 1991

Table 19. Annual Rates of Accidental Deaths in the United States[1]

Accident Cause	Mortality Rate per 100,000 People
Automobiles	18.6
Home Accidents	8.6
Falls	5.0
Poisoning	2.6
Fires	1.7
Suffocation	1.3
Hunting Among Participants	0.85
Lightning	0.04
Insect Stings	0.02
Hunting Among Non-participants	0.001

[1] U.S. National Safety Council Data 1991

Table 20. Fatalities Resulting from Various Outdoors Type Activities during 1995[1]

Outdoor Activity	Deaths
Swimming	1,700
Boating	836
SCUBA Diving	97
Hunting	87
Personal Watercraft	79
Hang Gliding	28
Sky Diving	28
Football	4

[1] National Safety Council 1995

***Hunting Related Injuries in Other States*:** Based on statistics from the State of Georgia, there has been an average of 73 hunting accidents and an average of 8 fatalities each year since 1979. Tree stand and self-inflicted accidents account for 72 percent, and shooter/victim accidents account for 28 percent of the total accidents. None of these accidents have involved a person not participating in the hunting activity. Furthermore, statistics from Georgia indicate that only 4 percent of hunters are cited for some type of hunting related violation. The top five violations were hunting without wearing hunter orange, hunting big game over bait, hunting without permission from landowners, possession of illegally taken wildlife, and hunting without a license.

In North Carolina, hunting firearm related injuries were categorized based on the distance of the gun muzzle to the victim (North Carolina Wildlife Resources Commission Division of Enforcement 2003). In 12 of the 26 non-fatal accidents, the distance from the shooter to the victim was 0 to 30 feet (46%) and in 7 instances it was 33 to 150 feet (27%). Together, these close range accidents accounted for 19 of the 26 (73%) accidents; therefore, the vast majority of hunting accidents occur at close range. Accidents with a shooting distance of 153 feet or more accounted for 6 incidents (23%).

In Texas, most hunting accidents between 1996 and 2002 occurred at close range with most injuries resulting from shots within 30 feet. Some accidents occurred from 30 to 150 feet, and very few occurred over 150 feet.

***Hunting Related Injuries Based on Shotgun Ballistics[11]*:** The following provides a brief synopsis of shotgun ballistics and injury potential, illustrating that potential non-hunter victims would have to be very close to a hunter and take a direct shot without any obstruction in between for a fatality to occur. Much of the hunting on CACO is for small game such as pheasants, rabbits, and waterfowl, typically using either 12, 16, or 20 gauge shotguns. Shotgun loads for these types of hunting would be either medium (#6 and #7) or small (#8 or #9), both of which have a shorter trajectory and a lower potential for injury to non-participants. In addition, deer hunting loads, including buckshot and slugs, carry only very modest trajectories. Furthermore, required safety distances, those distances from dwellings, paved roads, and bike trails that hunters cannot hunt within, generally prevents hunters from getting close enough to non-hunters, thus preventing possible severe injuries. The distance from the shooter to the victim for a potential injury decreases with smaller (i.e., 20 gauge) shotgun gauges, shot sizes, diameter of the choke, skill of the hunter, and obstructions (line-of-sight). For example, waterfowl hunters generally use 12 gauge shotguns with heavier loads of number 2 and 4 shot, but the trajectory is pointed up, the line-of-sight open, and generally away for human activities, hence unlikely to create injury to non-hunters. The trajectory of shots aimed at squirrels and pheasants are generally pointed up, so the further away a non-

[11] Information contained in this section is based on numerous sources and general information on firearms.

hunter is the less chance of an injury. The severity of potential injuries decreases as the distance increases between the shooter and potential victim and of course considering the variable listed above. The following excerpts illustrate this fact:

> "Damage suffered from a hunting related injury from a 12-guage, birdshot shotgun wound, would largely depend on how far away the victim was from the shooter. If a potential victim was 50 or more feet away, the shot would likely embed in his skin and muscles. If he were 100 feet away or more, the shot would likely only enter the skin. In these situations, the shot would be removed in the operating room or perhaps the emergency room. He would likely be admitted to the hospital for a couple of days, given antibiotics, then would rest at home for a few days and be none the worse for wear. If the shot were from close range, well less than 50-feet, and directed at his arm or shoulder, it could severely damage the arm or shoulder joint and possibly the blood vessels in that area. Damage could also occur to the heart or lungs. This injury might require orthopedic or vascular surgery and a prolonged recovery period and physical therapy." http://www.dplylemd.com The Writer's Medical and Forensic Lab. Copyright D. P. Lyle, MD 2001).

The following discussion focuses on the number of buckshot pellets (the shot used for deer hunting) that could hit a human under "testing" conditions, not actual field conditions. A 12 gauge shotgun (the gauge used for deer hunting), fired with a load of #4, #1, or #00 buckshot could provide several marginal hits on a full length human target out to about 75 yards when directed by good set of sights and no obstructions. For example, considering the type of shot used in deer hunting, #00/9 pellet (the number of pellets per shotgun shell), buckshot has 3 hits (the number of pellets that hit the target) at 50 yards and 1 hit at 75 yards. Considering a smaller buckshot load, #00/12 pellet buckshot has 4 hits at 50 yards and 2 hits at 75 yards. A smaller load, #000/8 pellet buckshot, has 1 hit at 50 yards and 0 hits at 75 yards. Generally the energy level of these larger loads diminishes significantly between 75 and 100 yards and has a lowered penetration value. In addition, the number of hits would be reduced if obstructions were between the shooter and other individual.

Shotgun slugs are effective against deer sized game out to 75 to 100 yards. Penetration and effectiveness drop off drastically beyond 125 yards due to velocity loss and soft lead construction. The effectiveness is reduced by obstructions such as trees.

***Hunting Related Injuries in Dogs*:** Although there have been no reports of hunting related injuries to dogs, there is some potential for risk. The following provides a discussion of circumstances where a canine could be injured or killed in a hunting-related situation. Many hunters use dogs for hunting pheasants, waterfowl, and rabbits; therefore, there is some potential for injuries to hunting dogs. For dogs that are pets of non-hunting visitors, CACO rules require that the dogs be leashed limiting the potential for an accident. In general, the most serious shotgun wounds to a dog would be the ones occurring at close range because that is where the pellet energy will be the highest. In addition, at close range more pellets will affect a given area and cause more tissue destruction. Close range shots to the chest, skull, abdomen, or other vital area are obviously the most serious. Close range shots to the thick skin and muscles of the neck are far less serious. If a dog is not shot at close range, the injury will probably be minor. In general most shotgun pellets penetrate only the skin and immediate subcutaneous tissues (Shotgun Injuries in the Hunting Dog at www.ThePetCenter.com).

Summary of Safety Statistics and Ballistics: Generally, the likelihood of a fatality to a non-hunter is extremely low based both on the statistical data and the range of shotgun ammunition. The mortality rate for non-hunters is substantially less than for lightning strikes and insect stings. The effectiveness of small game shot to inflict serious injury or mortality is generally less than 100 feet. Minor injuries can occur

from 100 to 150 feet and possibly longer distances. The effectiveness of buckshot and shotgun slugs is somewhat higher up to 300 feet with a direct shot. These effectiveness distances can be greatly reduced given the presence of obstructions and the trajectory of the shot.

Setback distances of 500 feet from dwellings and 150 feet from bike trails, with the requirement that the hunter is shooting away from the bike trail, should be very effective for protecting non-hunters. Expanding the setback for bike trails to 500 feet would increase the margin of safety.

3.6 Vegetation Resources

3.6.1 Plant Communities and Succession

Cape Cod is one of the first areas colonized by Europeans in North America and has one of the longest histories of alteration. Early English colonists described Wood End, near present-day Provincetown, as "all wooded with oaks, pines, sassafras, juniper, birch, holly, vines, some ash, walnut" (Frederick 1858). They also found woodland tracts, freshwater ponds and streams, salt marshes, and areas of fertile soils.

Upland Scrub Oak, Oak and Pitch Pine, and Pitch Pine Habitat (from left to right).

As the population grew, forest was cleared for farming, and large numbers of cattle and sheep ranged the open pastures. Cedar and maple swamps were transformed into cranberry bogs. By the mid-19th century, 30 percent of the county was used for agriculture, and farming reached its peak. These changes were not without environmental costs. By the time Thoreau visited Cape Cod in the 1850s, many resources had been depleted, and he wrote the following:

> "The old houses are built of the timber of the Cape; but instead of the forests in the midst of which they originally stood, barren heaths, with poverty grass for heather now stretch away on every side.[12]"

Wood End, where the Pilgrims stood, no longer supports forest cover. Old stumps and soil outcrops in the sand plains and dunes around Provincetown indicate how much more extensive the forests once were. Throughout the early 20th century human activities such as livestock grazing, agriculture, and accidental fires, continued to suppress tree growth. However, late in the century these activities were substantially decreased. Grazing and other forms of agriculture are no longer practiced on the Outer Cape, and natural and human-caused fires have been suppressed. These changes have resulted in an increased tree cover; pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*) have prospered, and the amount of heathland has decreased (Carlson *et al.* 1992).

[12] Thoreau, H.D. 1988 [1865]. *Cape Cod.* Joseph J. Moldenhauer, ed. Princeton Univ. Press, Princeton, NJ.

At least 800 species of plants occur within CACO in a wide variety of community types, including heathlands, freshwater and saltwater wetlands, upland forests, beaches, dunes, and grasslands. A 1991 vegetation study revealed 24 vegetation cover types within CACO (NPS 1991). This information is being updated through an ongoing mapping project, using aerial photography taken during 2000. Figure 5 provides the locations of these mapped vegetative communities and habitat, based on this ongoing mapping effort. These cover types and approximate acreages are shown in Table 21.

Tidal stream, low shrub, and herbaceous vegetation.

The vegetation in CACO is constantly changing in response to both natural and human-induced factors (including storms, sea level rise, fire, and human use). Recognizing changes in species composition and vegetation structure, and determining what factors contribute to these changes, are essential for effective management.

CACO staff initiated a revegetation program in 1985 to stabilize more than 900 acres of barren dunes in the Province Lands. To date, 110 acres of dunes have been planted with beach grass. This work was based on the assumption that human disturbance (such as deforestation and livestock grazing) had initiated dune migration (Leatherman *et al.* 1981). More recent information indicates that the Little Ice Age, with its correspondingly cooler temperatures and drier winds, may have contributed more to dune migration than human disturbance (Winkler 1990).

See 3.0 Affected Environment – Figure 5 (6 pages)

Table 21. Vegetative Community Cover Types for CACO

Cover Type	Description	Acreage	Notes
Forest	Generally a mix of mature pitch pine and mixed aged oaks	2,897	Primary habitat for deer and squirrels. Some rabbits, quail, and stocked pheasants may be found in these areas.
Woodland	A mix of various sized hardwoods and pines with no species dominance	12,931	Primary habitat for deer and squirrels. Some rabbits, quail, and stocked pheasants may be found in these areas.
Shrub	Along the leeward side of the dunes	3,456	Habitat for rabbits, stocked pheasants, and quail.
Dwarf Shrub	Along the leeward side of the dunes	364	Habitat for rabbits, stocked pheasants, and quail.
Grassland	Various annual and perennial grasses	46	Habitat for rabbits, stocked pheasants, and quail.
Open Dunes	Adjacent to the beaches	3,693	Very limited hunting opportunities here.
Beach	Natural beaches on the Atlantic and Bay sides	1,967	Very limited hunting opportunities here.
Wetland	Salt marshes	4,348	Large expansive emergent areas, generally open to waterfowl hunting.
Water	Freshwater ponds and lakes	1,035	Many of these areas are too close to buildings and are probably not hunted.
Developed	Residential, municipal, and commercial	7,999	Closed to hunting.
Disturbed	Human impacted areas	410	May provide some habitat for generalist species.

Heathland communities support a wide diversity of plants and animals, including many endemic species that are becoming increasingly rare. Protected heathlands are very rare in North America and uncommon globally. Approximately 670 acres of heathlands are found in 9 major areas in CACO. Some of these heathlands are becoming forested because of natural succession (tree growth). An ecological survey of heathlands (which includes management recommendations) was completed in 1992 (Carlson *et al.* 1992).

3.6.2 Plant Species That Are Endangered, Threatened, or of Special Concern

Between 1984 and 1987, the distribution of rare plants in CACO was mapped. Of all habitats surveyed, pond shores support the most threatened and rare plant species in CACO (NPS 1989). Massachusetts has listed 20 plant species within CACO that have been classified as threatened, endangered, or of special concern (Griffin 2006). Of these, four species have been recorded historically but have not been confirmed in recent years. There are no federally listed plant species known to occur in CACO.

3.6.3 Non-native Plant Species

Non-native species of plants have been introduced to CACO ecosystem and potentially compete with and displace native species. Data on the distribution, abundance, and impacts of non-native species on native biota and physical processes are currently limited to specific areas, including pond shores, salt marshes, and areas around some CACO facilities.

3.7 Cultural Resources – Cultural Heritage

Maintaining the cultural heritage of the Outer Cape Cod is an important aspect of the CACO mission statement,

> "CACO was established to preserve vital elements of the Cape's character, including flora and fauna, physiographic conditions, historic sites and structures, cultural heritage, and other unique natural and cultural features. This character also includes a certain ambience that is subtler and harder to define, but that provides both a sense of peace and relative isolation. A distinctive pattern of human activity has both shaped, and been shaped by, this special place. Management of the Seashore is a delicate balance in which the human needs of today and tomorrow must be addressed within the context of both preservation and tradition."

CACO was created in part to help preserve and maintain cultural heritage. This heritage is about people whose ways of life are traditionally associated with sites, structures, other material features, and natural resources in CACO. Several Cape Cod cultural communities have been identified as having traditional associations with the resources here, including Native Americans, Portuguese and Portuguese Americans, Cape Verdeans, and contemporary neighbors.

Cape Cod families who have hunted within CACO for generations could also be considered cultural heritage resources, as could the places they hunt and the game they have traditionally hunted. Numerous hunting families who have hunted for generations for the same game in the same areas of CACO were identified in the public meetings and through other forums. The vibrancy of traditional uses and ways of life on the Outer Cape is represented by these people. At one meeting, three generations of hunters from the same family were present. Preserving this cultural heritage should be compelling. The GMP calls for encouragement of customary activities and for collaboration with local entities to preserve and conserve the intangible elements of their cultural heritage, such as arts, skills, folk life, and folkways.

3.8 Public Use of CACO

3.8.1 Access

U.S. Route 6 is the primary access route for CACO. Roads and trails provide public access to CACO resources, and the access largely determines the range of public activities and experiences. There is increasing demand for access to ocean beaches, kettle ponds, historic sites, and other public use attractions, all with limited on-site parking. CACO managers must protect sensitive resources while providing an appropriate level of access to a variety of settings.

Access to some environmentally sensitive areas such as shoreline cliffs, kettle ponds, and dunes is often limited in order to protect these resources or out of concern for public safety. The presence of town-owned and privately owned property within CACO also leads to some access restrictions. Sand roads are a traditional means of access that link many features in CACO, yet ownership and access rights along these corridors are often complex, and the mixture of ownerships can confuse visitors. In developed areas of CACO and in town commercial areas, access is limited by the capacity of local access roads and the availability of on-site parking.

As access and parking facilities are lost to coastal erosion, CACO and surrounding towns are exploring cooperative solutions to public access and transportation problems. CACO staff are working with local,

county, and state agencies to identify transportation alternatives, particularly for the peak summer months, and are contributing to the Cape Cod Commission's *Long Range Transportation Plan.*

3.8.2 Facilities and Services

***Available Facilities*:** CACO provides a variety of facilities to support public use. Most facilities were built by the NPS or inherited from the state during the first decade after CACO was established. All the original facilities built in the 1960s are still in service. The towns own most of the Orleans and Chatham areas of CACO, and most management of these areas has been almost totally assumed by these towns. Except for the developed Nauset Town Beach, public facilities and services are lacking in the southern part of CACO.

Public facilities managed by CACO consist of six ocean beaches with bathhouses, two visitor centers, headquarters, and two environmental education centers. Smaller developments include 3 picnic areas with comfort stations, more than 10 historic sites and buildings, 8 interpretive trails, 3 bike trails, and 3 interpretive shelters. Most roads in CACO are owned and maintained by towns. Federally owned roads maintained by CACO include Doane Road and Cable Road in Eastham, Marconi Area roads in Wellfleet, and Race Point and Province Lands roads in Provincetown. Ownership of the sand (i.e., unsurfaced) roads is a mixture of municipal, federal, and private entities. CACO operates and maintains the following public use facilities:

Roads, trails, and parking - 25 pedestrian trails (24.5 miles), 3 bicycle trails (10.8 miles), 39 roads (22.5 miles), 3 horse trails (10.7 miles), 23 parking lots (2,600 spaces at beaches, 450 at visitor centers, 310 at picnic areas and trailheads, 73 at historic sites), 60 fire roads (35 miles), and 1 auto bridge.

Buildings and developed areas - 12 comfort stations/showers, 2 visitor centers with amphitheaters, 4 major picnic areas, 2 environmental education centers, 1 oversand station, 1 golf clubhouse and golf course, 1 snack bar, and 10 historic structures with public access.

***Capacity of Facilities*:** Nearly all public use opportunities within CACO are easily accessible. Parking lots are close to attractions, and most hikes are short and easy. Most visitors recreate together at the developed sites regardless of their level of ability, available time, or desire for challenge. In the summer, destinations are often crowded and sometimes suffer from overuse. Visitation meets or exceeds capacity at existing public use facilities at times, particularly at parking lots at certain beaches, visitor centers, trails, and scenic viewing areas.

The daily capacity of CACO was projected in the 1970 *Master Plan* as 48,000 people. This number was based on the maximum use of existing and proposed parking spaces at all locally, federally, or privately owned facilities within the boundaries of CACO. In 1995, the NPS managed more than 20 public use facilities, including onsite parking for approximately 3,400 vehicles. Towns and private operators provided recreation facilities with more than 5,000 additional onsite vehicle parking spaces. Use levels and access throughout CACO have been managed by the capacity and convenience of connecting roads and the size of onsite parking lots. There has been little coordinated federal, state, and local policy in regard to use levels. Visitors' perceptions of crowding or overuse indicate that they are willing to tolerate many other people at individual sites as long as they do not have to search for parking.

***Facility Use Survey*:** A 1994 study (Manning 1994) indicated that the most heavily used facilities and services in and around CACO are restrooms, restaurants, parking areas, self-guided nature trails, bookstores, and orientation films at visitor centers. The Audubon Sanctuary, gift and antique shops, roadside exhibits, and hotels, motels, and inns outside CACO are also heavily used. Visitor and resident

satisfaction with facilities and services was quite high, according to the survey. However, visitors expressed some dissatisfaction with CACO restrooms, parking (in general), Herring Cove Snack Bar, and facilities at Spectacle Pond. The most frequently mentioned public concerns were the presence of litter, the number of people, traffic, noise, and the adequacy and cleanliness of facilities (Manning 1994).

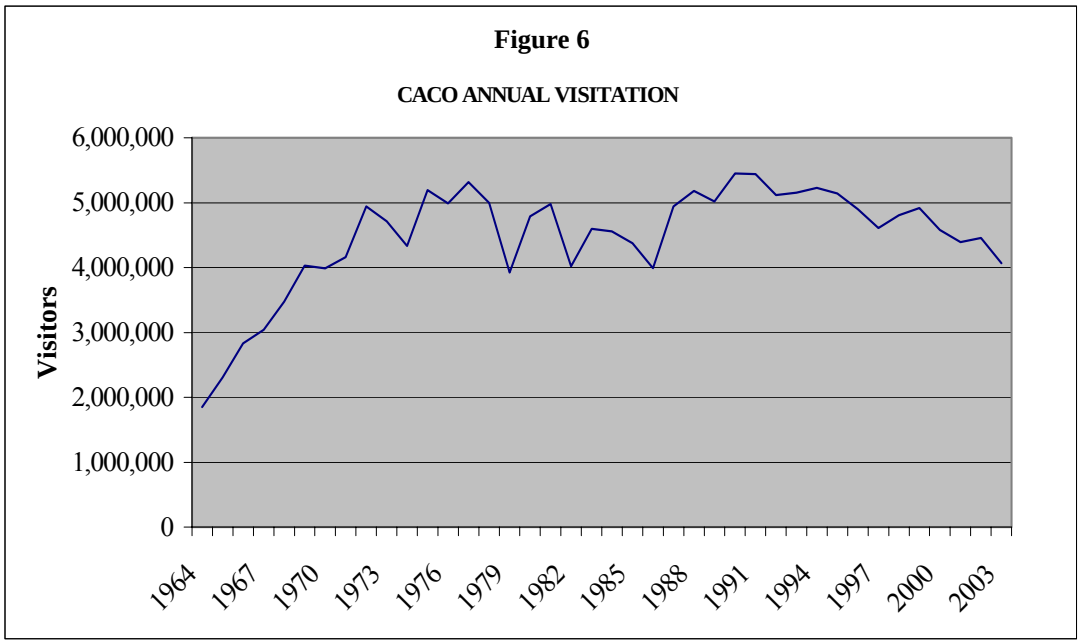
3.8.3 Profile of Visitation and Visitors

***Overview of Visitation*:** Two studies were completed with the purpose of documenting visitor profiles and uses of CACO. The first was conducted in 1992 by Manning (1994) and primarily focused on visitor profiles and uses. More recently during a study by Kuentzel (2006) CACO visitors were contacted during 2004 and a follow-up questionnaire was provided during 2005. This study covered the same general purpose, but also provided more detailed data on attitudes towards hunting and potential conflicts between hunters and other visitors.

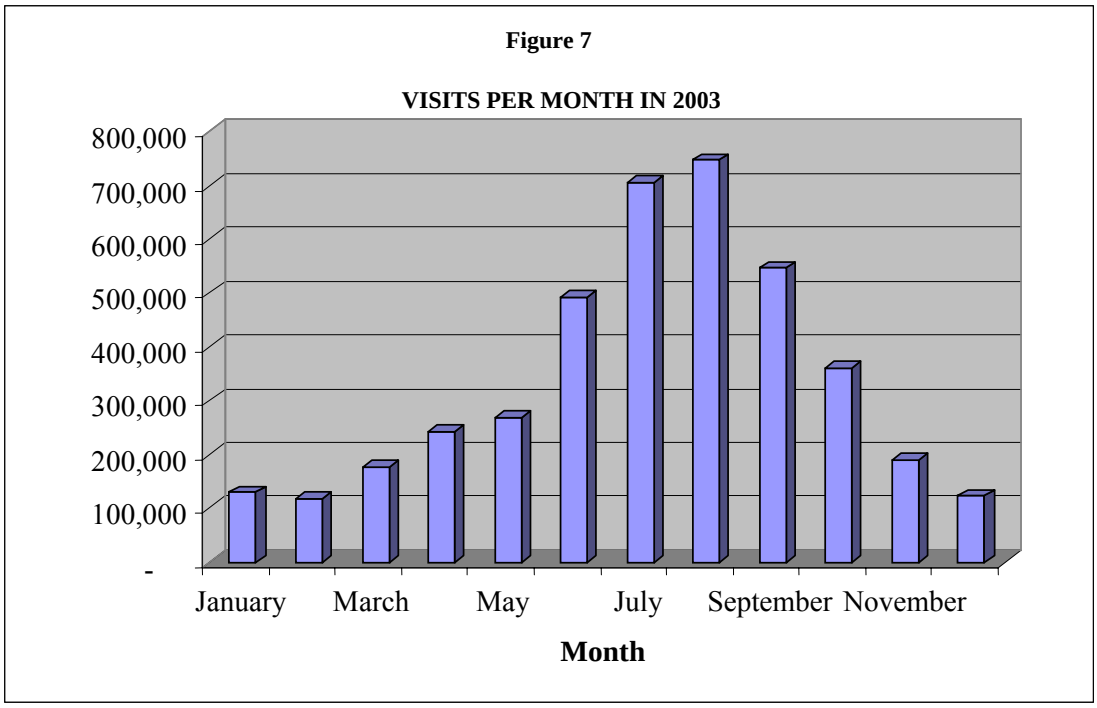
In 2003, tourists made about 4.1 million visits to CACO, ranking it as the 11th most visited area in the National Park System.[13] The promotion of Cape Cod as a resort and tourist destination began almost a century ago, and it was firmly established in 1961 when CACO was authorized. In 1964, 1.8 million visits were counted, and by 1969 that visitation had more than doubled to over 4 million. Visitation reached over 5 million in the 1970s, and it has generally fluctuated between 4 million and 5 million in the years since (Figure 6).

In the most recent decade, visitation has decreased from a high of 5.3 million in 1994 to roughly 4 million in 2003 (Figure 6). The reasons for this decrease are not entirely clear. It may be part of the natural variation experienced since CACO was established. Changes in the Cape Cod region may also be a contributing factor. Most notably, the more than doubling of year-round and seasonal residents has had a dramatic effect, contributing to traffic congestion, site-specific use pressures, and resource degradation. Many visitors have said that they visit less frequently or in alternate seasons as a result of the increased traffic and congestion.

[13] These statistics include repeat visits and visits by one person to more than one area of CACO on a single day.



The majority of visits to CACO occur in the summer months. As demonstrated in Figure 7, nearly two-thirds of all visits in 2003 occurred from June through September. However, visitation in the "shoulder" months of early spring and late fall has grown, partly as a result of marketing and promotional efforts made by planners and businesses owners. A great deal of this growth may also be attributed to the dramatic increase in the number of vacation homes that are owned by visitors (approximately 7% in 1992 to about 34% in 2005).



The park is used mainly during the day; however, evening programs have been popular, and requests often exceed the programs available. Frequent visitors generally have a consistent pattern of use, usually engaging in particular activities at favorite sites in CACO during the day and leaving in the afternoon or evening to seek overnight accommodations in the local and regional area. The most popular destinations in the Outer Cape Cod region are beaches managed by the NPS, visitor centers, headquarters, the Marconi Station site, lighthouses, Nauset Beach, Fort Hill and trails, and the Atlantic white cedar swamp. According to the survey, most visitors do not consider CACO their primary destination on Cape Cod. Of summer visitors surveyed in 1992, approximately 18 percent indicated that CACO in particular was the primary reason for the trip to Cape Cod; this compares with approximately 16 percent of fall visitors, 22 percent of winter visitors, and 13 percent of spring visitors (Manning 1994).

***Profile of Park Users*:** A survey of visitors and local residents conducted in 2004 indicated that most CACO visitors (76.4%) come from the northeastern United States (New England states, New York, and Pennsylvania) although a total of 46 states were represented (Kuentzel 2006). Over one-third of the visitors were from Massachusetts. The mean size of groups visiting CACO is three (2.67 in 2004) in the summer, two in the fall (1.98), and two in the winter and spring. In general, visitors tend to be frequent, repeat visitors, and more than 85 percent of Cape Cod residents reported frequent visits to CACO.

CACO visitors often were families with children. In 2004, 37 percent of the people questioned had children with them during the summer, but only 7.8 percent during the fall. Consistent with the characteristics of Cape Cod residents, CACO visitors are typically in their mid-forties during 1992 and the average was 55 during 2004. The average age of fall visitors was 49 in 1992 and 55 in 2004, showing a dramatic increase. The number of visitors having college degrees increased from 1992 to 2004, going from 75 to 81 percent during the summer and 60 percent to 73 percent in the fall. Many visitors reported annual household incomes of $50,000 or greater. The percentage of visitors from 1992 to 2004 that were retirees also increased, going from 9 to 12 percent during the summer and 21 to 31 percent during the fall. The majority of visitors, 93 percent in summer and 100 percent in winter, travel to CACO by car, truck, or motorcycle. A small percentage of visitors travel by recreational vehicle, boat, or plane during the summer.

In the summer season, many visitors stay in rented homes, while spring and fall visitors primarily stay in hotels or motels. Winter visitors stay in their own privately-owned houses, as found during 1992. A total of 7 percent of CACO visitors stayed in their own vacation homes during 1992. In 2004, 36 percent of the summer visitors stayed in their own vacation homes. This increase was related to a decline in the proportion of people who stay in hotels and the proportion of people who rent houses/cabins at the Cape.

Expenditures by CACO visitors totaled $333 million in 1992, approximately half of which was spent in the summer season. The greatest percentage of these expenditures was for lodging, followed by food and beverages and retail shopping. During their visits, more than half of summer, spring, and fall visitors patronized Cape Cod restaurants, and approximately one-third of these visitors shopped area gift and antique stores.

***Recreational Uses*:** The vast majority of CACO visitors (over 99%) use CACO for recreational purposes (with the remainder including uses such as research). NPS provides and maintains a wide variety of recreational resources for Park users, including hiking and cycling trails, educational presentations and exhibits, ranger-guided nature walks, picnic and camping areas, and access for boating and fishing in designated areas. According to the Manning (1994) CACO user survey, the principle activities taking place in CACO were viewing scenery, sunbathing, swimming, beachcombing, hiking, and taking scenic drives. The level of participation in these activities was dependent upon the season (Manning 1994).

Summer visitation, roughly from Memorial Day to Labor Day, consists of regional, national, and occasionally international visitors. These visitors are attracted by outdoor activities, principally swimming, sunbathing, and beachcombing. Other outdoor activities such as nature study, photography, picnicking, and camping (at private or state campgrounds) are also quite popular. More than half of all visitors participate in some road- and trail-related activities, including driving on scenic roads, hiking, and bicycling. More than a third of the summer visitors take advantage of educational displays, ranger-guided programs, and other services offered through the visitor centers. These centers receive about half of their annual visitation during this 10-week period. The wider configuration of the Outer Beach and the presence of sport fish make summer the peak season for surf fishing and off-road vehicle (ORV) beach driving.

Winter visitation (November through March) consists primarily of local and regional visitors. Despite frequently harsh weather, winter visitors continue to be attracted to the beaches to walk, beachcomb, and watch nor'easter storms. Most visitors favor scenic driving and hiking, but when the weather permits, cross-country skiing and bicycling are also popular. Off-season visitors take advantage of exhibits and services at the visitor centers and historic structures, although these facilities often are closed or run at reduced schedules.

Tables 22 and 23 highlight the relative importance of recreational activities occurring within CACO, during 1992 (Manning 1994) and 2004 (Kuentzel 2006), respectively. As noted, swimming, sunbathing, beachcombing, driving, and hiking are major attractions. Somewhat less popular activities include bicycling, viewing visitor center exhibits, picnicking, nature study, photography, and visiting historic sites. Activities such as freshwater fishing, shellfishing, horseback riding, ORV driving, surfing, SCUBA diving, boating, windsurfing, ranger-guided activities, hunting, and cross-country skiing were less popular among survey respondents, with fewer than 10 percent of surveyed visitors participating in any given season. Hunting was among the least common activities occurring within CACO, with less than one percent of visitors engaging in the activity in each season.

In general, residents of Cape Cod engage in similar recreational activities to those of out-of-town visitors. The most common activities among residents are viewing scenery, swimming, scenic drives, beachcombing, and sunbathing. The least common activities of residents are SCUBA diving, tour bus rides, cross-country skiing, and hunting. It is noteworthy, however, that approximately 3.8 percent of surveyed residents hunt within CACO, a figure that is significantly higher than for visitors in general. Shoulder seasons (April – May and September – October) are the most popular periods for many local and regional visitors because of the combination of moderate weather and smaller crowds.

Table 22. Relative Levels of Participation in Recreational Activities at CACO (1992)

Activity	Seasonal Level of Participation			
	Summer	Fall	Winter	Spring
Ocean swimming	60.9%	15.5%	11.5%	15.6%
Pond swimming	15.1%	2.8%	1.0%	4.5%
Sunbathing	64.2%	13.6%	22.1%	32.6%
Beachcombing	54.6%	50.0%	54.8%	62.6%
Saltwater fishing	11.6%	8.9%	7.7%	6.8%
Freshwater fishing	1.9%	1.9%	1.0%	2.3%
Shellfishing	4.7%	3.8%	1.9%	2.3%
Hiking	46.4%	50.6%	49.0%	48.7%
Cycling	31.5%	22.5%	14.4%	25.5%
Scenic drives	53.9%	62.0%	53.8%	60.9%
Horseback riding	0.6%	0.9%	2.9%	1.7%
Off-road vehicle use	7.1%	4.4%	1.0%	2.5%
Surfing	2.9%	1.6%	3.8%	1.7%
SCUBA diving	1.3%	0.3%	1.0%	0.0%
Boating	9.3%	4.7%	5.8%	4.0%
Windsurfing	1.8%	0.3%	1.0%	1.4%
Viewing scenery	71.5%	78.5%	76.9%	80.5%
Camping	11.3%	5.1%	3.8%	7.4%
Picnicking	31.1%	21.8%	15.4%	27.5%
Nature study	25.3%	24.1%	28.8%	28.2%
Photography	29.1%	35.8%	32.7%	31.2%
Ranger-guided activities	8.3%	6.0%	7.7%	6.5%
Visiting historic sites	29.5%	32.3%	17.3%	28.6%
Tour bus rides	0.9%	0.3%	0.0%	0.0%
Cross-country skiing	0.6%	0.3%	0.0%	1.1%
Hunting	0.4%	0.9%	0.0%	0.6%
Viewing visitor center exhibits	39.1%	48.1%	40.4%	45.3%
Other	8.5%	6.3%	2.9%	8.5%

Source: Manning 1994.

Table 23. Relative Levels of Participation in Recreational Activities at CACO (2004)

Activity	Summer Visitors	Fall Visitors
Ocean swimming	86.2%	50.9%
Pond swimming	29.1%	10.1%
Sunbathing	80.2%	51.5%
Beachcombing	67.6%	66.1%
Saltwater fishing	21.3%	18.5%
Freshwater fishing	04.2%	2.2%
Shellfishing	5.7%	4.5%
Hiking	50.2%	52.9%
Cycling	52.6%	35.1%
Scenic drives	64.0%	72.0%
Horseback riding	1.5%	1.6%
Off-road vehicle use	11.1%	11.2%
Surfing	6.6%	3.6%
SCUBA diving	0.3%	0.8%
Boating	20.7%	14.6%
Windsurfing	0.9%	0.8%
Viewing scenery	75.1%	84.4%
Camping	15.3%	9.5%
Picnicking	47.1%	35.3%
Nature study	26.7%	31.6%
Photography	44.7%	46.9%
Ranger-guided activities	10.5%	10.1%
Visiting historic sites	29.1%	39.3%
Tour bus rides	0.9%	2.0%
Hunting	0.3%	0.4%
Cross-country skiing	0.3%	1.0%
Viewing visitor center exhibits	40.8%	50.9%
Other	8.1%	7.7%

Source Kuentzel 2006

***Quality of Recreational Experience*:** In the Manning (1994) user survey, greater than 95 percent of CACO users rated their experience at CACO as "good" or "excellent." Visitors expressed general levels of satisfaction with the management of particular recreational activities within CACO. Participants communicated high levels of satisfaction with beach experiences, self- and ranger-guided trail walks, and boating, fishing, and cycling. They expressed a nominal level of interest in increasing the number of hiking/walking and bicycle trails and providing more rustic camping opportunities for backpackers. The majority of visitors and residents said that CACO employees were friendly and helpful.

The public concerns mentioned most frequently in surveys were the presence of litter, the number of people, traffic, noise, and the adequacy and cleanliness of facilities. Most visitors and almost half of the residents surveyed said that crowding at CACO was not a problem, and a majority did not support the idea of placing overall limits on the numbers of visitors at a given time.

The majority of surveyed CACO users, both visitors and residents, emphasized the importance of maintaining balanced management of the natural resource and public use dimensions of CACO and valued preservation of natural resources over public use of the area.

***Regulations and Safety*:** All public use activities at CACO are managed to preserve and protect resources, promote public safety and enjoyment, and minimize conflicts between users and others. All activities are subject to the regulations found in the CFR on Parks, forests, and public property, as well as various titles of the *United States Code*.

While there have been no hunting related injuries, some individuals do not visit CACO during the fall and winter based on concerns related to safety. Some individuals (31.9%) report avoiding areas where hunters are present or on days when hunting occurs, but there is no evidence that areas where hunting is prohibited are also avoided due to hunting taking place elsewhere in CACO.

Examples of regulations that apply to all visitors.

DLW In addition to nationwide regulations, special regulations have been added for CACO. These regulations pertain to activities that require special rules or codes to protect public safety or resources or to control ORV use (routes, access periods, equipment, permits), camping (limited to self-contained ORVs on beaches), aircraft use (permitted landing area), motor boating (permitted areas), shellfishing (town regulation), and hunting (based on state regulations). Public nude sunbathing at CACO is prohibited by regulation.

The CACO superintendent has discretionary authority to impose additional regulations regarding designations, closures, and limits of certain permitted activities, including hours of operation, campfires, fee collection, pets, hunting and fishing, surfing, personal watercraft use, horseback riding, skating, smoking, consumption of alcoholic beverages, public assembly, special events, speed limits, and bicycle use.

Some customary activities like hunting and fishing predate the establishment of CACO and are identified in its enabling legislation. Those activities are allowed under the discretionary authority of the superintendent.

CACO maintains cooperative agreements with local police and fire departments. These agreements are critical to managing public uses and protecting resources. In 1995, CACO protection rangers recorded 734 incident reports, 376 courtesy tags (warnings), and 983 violation notices issued. The largest number of offenses was for traffic violations, vandalism, natural resource violations (poaching, dumping, etc.), theft, burglary, nudity, drug possession, and drunk and disorderly conduct. There were 170 emergency incidents in 1995, which mostly involved lost children; swimming-related incidents; and bicycle, boating, and motor vehicle accidents. Rangers typically arrest 10 to 15 people annually; usually they are drug, alcohol, or assault cases. There have not been any arrests related to hunting activity.

3.8.4 Hunting Activity

Section 7(c) of the legislation authorizing CACO (Public Law 87-126, August 7, 1961) authorizes the Secretary of the Interior, cooperatively with the Commonwealth of Massachusetts, to permit and regulate hunting and fishing within CACO. Hunting is currently allowed on approximately 37,641 acres of Federal land within CACO. Table 2 reviews the hunting seasons and additional CACO-specific regulations.

To assess effects of the management alternatives, it is important to examine the level of hunting activity at CACO. The recently completed CACO Hunting Survey (Kuentzel 2006) provides key information. This survey, conducted in 2004 and 2005, presented hunters with questions concerning their hunting habits, preference for hunting at CACO versus substitute locations, and other considerations. The survey was administered to three separate respondent groups: (1) hunters intercepted at CACO; (2) a random sample of licensed hunters in Barnstable County; and (3) a set of self-selected hunters from Outer Cape hunting organizations. Kuentzel (2006) provided a current assessment of visitor characteristics and use of CACO.

Survey responses from hunters using CACO suggest the following characteristics:

- Hunters using CACO most commonly target deer, waterfowl, pheasant, and rabbit. Over 70 percent of hunters intercepted at CACO listed deer as their preferred species.
- Based on the survey of hunters in the field, the most heavily hunted areas of CACO include the Marconi WMA and the Collins Road/kettle pond area. However, hunting occurs in many areas of CACO (Figure 2).
- In general, CACO is used by a limited set of local hunters who hunt extensively. Hunters intercepted at CACO indicated that they hunt at CACO 32 days out of the year on average. This exceeds the average hunting days for Massachusetts hunters (17.5 days per year) by a large margin (USFWS 2001). Inspection of license plates in parking areas suggests that CACO hunters are Massachusetts residents, primarily from Cape Cod (NPS 2003 and 2004a).

To develop a bounded estimate of baseline hunting activity, the following analysis incorporates data from the recent CACO Hunting Survey (Kuentzel 2006). The survey indicates 43 percent of licensed Barnstable County hunters have hunted at CACO in the past 12 months. Approximately 84.4 percent of the Barnstable hunters had hunted at CACO at some time in the past. Of those, 68.6 percent (or 57.9% of all people in the license sample) said they hunted "most" years or "every" year. This figure can be multiplied by the total number of licensed Barnstable County hunters to derive a rough estimate of the total number of hunters using CACO each year.[14] Next, the analysis considers the average number of days that each individual hunts. Survey responses from licensed hunters indicate that those who use CACO regularly hunt there an average of 20.1 days per year. Hence, the estimated total CACO hunting days is 25,151 days per year, cumulatively (Table 24).

Table 24. Estimate of CACO Hunting Days as a Percent of Licensed Hunters

Number of Licensed Barnstable County Hunters	2,910
Percent of Licensed Hunters Who Use CACO	43.0%
Average Annual Number of Days Per Hunter	20.1
Estimated Hunting Days	25,151

Sources: CACO Hunting Survey (Kuentzel 2006).

[14] The Massachusetts Department of Fish and Game maintains hunting license data in paper form only and, therefore, was unable to provide specific data on the number of hunting licenses issued in Barnstable County. The figure used here (2,241) is derived by multiplying the Massachusetts hunting rate by the population of Barnstable County. Specifically 0.98 percent of Massachusetts residents hunt (USFWS 2002); multiplying by the county population (228,683) yields the estimate of 2,241 hunters in Barnstable County. Massachusetts has a very low hunting rate compared to other states; to the extent that Cape residents are more avid hunters than Massachusetts residents overall, the analysis may understate CACO hunting activity.

3.8.5 Use/Resource Conflicts and Attitudes Towards Hunting

The scoping process for this EIS revealed some tension between different interest groups involved in the issue of hunting at CACO. This tension divides hunters, whose views on hunting appear to be strongly held and rooted in values and personal history, from non-hunters, whose values may be reflected in their choice of other recreational activities. This issue is also stratified by traditional residents of Cape Cod and newcomers, who have taken up summer or year-round residence relatively recently.

This impact analysis does not attempt to present a comprehensive assessment of all the views either for or against hunting. The objective is to frame the positive and negative social effects that different groups would potentially experience under the various regulatory alternatives, and look for ways not to reconcile the different opinions, but to find opportunities to balance the uses and share the resources at CACO if possible, to meet the divergent interests in the Park while acknowledging the reality of those differing values and views.

The scoping process involved public outreach meetings with towns, animal rights advocates, and hunting organizations, as well as acceptance of letters (conventional and e-mail) from interested parties. Meeting notes and written correspondence help identify key affected groups, characterize their views on hunting in CACO, and understand how they would be affected by changes to the hunting program. Additional information is taken from a 1992 survey of CACO visitors and Outer Cape residents (Manning 1994). Data gathered in a similar survey of CACO visitors and Cape Cod residents provides a more detailed understanding of the social effects associated with the CACO hunting program (Kuentzel 2006).

***Hunter Attitudes Towards Hunting*:** Many hunters feel that a sense of tradition surrounds hunting. The cultural heritage of hunting was highlighted by many individuals offering comments in the public scoping meetings (NPS 2004a). Likewise, in the hunting survey (Kuentzel 2006), 23 percent of hunters identified "tradition" as their primary motivation for hunting at CACO. Finally, 98 percent of hunters surveyed agreed with the statement that "hunting on Cape Cod is an important tradition."

Similarly, hunting is frequently a practice shared by family members and passed on from one generation to another. Maintaining this sense of continuity is often important to hunters. Hunters often hunt in groups, so that hunting may provide a chance to bond with family and friends. Hunting trips may be the basis of additional social interaction.

While it is unlikely that outright subsistence hunting exists on the Outer Cape, hunting may supplement the food budgets of some families. In the scoping process, some hunters indicated that they combined food from hunting with food obtained in other sporting and recreational pursuits (e.g., lobster, fish). In the hunting survey (Kuentzel 2006), 16 percent of hunters identified "food/subsistence" as their primary motivation for hunting at CACO. Likewise, nearly 78 percent of hunters agreed with the statement that hunting is important because it provides a supplemental source of food.

The CACO hunting survey (Kuentzel 2006) included two questions that examine how respondents perceive the substitute hunting sites that they would use in the event of a CACO hunting ban. First, respondents were asked to rate the quality of hunting at the substitute site, relative to hunting at CACO, on a scale of 1 to 10, with 1 being not as good as CACO, 5 being the same as CACO, and 10 being better than CACO. Of the hunters who said they would choose a substitute site, the average rating was 4, indicating that hunting at the substitute sites would be roughly the same quality as CACO. A second question asked the respondent to rate the convenience (e.g., travel distance, access) of the substitute site, with a low rating indicating a site less convenient than CACO. On average, the hunters rated the alternative sites at about 3, indicating the sites would be somewhat less convenient than CACO.

***CACO Non-hunting User Attitudes Towards Hunting*:** Residents and visitors were somewhat unaware about the presence of hunting at CACO. Almost 30 percent of residents and 80 percent of non-residents did not know that hunting was allowed at CACO. Overall results from the attitude research shows that residents and visitors are almost evenly split across the spectrum of opposition and support for hunting. Approximately 20 percent of those surveyed strongly oppose hunting, and there is a slightly smaller group (16%) of residents and visitors who are strongly supportive of hunting. About one-quarter of the residents and visitors generally do not have an opinion either for or against hunting. An additional one-third are either somewhat for or somewhat against. Thus, the majority of visitors and residents surveyed (approximately two-thirds) do not have strong feelings about hunting. Residents and visitors are typically not concerned with the ethics of hunting, and respondents to the survey generally *disagreed* that hunting was wrong or unethical. Overall, respondents report less opposition to hunting as a recreational activity in 2006 than in 1992.

Opinion about whether hunting is appropriate *at CACO* shows a greater number of resident and visitors are uncomfortable, with between 40 and 50 percent of residents and visitors opposed to hunting at CACO and 30 to 40 percent in favor of hunting at CACO. Summer visitors were the most opposed to hunting at CACO, and visitors overall were more likely to oppose hunting at CACO than residents. Visitors were also more likely than residents to be concerned about safety issues related to hunting at the Seashore. However, almost no visitors, either in the fall or summer, reported situations where they felt unsafe because of hunters or hunting activity (~10%).

Survey responses indicate that, when conflicts have been reported, non-hunters were the antagonists. The surveys (Kuentzel 2006) provided evidence that some non-hunters (approximately 1/3) feel hunting is in conflict with other activities and the CACO general purpose, and of this group, a smaller number is opposed to hunting under any circumstances. Essentially, this study documents some conflict for a minority of users due to differing philosophies of activities that are appropriate uses of CACO.

Data collected by an NPS intern suggested that common winter activities such as hiking and dog walking decrease during the week-long shotgun hunting season, suggesting that this week-long hunting event deters other types of recreation (NPS 2005a). During the scoping process, several non-hunting individuals provided personal accounts of conflicts with hunting and hunters. Notwithstanding these accounts, none have been documented through formal complaints. Likewise, anecdotal evidence was offered through an unofficial survey of CACO visitors, suggesting that negative interactions may occur between hunters and non-hunters (NPS 2005b). Some Park users believe that the sight of hunters and sound of gunshots can undermine their enjoyment of CACO. In the recent survey (Kuentzel 2006), visitors and residents expressed low tolerance for sharing the same space with hunters or experiencing hunting activity. However, fewer than 10% of visitors reported situations in which they felt unsafe because of hunters or hunting activity.

In the hunter survey (Kuentzel 2006), 46 percent of CACO hunters reported being harassed by people who were not hunting. In contrast, non-hunters reported very few incidents where they were harassed by hunters; for instance, less than one percent indicated that they had argued with hunters. The relative lack of conflict may be partially attributable to visitors avoiding areas frequented by hunters as well as of hunters avoiding areas most frequented by non-hunters. It is important to note that on-site conflict between hunters and non-hunters has actually not resulted in serious altercation or continuing problems. Generally, users move away from one another and continue with their individual pursuits. This is consistent with other findings of the survey, which showed that visitors generally wish to stay on and around amenities at the Seashore that are readily accessible by road. Hunters report a desire to avoid developed amenities, and express little interest in the beaches or picnic areas at the Park. These groups are generally looking for different experiences and different areas of the Park. This provides some opportunity for considering ways to balance these uses at CACO. Fall hikers and other non-hunting users

seeking solitude may be an exception since these types of users seek conditions similar to those desired by hunters.

***Resident Attitudes Towards Hunting*:** Attitudes of residents living near CACO are similar to those of non-hunting CACO visitors. Residents use CACO during the periods outside of high tourist season; therefore, they likely represent a significant share of CACO users during the fall and winter months.[15] Although perceptions of hunting are somewhat more positive in 2005 than in 1992, nearby residents have concerns about hunting related to noise and safety. For example, some participants at scoping meetings pointed to hunting as a source of anxiety over personal safety and enjoyment of their property. In the recent survey of residents, 51 percent felt that there are too many year-round residents for hunting at CACO to be safe (Kuentzel 2006). Some residents also expressed concern over their property rights, citing instances when hunters may have trespassed, although actual violation notices suggest otherwise. Some residents object to hunting under any circumstances. Over 55 percent of residents disagree with the statement that hunting for sport is an appropriate activity at CACO, while 32 percent agreed with that statement. When those same questions were asked regarding "hunting for food," 43 percent disagreed and 39 percent agreed (Kuentzel 2006).

***General Public Attitudes Towards Hunting*:** Hunters were, as expected, strong proponents of their sport and of the value of hunting as part of their culture.

Also as expected, resident and visitor attitudes toward hunting were less positive towards hunting than hunters, with comparable numbers of respondents for and against hunting. The majority had relatively neutral attitudes, with no specific preference towards or against hunting. Approximately half of both residents and visitors agreed that hunting is an effective wildlife management tool, and more residents and visitors disagreed that hunting was wrong or unethical. Nevertheless, for the remaining anti-hunting/pro-hunting items, slightly more respondents in these two samples expressed attitudes opposed to hunting. Similarly, slightly more residents and visitors were opposed to hunting (40% to 50%) at CACO than were in favor of hunting (30% to 40%). In addition, visitors were more likely than residents to oppose hunting at CACO. Visitors were significantly more likely than residents to be concerned about safety issues, and more likely to favor more limited access for hunters at CACO. Additionally, summer visitors were most opposed to hunting in general, and more opposed to hunting at CACO than were fall visitors.

***Conflicting Attitudes Regarding Hunting*:** Conflict over hunting practices at CACO was documented by Kuentzel (2006). Nearly half the hunters (47%) report some degree of harassment by non-hunters and had their hunting experience disrupted in some way (Kuentzel 2006). This harassment is in part motivated by non-hunter safety concerns and anti-hunting sentiments. However, there also appears to be an effort by some anti-hunters to disrupt hunting activity at CACO (Kuentzel 2006). Most of the harassment reported by hunters, however, may not be very serious as few hunters said that they left CACO, but they did tend to avoid areas used by non-hunters (Kuentzel 2006). Few hunters reported the incidents to NPS officials.

A large portion of residents (47%) avoided certain areas where hunting was likely to be taking place. Residents were also more likely than visitors to report situations where they felt unsafe because of hunters or hunting activity. Approximately 27% percent of residents avoided visiting CACO on days when hunting was likely and 24.1% percent felt they were unable to participate in activities at CACO. There was a measurable concern among some residents about hunting in the vicinity of their homes.

[15] Kuentzel (2006) reported that 85% of Cape Cod residents use CACO in the fall months and 50% use CACO in the winter months.

A small portion of visitors (11%), either in the summer or the fall, reported situations where they felt unsafe (10.5%) because of hunters or hunting activity. Approximately 21 percent avoided certain areas and 10 percent avoided visiting CACO on certain days. A small portion, 9 percent, felt they were unable to participate in activities at CACO due to hunting activities.

There was evidence that residents and visitors who are spending time at CACO, do not want to share the same space with hunters. Resident and visitor tolerance for hunter encounters and shots heard was uniformly low for any level of encounter. Conversely, the data provided evidence that hunters do not care to hunt in areas where there are a lot of non-hunters. In particular, hunters do not appear happy about sharing space with bicyclists.

Where there is inter-group conflict at CACO, the main trouble spots are at the Marconi WMA just south of the CACO headquarters, the Eastham waterfowl hunting areas, and bicycle paths and walking trails.

Finally, most people do not characterize various user groups with extreme stereotypes, and the majority is disinclined to do so. Overall, civility currently appears to dominate over open conflict about hunting at CACO.

3.9 Socioeconomic Environment

3.9.1 Demographic Features

Consistent with its largely rural, tourist reputation, the population of Cape Cod is relatively sparse and the area is divided into small municipalities. As shown in Table 25, the overall population of the Cape is about 222,000, with the 6 Outer Cape towns accounting for only about 12 percent of this population. However, the population of the Cape is growing rapidly as a result of growth in the retiree and commuter populations and the rising cost of housing in the metro Boston area. As shown, the population of the Cape grew by 19 percent between 1990 and 2000, far surpassing the 6 percent population growth experienced in Massachusetts overall. Growth in the Outer Cape is somewhat less; although towns such as Truro and Eastham have seen their populations grow rapidly in the last decade. The overall Outer Cape population growth rate is more apparent when considered over the long-term. Since 1950, the Outer Cape population has grown approximately 219 percent, 6 times the population growth rate in Massachusetts statewide (University of Massachusetts 2004).

Table 25. Population Trends for Socioeconomic Impact Area

Area	1990 Population	2000 Population	Percent Change
Cape Cod (Barnstable Co.)	186,605	222,230	19.1%
Outer Cape			
Chatham	6,579	6,625	0.7%
Eastham	4,462	5,453	22.2%
Orleans	5,838	6,341	8.6%
Wellfleet	2,493	2,749	10.3%
Truro	1,573	2,087	32.7%
Provincetown	3,561	3,431	-3.7%
Outer Cape Total	24,506	26,686	8.9%

Source: Cape Cod Commission, "Cape and Islands Population, 1930-2000," based on U.S. Census of Population.

The census has identified places in Chatham, Eastham, Orleans, and Provincetown that are densely settled population centers without legally defined corporate limits. Many of these village centers are at or near central business districts. Their population densities are high, and development is intensive. By far the most densely populated of these is an area in Provincetown where there are 1,874 people per mi^2.

In each of the Outer Cape communities, there is a small but growing minority population. Provincetown has the largest minority community, comprising 4 percent of the town's population. Overall, the Outer Cape population is 98 percent Caucasian.

The influence of retirement living on Cape Cod is evident in population statistics. The percent of the Cape population 65 years of age or greater is 23.1, nearly double the national figure of 12.4 percent. The median age of Cape Cod residents is 44.6 years, significantly greater than the national median of 35.3 years. Likewise, the influence of tourism and seasonal visitation on Cape Cod is evident in population and housing statistics. The summer population is roughly triple the year-round population presented above. Table 26 illustrates the prevalence of vacation unit housing on the Cape. The percent of all housing units that are vacation units on the Cape is nearly 10 times than that for Massachusetts as a whole. This pattern is especially true for Outer Cape communities, where vacant vacation units often constitute more than half of all housing.

Table 26. Vacant Vacation Units as a Percent of all Housing Units

Area	Vacant Vacation Units as a Percent of All Housing Units
Massachusetts	3.6%
Cape Cod	32.0%
Outer Cape Communities	
Chatham	46.7%
Eastham	52.3%
Orleans	34.6%
Wellfleet	64.2%
Truro	60.8%
Provincetown	47.0%

Source: Cape Cod Times, "Cape & Islands Vacant Units: 1990-2000," obtained on-line at http://www.capecodonline.com/special/census/.

As reflected in Table 27, Cape Cod communities are generally wealthier than their counterparts nationwide, with slightly higher median incomes. Wealth is also reflected in median home values on the Cape, which greatly surpass national values. Outer Cape communities exhibit this pattern even more strongly, with median home values inflated by large summer residences and a generally strong demand for real estate in the region. The percent of families living below the poverty level further reflects the relative wealth of the Outer Cape region; except for Provincetown, poverty levels are well below the national average, as well as below the average for Massachusetts.

Table 27. Income and Wealth Indicators for Socioeconomic Impact Area

Area	2000 Median Income	2000 Median House Value	2000 Percent of Families Below Poverty Level
United States	$41,994	$119,600	9.2%
Massachusetts	$50,502	$185,700	6.7%
Cape Cod (Barnstable Co.)	$45,933	$178,800	4.6%
Outer Cape			
Chatham	$45,519	$273,900	1.9%
Eastham	$42,618	$192,300	4.5%
Orleans	$42,594	$300,700	2.7%
Wellfleet	$43,558	$242,700	5.7%
Truro	$42,981	$286,500	4.8%
Provincetown	$32,716	$323,600	8.5%

Sources: Cape Cod Times, "Cape & Islands Vacant Units: 1990-2000," obtained on-line at http://www.capecodonline.com/special/census/. U.S. Census Bureau, American FactFinder data base.

3.9.2 Local Economy

Into the 20th century, the economy of Cape Cod centered on whaling, fishing, and related industries such as shipbuilding and fish processing. The demise of whaling coincided with the Cape's rise to prominence as a summer destination for wealthy industrialists and intellectuals. After the Second World War, the Cape established its enduring reputation as a summer vacation center for families from New England and the Middle Atlantic states. In recent decades, the Cape economy has diversified, although tourism remains the cornerstone of the regional economy (Barnstable County 2003).

Table 28 examines economic census data for Barnstable County, providing insight into key sectors of the Cape Cod economy. Based on the value of output (in terms of sales or revenue), the largest sector is retail trade, with sales of over $2 billion. Within this sector, food and beverage stores are most prominent, accounting for over $600 million in sales. The second largest sector is accommodation and food services, with sales of over $600 million, most of which is associated with restaurants, bars, hotels, and motels. Other major sectors include wholesale trade as well as health care and social assistance.

A similar profile of the region can be seen when the distribution of employment across all sectors is considered. Table 28 shows this distribution, incorporating the manufacturing, service, and public administration portions of the Barnstable County economy. Consistent with the preceding discussion, the retail and service sectors account for much of the region's employment. The public sector (including Federal, state, and local employees) is the next largest sector, accounting for 15 percent of employment. While the fishing industry is a visible and valued component of the regional economy, it accounts for very little employment in Barnstable County. Job growth on the Cape has been strong in recent years. The region has experienced job growth for 11 straight years, even during periods of statewide job loss (Cape Cod Commission 2003)

Table 28. Barnstable County Economic Sectors

NAICS Industry Code	Industry Description	Number of Establishments	Number of Employees	Annual Payroll ($1,000)	Shipments/ Sales/Receipts ($1,000)
11	**Forestry, fishing, agriculture**	**1,025**	**NA**	**NA**	**30,950**
23	**Construction**	**4,107**	**NA**	**NA**	**251,191**
31-33	**Manufacturing**	**226**	**2,561**	**82,427**	**349,442**
334	Computer and electronic product mfg	24	d	a	a
42	**Wholesale trade**	**259**	**1,361**	**45,462**	**462,848**
421	Wholesale trade, durable goods	135	698	24,222	240,080
422	Wholesale trade, nondurable goods	124	663	21,240	222,768
44-45	**Retail trade**	**1,592**	**13,675**	**256,460**	**2,518,765**
441	Motor vehicle & parts dealers	105	1,430	44,369	549,705
442	Furniture & home furnishings stores	94	757	12,623	114,270
443	Electronics & appliance stores	47	302	7,078	51,635
444	Building material & garden equipment & supplies dealers	129	1,141	32,443	266,973
445	Food & beverage stores	258	3,954	62,173	614,978
446	Health & personal care stores	91	906	15,382	149,704
447	Gasoline stations	130	820	11,392	171,248
448	Clothing & clothing accessories stores	256	1,509	24,774	210,899
451	Sporting goods, hobby, book, & music stores	136	531	8,215	73,047
452	General merchandise stores	28	1,150	15,983	159,250
453	Miscellaneous store retailers	260	805	12,618	93,819
454	Nonstore retailers	58	370	9,410	63,237
512	Motion picture & sound recording industries	22	176	2,820	16,089
513	Broadcasting & telecommunications	40	620	28,462	94,823
53	**Real estate & rental & leasing**	**286**	**917**	**21,356**	**138,106**
531	Real estate	220	700	17,442	118,475
532	Rental & leasing services	64	c	a	a
54	**Professional, scientific, & technical services**	**571**	**1,919**	**63,918**	**173,744**
541	Professional, scientific, & technical services	571	1,919	63,918	173,744
56	**Administrative & support & waste management & remediation services**	**262**	**1,830**	**32,602**	**99,055**
561	Administrative & support services	241	1,707	28,788	81,430
562	Waste management & remediation services	21	123	3,814	17,625
61	**Educational services**	**30**	**91**	**1,586**	**6,027**
611	Educational services	30	91	1,586	6,027
62	**Health care & social assistance**	**482**	**5,989**	**163,772**	**336,525**
621	Ambulatory health care services	413	3,617	116,908	238,441
623	Nursing & residential care facilities	24	2,089	42,898	90,620
624	Social assistance	45	283	3,966	7,464
71	**Arts, entertainment, & recreation**	**142**	**1,455**	**23,696**	**96,962**
711	Performing arts, spectator sports, & related industries	25	b	a	a
713	Amusement, gambling, & recreation industries	115	1,375	20,704	88,191
72	**Accommodation & foodservices**	**1,144**	**11,852**	**177,312**	**624,340**
721	Accommodation	347	3,015	59,440	212,506
722	Food services & drinking places	797	8,837	117,872	411,834
81	**Other services (except public administration)**	**439**	**1,819**	**36,020**	**124,634**
811	Repair & maintenance	233	833	19,970	82,774
812	Personal & laundry services	206	986	16,050	41,860

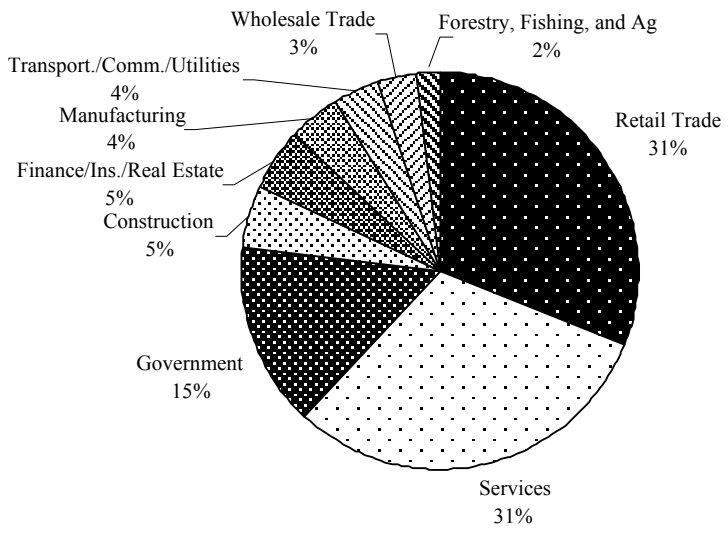
The vast majority of the existing commercial establishments on the Cape are small businesses. Data suggest that roughly 95 percent of all businesses on the Cape and Islands have fewer than 20 employees. Furthermore, over 19 percent of all workers in the Cape/Islands region are self-employed in unincorporated businesses; this is significant when compared to the statewide figure of 6.4 percent (Barnstable County 2003).

Economic census data for the Cape clearly indicate the importance of tourism-related industries. Roughly six million tourists visit Cape Cod and the Islands every year, with two-thirds of the activity occurring in summer and early fall. It is estimated that these tourists spend approximately $1 billion annually. The "hospitality" industry that serves tourist needs accounts for an estimated 23 percent of employment in the Cape and Islands region. The industry includes eating and drinking establishments, hotels and other lodging, souvenir shops, and other businesses.

The hospitality sector has several disadvantages that present a challenge to the economy of Cape Cod. First, the sector generally is composed of lower-wage jobs (Figure 8). Hospitality services are included within the general services category above. The average hospitality wage is 37 percent lower than the average wage for all industries in the region. Second, the hospitality sector is highly seasonal and is subject to unpredictable factors such as weather and the economic health of the New England and Mid-Atlantic regions from which most visitors come. Recent marketing campaigns have focused on expanding the Cape tourist period to include the "shoulder" seasons of early spring and late fall (Barnstable County 2003).

Figure 8

DISTRIBUTION OF CAPE COD EMPLOYMENT ACROSS ECONOMIC SECTORS



Economic development planning interests such as the Cape Cod Commission are targeting diversification of the Cape's economy in coming years. These efforts are designed to promote key industries while preserving the natural resource base on which the tourist economy relies. Therefore, planners are emphasizing development of light/clean industries (e.g., high technology, professional services) that provide higher wages but have limited environmental implications relative to manufacturing.

3.9.3 Economic Effects of Hunting at CACO

The economic effects of hunting activity in CACO can be characterized in two distinct ways (USFWS 2002, 2003). First, decision-makers and citizens are frequently interested in how outdoor recreations such as hunting influence the local economy. The local economic effects can be assessed by examining the expenditures that hunters make to support their hunting activity and by identifying the portion of these expenditures that are made locally (i.e., in Barnstable County).

Second, economists typically frame economic impacts in terms of changes in economic welfare. In the case of hunting, economic welfare is measured based on consumer surplus. The concept of consumer surplus focuses on the principle that some consumers benefit at current prices because they are able to purchase goods or services at a price that is less than their total willingness to pay for the good. In the current context, a hunter may be willing to pay $50 for a day of hunting, but may only incur $20 in costs (for transportation, ammunition, etc.). This individual would therefore realize a consumer surplus of $30 ($50 minus $20) for each day of hunting. To measure consumer surplus, economists apply a variety of methodological approaches, including revealed preference studies (such as travel cost models) and stated preference approaches (in which survey methods are used to estimate willingness to pay for hunting or a change in hunting quality).

Because original research methods are time and resource intensive, economists frequently employ information from existing studies of comparable resources to estimate the economic value of recreational services associated with a particular public resource.[16] To calculate hunters' consumer surplus, we multiply existing estimates of per-trip consumer surplus (see below) with the estimated number of hunting trips discussed above. This analysis offers a rough estimate of the annual economic value of hunting in CACO in the baseline, as well as the potential economic welfare changes associated the management alternatives.[17] These economic losses must then be weighed against qualitative benefits related to the curtailment of hunting (e.g., improved recreation for non-hunters).

***Hunter Expenditures*:** To estimate baseline expenditures associated with CACO hunting activity, current hunting days are multiplied by typical hunter expenditures. Hunter expenditures may include money spent on food, lodging, shells, gasoline, and other expenses. The typical expenditure profile varies depending on the geographic area under consideration, the species sought, and other factors. This analysis incorporates findings from the USFWS 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (USFWS 2002). The survey estimates that hunters hunting in Massachusetts spent an average of $9 per hunting day on trip-related expenditures.[18] This figure is low compared to per-trip expenditures found for other hunting studies in the economics literature.[19] However, the $9 figure is consistent with the fact that CACO hunters are predominantly local and therefore spend relatively little

[16] This practice, commonly referred to as the benefit transfer approach, is one of the methods designated for use in DOI guidance on recreational benefits evaluation (U.S. DOI 1983). It also is used in assessing compensable losses under DOI and National Oceanic and Atmospheric Administration rules for damage assessment [43 CFR 11.83 (c)(2)(vi) and 15 CFR 990.78 (c)].

[17] For additional information on the definition of "surplus" and an explanation of consumer and producer surplus in the context of regulatory analysis, see: Gramlich (1990) and USEPA (2000).

[18] All expenditures examined here are trip-related, i.e., they vary with the number of hunting trips made. Equipment expenditures (e.g., rifles, clothing) associated with hunting may also be significant; however, we assume that hunters will either make these expenditures regardless of the changes in hunting regulations in CACO, or that the purchases are made outside the region. All figures converted to 2004 dollars using the Gross Domestic Product implicit price deflator.

[19] For instance, Hotvedt and Luzar (1989) estimated expenditures of $57 (1989) per deer-hunting trip in Louisiana. Nationally, trip-related expenditures per hunting trip are $90 (USFWS 2002).

accessing the hunting grounds. Likewise, the figure is reasonably consistent with available studies of *annual* expenditures per deer hunter in other New England states.[20]

A portion of these expenditures are made locally. The CACO hunting survey (Kuentzel 2006) asked hunters whether they typically spend money at Outer Cape businesses when hunting at CACO. Table 29 summarizes the responses given by hunters in the field sample. The responses are generally consistent with the characterization of CACO hunters as Cape residents who spend the majority of their trip-related dollars locally. The percent of hunters indicating local expenditures on lodging is low, but this is likely because few hunters seek overnight accommodations on the Outer Cape. While a limited number of respondents listed "other" expenses, these were generally equipment purchases, rather than trip-related expenses. To simplify, we therefore assume that all trip-related expenditures go to Outer Cape businesses.

Table 29. Extent of Hunting Related Expenditures Made at Outer Cape Businesses

Expenditure Category	Percent CACO Hunters Indicating that They Spend Money Locally
Food	90%
Lodging	18%
Gas	94%
Ammunition	74%
Other	18%

Source: CACO Hunting Survey (Kuentzel 2006)

Multiplying baseline hunting days (lower and upper) by the estimated per-day expenditures at Outer Cape establishments yields estimated expenditures of between $89,000 and $256,000. These expenditures are a minor component of total regional economic activity on the Cape, representing a very small portion of the roughly $2 billion in retail sales in Barnstable County. However, while not large relative to the overall regional economy, these expenditures may be significant to a small number of local businesses.

Note that a more comprehensive analysis would consider the secondary effects of hunting expenditures in the regional economy. Specifically, expenditures in food and retail establishments may be amplified as they influence related sectors. For example, spending at restaurants may increase activity in this sector, leading restaurants to increase purchases from food wholesalers, thereby affecting output and employment in the wholesale sector. However, NPS believes that the potential multiplier effects associated with Outer Cape hunting expenditures are too minor to warrant comprehensive regional economic modeling.

***Economic Welfare*:** Characterizing the economic welfare associated with baseline hunting activity involves multiplying the number of hunting days by measures of consumer surplus per hunting day. Consumer surplus estimates will vary depending on numerous factors, including the species hunted, the hunting location, the cost of accessing the hunting site, and the overall quality of the hunting experience (e.g., bag rates). Table 30 summarizes several studies that provide relevant consumer surplus values. Based on the available estimates, a range of $35 to $50 per day was used to value hunting at CACO.

[20] See Boyle, *et al.* (1990). This study estimated annual expenditures of about $140 (2004) per resident deer hunter in Maine. The study does not report the average number of hunting trips on which this figure is based. However, the CACO survey data indicate that the days per hunter average roughly 20 during the October through December months (deer season). Multiplying 20 days by $9 per day implies about $189 in expenditures per deer hunting season, a figure reasonably consistent with the figure for Maine deer hunters.

Multiplying by the estimated range of baseline hunting days yields a consumer surplus estimate of $339,000 to $1.4 million.

Table 30. Consumer Surplus Values Per Day of Hunting

Study	Location	Species	Consumer Surplus Estimate ($2004)
FWS 2003	Massachusetts	Deer	$51*
FWS 2003	New England (average of 5 states)	Deer	$48
Boyle and Roach 1998	New England	Deer	$33
Hay 1988	Massachusetts	Waterfowl	$37
Walsh, *et al.* 1992	U.S. (median of 17 studies)	Waterfowl	$37

* Value based on small sample size, between 10 and 29.

3.10 Management and Operations

3.10.1 Consistency with CACO and NPS Goals, Plans, Policies, Guidelines, and Mandates

The current hunting program is generally consistent with NPS guidelines, policies, and mandates, with the exception of the pheasant program. The basic day-to-day hunting activity is consistent with the goals, plans, guidelines, and mandates of the NPS, and is consistent with the enabling legislation for CACO. The Director has specifically issued a waiver from the exotic species management policies for the CACO pheasant hunting/stocking program (October 7, 2002), while the Park examines options for phasing it out. Continuing the pheasant stocking program in absence of a phase out would require a new waiver.

Exceptions to management policies are available, and specific provisions may be (1) waived or modified by the Secretary, the Assistant Secretary, or the Director; or (2) superseded by "higher authorities", including public laws, regulations, and specific directives. It is specified that, "policy must be consistent with these higher authorities." In this case, higher authorities include the 1961 Seashore Act.

In 2001, the NPS established management policies which are subject to higher authorities such as statutes and regulations. These policies were revised and reissued in 2006 (NPS 2006a). The policies do not permit stocking new exotic species in most circumstances; however, pheasants are not a new exotic species and have been stocked throughout Cape Cod since at least 1906. Additionally, these policies incorporate some flexibility into the sections regarding the management of exotic species, which do authorize recreational harvesting in some circumstances where the practice is historical or Congressional intent for stocking is expressed in statute or a House or Senate report accompanying a statute.

Pheasants have not become a pest species at CACO (Bump and Field 1999). The October 2002 waiver allows for the continuation of the stocking program while CACO initiates procedures to improve upland game habitat as part of a larger cultural landscape restoration program. The waiver further describes that the pheasant hunt would eventually be phased out as upland game hunting opportunities improved, and probably discontinued after 15-years.

3.10.2 Changes to Staffing Levels and Ranger Duties

The current hunting program does not require any additional staff or create any additional ranger duties that go beyond what is expected from Resource and Visitor Protection rangers. The protection division is divided into two districts at CACO, namely the north and south districts. A total of 13 rangers are part of the permanent force and work year-round. During the summer, 12 seasonal rangers are hired to support the permanent, full-time rangers. These rangers are not needed for enforcement duties during the hunting

season due to the low number of hunting violations and complaint calls and due to the lower numbers of visitors. Enforcement duties directly related to hunting include hunter checks. Other staffing indirectly related to the hunting program includes having temporary or seasonal help to collect data and information on the presence and abundance of wildlife species.

3.10.3 Cost to Implement

The hunting program costs a very nominal amount to implement and manage. Annual costs that are unique to the hunting program include the production of hunting brochures and posting lands.