CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This section analyzes and describes potential environmental impacts and consequences that could result from the implementation of Alternatives A, B, C, or D. This chapter is organized by impacts, with discussion of the consequences of each alternative relative to each impact. Generally, the impacts discussed are common to all alternatives, varying only in magnitude. Where appropriate, discussion of impacts will be separated by different populations of geese.

4.2 Impacts on Light Geese

4.2.1 Alternative A. No Action.

Greater snow geese

Management of greater snow geese under current wildlife management policies would result in a continued increase in population size. Based on a growth rate of 8.8%, we expect the greater snow goose spring population estimate to reach one million birds by 2002 and 2 million birds by 2010. Under current hunting season frameworks, the regular-season harvest of greater snow geese in the U.S. is increasing by approximately 1,100 birds annually. This small annual increase in harvest will not significantly slow the population growth rate. In spring 1999, Canada implemented special snow goose hunting regulations in Quebec that resulted in an additional harvest of 44,171birds. Therefore, total continental harvest of greater snow geese during the 1998/99 season was approximately 187,000 birds. This level of harvest may be sufficient to stabilize the population at its current level (Gauthier and Brault 1998, Giroux et al. 1998). However, failure to maintain the current harvest level would allow the population to increase, and potentially escape from control efforts.

The breeding range of greater snow geese has expanded only slightly during the past 30 years. As a result, the density of birds at breeding colonies has increased. Without any management action to stabilize population size, we expect that bird densities on breeding colonies would continue to increase. Higher densities of birds on breeding colonies would eventually cause food supplies to become depleted and likely would result in poor body condition of adults and slower development and/or starvation of goslings. The geographical extent of the breeding range, and the likelihood of habitat degradation on new sites, would become greater as the population increases. However, this expansion likely would not occur until significant habitat damage has occurred on existing colony sites.

<u>CMF Light Geese</u>

Management of CMF light geese under the No Action alternative would result in a continued increase in goose numbers in the eastern and central Arctic, and expansion of the geographic range in which geese breed, migrate, and winter. Based on the current growth rate of 4.7% per year, we expect the number of lesser snow geese in the eastern Arctic to be 4.3 million in spring 2005 and 5.5 million in 2010. Similarly, we expect the rapid increase in the number of Ross's geese in the eastern Arctic to continue.

The number of lesser snow geese in the central Arctic would continue to increase at the annual rate of 14.6%. At that rate, the number of breeding birds would increase to 2.1million by spring 2005, and 4.1 million by 2010. The number of Ross's geese in the central Arctic likely would continue to increase at the current rate of 9.0% per year to slightly over 1 million birds by 2005, and 1.6 million birds by 2010.

Based on linear regression of annual harvest in the U.S. during 1992-97, we expect that regular-season harvest of CMF light geese would increase by approximately 78,433 birds/year for at least several more years. However, this increase would be insufficient to cause a significant slowing of the population growth rate. Furthermore, we expect at some point that the magnitude of annual increase in regular season harvest would eventually subside and that total harvest would plateau, thus making control by hunting more difficult.

As the number of geese on eastern and central Arctic breeding areas increases, the amount of habitat degradation would increase as well. The geographic extent of breeding colonies would expand as geese seek out food resources in less disturbed areas. Impacts of decreased food supplies on light geese would likely occur over an extended period of time, and include an increase in mortality of goslings and adults from malnutrition, physiological stress, parasites, disease and predation due to insufficient breeding and brood-rearing habitat. Survivors likely would continue to decline in body size, possibly affecting breeding propensity and success over their lifetimes.

In the absence of population control, expansion of CMF light goose wintering and migration ranges within the conterminous United States would continue. Use of traditional migration routes and stopover areas likely would decline as the birds deplete local resources more quickly and earlier in each respective season, forcing light geese to occupy new areas where they would overlap with other species that heretofore were not directly affected. Mortality of light geese from avian cholera, and collateral mortality of bird species associating with light geese, likely would increase over time. Although uncertain, it is possible that density-dependent regulation of the population would occur at some point. That is, it is possible that light geese would so deplete their food resources that a population decline would begin. The timing of a population decline of this nature currently is unpredictable, and the magnitude of such a decrease would depend on where the depletion of resources occurs (nesting areas, migration areas or wintering areas). The likelihood and time-scale of recovery of those resources is unknown. It is possible that light geese would learn to exploit new habitats in both the Arctic and elsewhere, thus spreading the damage and prolonging the habitat/population problem.

Western Population of Ross's Geese

Under the No Action alternative we expect the WPRG to continue to grow. In 1998, the estimated number of breeding Ross's geese in the central Arctic was a minimum of 567,100 birds, of which 60% likely migrated to the Pacific Flyway in winter. As mentioned previously, we expect the number of breeding Ross's geese in the central Arctic to be over 1 million birds in 2005, and nearly 1.6 million birds by 2010. If Ross's geese continue to shift their wintering range eastward, the proportion of central Arctic Ross's geese that migrate to the Pacific Flyway likely would decrease. The consequences of increased population size and bird density on breeding colonies in the central Arctic was described under CMF light geese above.

Pacific Flyway Population of Lesser Snow Geese

At the current rate of population growth, the number of breeding lesser snow geese in the western Arctic will reach 800,000 birds by spring 2005, and 1 million by 2010. Approximately 76% of western Arctic lesser snow geese would migrate to the Pacific Flyway. As of yet, extensive damage to vegetation has not been reported on breeding areas in the western Arctic; however, field studies have not been in place to document whether or not any significant impacts have occurred. As population size and bird density increases on colony sites in the western Arctic, geese likely would begin to impact breeding habitats in a manner similar to birds in the eastern and central Arctic.

Wrangel Island Lesser Snow Geese

The population of Wrangel Island lesser snow geese has averaged less than 100,000 birds since the 1980s. Spring weather on Wrangel Island directly influences goose productivity and may limit population growth. There are no indications that this population is impacting breeding habitats. Given the static nature of the trend of this population, it is unlikely that large-scale habitat damage by geese would occur in the near future.

4.2.2 Alternative B. (PREFERRED ACTION) Modify harvest regulation options and refuge management.

Harvest Regulations

We estimated the potential impacts of this alternative using data resulting from regulatory liberalizations in the Central and Mississippi Flyways in 1999 and 2000. The impact of authorizing new methods of take during the regular season was estimated by comparing mean light goose harvest in the 2 Flyways during 1996-98 to harvest in 1999 and 2000 for specific calendar dates in which states implemented regulation changes. Date-specific harvest estimates were not available for all participating States.

Mean light goose harvest increased 244% on days for which special regulations were in effect (Table 4.1). During liberalized time periods, mean lesser snow goose harvest increased 253%, whereas mean Ross's goose harvest increased 462%. The harvest of lesser snow geese far exceeded the harvest of Ross's geese. The change in lesser snow goose harvest among States ranged from a decrease of 1,787 birds to an increase of 29,039 birds. The change in Ross's goose harvest among States ranged from 0 to 2,873 birds. These estimates apply only to the time period in which methods of take were liberalized in various States (usually less than 30 days), and do not apply to the entire regular season.

We estimated the potential combined impact of new methods of take during the regular season and implementation of a conservation order by examining the harvest resulting from regulatory changes that occurred in the Central and Mississippi Flyways during 1999 and 2000. In this assessment, we assumed that regular season harvest of light geese would have continued to increase by 78,433 birds/year in the absence of new regulations. The rate of increase was based on linear regression of harvest observed during 1992-97. By subtracting the expected regular season light goose harvest from the total observed harvest, we estimate that new regulations resulted in nearly a 50% increase in harvest during 1999, and a 69% increase in 2000 (Table 4.2). Only 14 of 24 eligible States implemented new regulations in 1999, primarily because some States did not have sufficient time to amend their regulations. Furthermore, the regulations were implemented in 1999 after northward migration of light geese from major wintering areas had already begun. Therefore, we believe the additional light goose harvest observed during 2000 better represents the combined impact that would occur as a result of authorization of new methods of take during the regular season and implementation of a conservation order.

Table 4.1. Impacts of liberalization in methods of take (electronic calls, unplugged shotguns) on harvest of lesser snow geese (LSGO), Ross's geese (ROGO), and total light geese (LSGO plus ROGO) in 1999 and 2000, versus mean harvest for the same calendar periods in late winter/spring 1996-98.

		Light goose harvest								
	No. of	Mean 1996-98[2]			1999			2000		
State	days[1]	LSGO	ROGO	Light[3]	LSGO	ROGO	Light	LSGO	ROGO	Light
AR	16, 0	14,616	301	14,918	12,829	987	13,816	na	na	na
MO	23, 0	9,709	119	9,828	38,749	1,345	40,094	na	na	na
IL	22, 0	1,941	0	1,941	369	0	369	na	na	na
IA	29, 20	1,755	0	1,755	2,831	0	2,831			
		1,755	0	1,755				5,979	0	5979
CO	14, 6	335	167	502	3,517	703	4,220	0	0	0
KS	20, 32	2,209	364	2,573	5,029	718	5,747			
		4,007	471	4,478				1,519	676	2,195
NE	15, 36	3,144	131	3,275	11,035	811	11,846			
		6,035	289	6,324				17,859	3,162	21,021
SD	21, 0	601	0	601	7,623	173	7,796	na	na	na

[1] Number of days in 1999 and 2000 in which methods of take for light geese were liberalized.
[2] If two estimates are provided for a state in a species column, the top number refers to mean harvest for dates chosen in 1999; bottom number refers to dates in 2000; "na" indicates that regulations were not changed.
[3] Lesser snow and Ross's geese combined.

Table 4.2. Estimated impacts resulting from implementation of new light goose (lesser snow and Ross's geese) harvest regulations in the Central and Mississippi Flyways.

Hunting season	Expected regular-season harvest with no new regulations[1]	Observed harvest with new regulations[2]	Additional harvest resulting from new regulations[3]	Percent increase in harvest resulting from new regulations
1998/99	716,960	1,072,139	355,179	49.5
1999/00	795,394	1,340,794	545,400	68.6

[1] Estimated from linear regression of annual light goose harvest (Federal survey estimate) in the Central and Mississippi Flyways, 1992-97. Total harvest increased by 78,433 birds/year during 1992-97.
[2] Determined from Federal and State harvest surveys.
[3] Observed harvest (third column) minus expected harvest (second column).

Management on National Wildlife Refuges

Options for altering management practices on national wildlife refuges for the purpose of reducing food and sanctuary available to light geese are limited to changes in habitat management and hunting programs. Refuge croplands comprise less than 0.04% of total croplands in the U.S., and only 40-60% of such lands are actually planted each year. Furthermore, a certain percentage of crops are harvested and removed from refuges by cooperative farmers prior to arrival of geese. Therefore, we believe our ability to cause meaningful overall decreases in food availability is limited. This is especially true when geese utilize refuges as roosting areas and fly to adjacent croplands on private land to feed. Nevertheless, we have chosen to retain refuge crop reduction in this alternative as part of our overall effort to address the light goose problem. Acreage of crops that might be utilized by geese on refuges likely is variable from year to year depending on weather conditions, water level control, and reforestation efforts on some refuges. Therefore, we cannot determine the extent to which food availability can be altered. Given the above information, it is likely that the overall impact on food availability would be small.

Modification of refuge hunt programs has already occurred in concert with changes in overall light goose hunting frameworks (i.e., increased bag limits, season length). Furthermore, additional refuge areas in the mid-continent region have been opened to hunting in the past 3 years as a result of implementation of regional action plans (see Section 3.6). The impact of such changes has already been accounted for in recent light goose harvest estimates. Based on the small increase in harvest observed when refuges have expanded their hunt programs in recent years, we expect the impact of any additional openings in the mid-continent region to be minimal.

Greater snow geese

Adoption of this alternative is expected to result in a reduction of the population to 500,000 birds. Using the spring 2000 population estimate as a benchmark, this alternative would require the removal of approximately 314,000 birds from the population. Such removal would include annual harvest that already occurs in the U.S. and Canada. We estimated the impact of this alternative on greater snow geese by subtracting harvest that occurred in 1999/00 from the total number of birds that need to be removed in order to achieve our management goal. The continental harvest of greater snow geese in 1999/00 was approximately 198,000 birds (Table 4.3). The impact of this alternative is equal to the additional 116,000 birds that would need to be removed from the population to achieve our population objective (Table 4.3). The magnitude of this impact is subject to change, depending on the actual spring population size immediately prior to implementation of any new regulations.

Table 4.3. Estimated impact of authorizing new regulations to increase harvest of greater snow geese in the U.S.

	Annual harvest (1999/00)						
	Regular season	Conservation Order	Total	Spring population	Population goal	Population reduction required	Estimated impact of alternative
U.S.	39,000	na[1]	39,000				
Canada	104,000	55,000	159,000				
Total	143,000	55,000	198,000	814,000	500,000	314,000[2]	116,000[3]

[1] Conservation order not implemented in the U.S.
[2] Spring population (year 2000) minus population goal.
[3] Population reduction required minus total annual harvest observed in 1999/00.

We used results of population modeling (Gauthier and Brault 1998) to predict the size of the spring population following implementation of various levels of increased harvest rate (Fig. 4.1). At the time of the modeling exercise, the overall harvest rate was approximately 12% (Reed et al. 1998). Population trajectories in Fig. 4.1 correspond to levels of harvest rate ranging from 21% to 35%. We did not examine harvest rates less than 21% because they did not cause decreases in population size (Gauthier and Brault 1998). We estimate that harvest rates between 30% and 35% are necessary to achieve a reduction of the population to 500,000 birds by the year 2003 at the latest, whereas a 27% harvest rate would achieve the reduction by 2005. Extension of the population trajectories indicates that a 24% harvest rate would reduce the population by the year 2008, and a rate of 21% would achieve reduction by the year 2020.

Previously, we estimated that the current harvest rate for greater snow geese was approximately 17% (see Chapter 3.1.10). Based on information from the Central and Mississippi Flyways (Table 4.2), we estimate that authorization of new methods of take (regular season) and a conservation order in the U.S. portion of the Atlantic Flyway would result in a 69% increase in U.S. harvest. Such an increase would raise the continental harvest from 198,000 to 224,910 birds (Table 4.4). Using the 1999 fall population estimate, harvest of this magnitude would represent a harvest rate of approximately 29%. Therefore, our preferred alternative may achieve the population reduction goal by 2004 (Fig. 4.1).

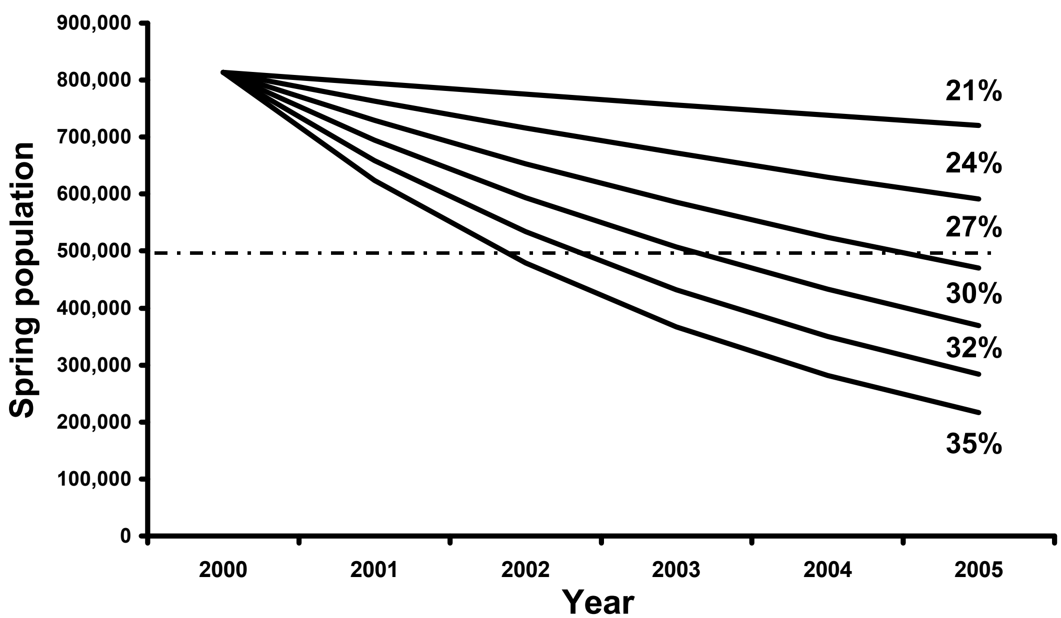

Fig. 4.1. Trajectories of the greater snow goose population resulting from implementation of various harvest rates (expressed as %), in relation to a population goal of 500,000 birds (dashed line). Trajectories begin with the spring 2000 population estimate of 813,900 birds.

Table 4.4. Projected continental harvest and harvest rate of greater snow geese following implementation of special regulations in the U.S. portion of the Atlantic Flyway.

	Annual Harvest				
	Regular season with no special regulations[1]	Using special regulations	Total	Fall population	Harvest rate
U.S.	39,000	26,900[2]	65,900		
Canada	104,000	55,000[3]	159,000		
Total	143,000	81,900	224,900	778,900	0.29

[1] Estimates from 1999/00 hunting season.
[2] Represents additional 69% increase in harvest resulting from special regulations.
[3] Harvest from conservation order in Quebec during spring 2000.
[4] See section 3.1.10 for calculations.
[5] Total expected harvest divided by fall population size.

Peak populations of greater snow geese on national wildlife refuges occur during October through December (USFWS, unpublished data). Therefore, management actions to influence distribution of birds to make them more available to hunters should be implemented in fall. Previous experience with such efforts (see Chapter 3.6) has resulted in minimal success. The impacts associated with changes in refuge management in the mid-continent region were incorporated into the estimated increase in harvest following regulation changes in 1999. Because we utilized the same projection for the Atlantic Flyway, we do not anticipate additional impacts beyond the 69% increase in harvest if refuge actions are implemented there.

Once population reduction goals are achieved, steps would be taken to ensure that the number of greater snow geese remains stabilized and a resumption of population growth does not occur. Regular season harvest of geese in the U.S. portion of the Atlantic Flyway has not been increasing to the same extent as harvest in the mid-continent region. Future light goose hunting regulations would be determined using existing administrative procedures, taking into account population surveys, harvest rates, and the outlook for production of young in a given year. Normal hunting regulations can be used during the regular season in years when population status appears to be stable. Additional methods of take and liberalization or removal of bag limits may need to be authorized during the regular season if additional harvest is required in a given year to achieve a stable population level. In years when a substantial increase in harvest is needed to reduce the population, a conservation order may be temporarily re-instated.

CMF Light Geese

Adoption of this alternative would result in a 50% reduction of the CMF light goose winter index from the 1997 estimate of 3.1 million, to our management goal of 1.55 million birds. Once achieved, a winter index of 1.55 million would correspond to a minimum of 2.48 million breeding light geese on breeding colonies in the eastern and central Arctic. Accounting for an additional 30% for non-breeding birds, the total number of light geese following population reduction would be approximately 3.2 million in spring.

Because a large proportion of Ross's geese migrate to the Pacific Flyway, control activities implemented in the Central and Mississippi Flyways would impact Ross's geese to a much smaller degree than they would lesser snow geese. During 1997-99, the average composition of the Central Flyway light goose harvest was 92% lesser snow geese and 8% Ross's geese. During the same period, the average proportion of lesser snow and Ross's geese in the Mississippi Flyway was 97% and 3%, respectively. Upon implementation of this alternative, we assume that the proportions of lesser snow geese and Ross's geese in the Central and Mississippi Flyway harvests would be similar to those observed during 1997-99.

An annual harvest of 1.4 million birds is required to reduce the number of CMF light geese by 50% (Rockwell and Ankney 2000). The estimated harvest of CMF light geese in the U.S. during 1999/2000 was 1,346,371 birds. In addition, the harvest of light geese in Manitoba and Saskatchewan during 1999/2000 was 141,911 birds (Peterson 2000). Although a certain proportion of geese harvested in Saskatchewan would have migrated to the Pacific Flyway, the harvest of CMF light geese in North America during 1999/2000 likely exceeded, 1.4 million birds. Any harvest in excess of 1.4 million birds in a given year reduces the amount of time required to reach population reduction goals (Rockwell and Ankney 2000). Adoption of this alternative would maintain an annual continental harvest of approximately 1.4 million CMF light geese until management goals are achieved.

We would closely monitor the status of CMF light geese using a combination of the annual winter population index, periodic photographic surveys of breeding colonies, Federal and State harvest surveys, and banding programs that provide estimates of survival and harvest rates. These monitoring capabilities ensure that our population control program can be curtailed when no longer needed, and that light geese will be in no danger of being over-harvested. We believe the target winter index is well above the level needed to sustain a healthy population. Reduction of the number of light geese also would reduce the possibility of outbreaks of avian cholera within the population.

Once goals are achieved, steps would be taken to ensure that the number of light geese remains stable. Regular season harvest of CMF light geese, without special regulations, may be sufficient to maintain the goose population at desired levels if harvest continues to increase annually. However, we expect at some point that the magnitude of annual increase in regular season harvest will decrease and that total annual harvest will plateau. Future light goose hunting regulations would be determined using existing administrative procedures; taking into account population indices, harvest rates, and the outlook for production of young in a given year. Normal hunting regulations can be used during the regular season in years when population status appears stable. Additional methods of take and liberalization or removal of bag limits may need to be authorized during the regular season if additional harvest is required in a given year to achieve a stable population level. A conservation order may be temporarily reinstated in years when a substantial increase in harvest is needed to reduce the population.

As mentioned previously, several federal refuges in the Central and Mississippi Flyways have expanded hunt programs during the past 3 years to increase harvest of light geese. The impacts we estimated for this alternative have already incorporated any harvest increases that occurred as a result of changes to refuge hunting programs. Furthermore, we believe we have limited potential to affect landscape-level changes in food availability. Therefore, we estimate that overall impacts associated with changes to refuge management would be minimal.

Western Population of Ross's Geese

Under this alternative we expect an increase in the number of Ross's geese that migrate from the central Arctic to the Pacific Flyway. This growth would continue as long as initial population control efforts are focused solely on birds that winter in the Central and Mississippi Flyways. However, growth of the WPRG will be offset somewhat by the continued eastward shift in the wintering range of Ross's geese. If habitat deterioration on breeding grounds in the central Arctic continues, despite efforts to reduce the number of light geese in the Central and Mississippi Flyways, it may become necessary to increase harvest of Ross's geese that migrate to the Pacific Flyway. However, such a strategy should consider the geographic distribution of wintering Wrangel Island lesser snow geese, which should not be subjected to increased harvest. Most Pacific Flyway Ross's geese follow a migration route through southwestern Saskatchewan, southeastern Alberta, and western Montana to wintering grounds in central California (Kerbes 1994). This geographic pattern should be considered when designing potential regulation changes to increase harvest of Ross's geese.

Pacific Flyway Population of lesser snow geese

Approximately 76% of lesser snow geese from the western Arctic migrate to Pacific Flyway Population wintering areas, and they comprise over 85% of snow geese found in California (Hines et al. 1999). At the current rate of population growth, the number of breeding lesser snow geese in the western Arctic will reach 0.8 million by 2005 and one million by 2010. Although studies have not been conducted, extensive damage to vegetation has not been reported on breeding areas in the western Arctic. However, as population size and bird density increases on colony sites, geese likely would begin to impact western breeding habitats in a manner similar to birds in the eastern and central Arctic. Hines et al. (1999) suggested a proactive approach to management of western Arctic lesser snow geese by stabilizing the population at its current level (i.e., approximately 0.5 million) before it escapes control via normal harvest. Alternative B would retain the option of implementing special light goose regulations in the Pacific Flyway if damage to western Arctic breeding habitats becomes evident. However, such a strategy should consider the geographic distribution of wintering Wrangel Island birds, which should not be subjected to increased harvest. Because 24% of western Arctic lesser snow geese migrate to the western Central Flyway, implementation of special regulations in the Central Flyway would help slow the growth of western colonies.

Wrangel Island lesser snow geese

The population of Wrangel Island lesser snow geese has averaged less than 100,000 birds since the 1980s. Spring weather on Wrangel Island has a profound influence on productivity of geese and may limit population growth. There are no indications that this population is impacting breeding habitats. Given the static nature of the population of these geese, it is unlikely that they will cause large-scale habitat damage in the near future. Consequently, we do not anticipate that reduction measures will be necessary for this population.

Any future control measures for central and western arctic light geese that are implemented in the Pacific Flyway would be designed to avoid increased harvest of Wrangel Island birds. Wrangel Island birds that migrate through British Columbia and Washington are geographically separated from western Arctic birds, which tend to migrate through Alberta and Saskatchewan. Harvest pressure on Wrangel Islands birds in eastern Oregon can be reduced by delaying hunting seasons, or control efforts, in the fall. This is possible due to the tendency of Wrangel Island birds to arrive two weeks earlier than western Arctic birds in such areas. Furthermore, Wrangel Island birds do not winter in the Imperial Valley of southern California, which is frequented by birds from the western Arctic (Armstrong et al. 1999).

4.2.3 Alternative C. Implement direct light goose population control on wintering and migration areas in the U.S.

Under this alternative, population reduction and/or stabilization would be achieved by direct removal of birds from the population using lethal means. Direct control efforts would be undertaken by wildlife agencies, and/or their designated agents, on light goose migration and wintering areas in the U.S. Methods of removal may include shooting, trapping, and/or chemical control. Traditional harvest of light geese would continue during the regular hunting season and would be authorized using existing administrative procedures. Light goose hunting regulations adopted by States would be confined to Federal frameworks that provide for a maximum season length of 107 days, occurring during the period September 1 through March 10 (U. S. Fish and Wildlife Service 1988). Existing hunting programs, and existing administrative procedures for establishing new hunt programs, on national wildlife refuges would remain in place.

The magnitude of direct removal of birds needed for a particular population of geese would be determined by the anticipated harvest resulting from normal hunting seasons. Direct removal would supplement normal harvest to achieve management goals. In most instances, impacts of this alternative on light geese are similar to impacts anticipated from alternative B. However, direct removal would be costly to wildlife agencies, and could result in disposal and waste of potentially large numbers of geese if uses for carcasses could not be found. Failure to collect carcasses from wetlands could increase the likelihood of outbreaks of avian botulism, which are often associated with the presence of dead animal carcasses (Rocke and Friend 1999). The impacts of this alternative on individual light goose populations are discussed below.

Greater snow geese

Adoption of this alternative would result in a reduction of the population to 500,000 birds. If normal harvest of geese is insufficient to reduce the population, direct control would be implemented. The magnitude of direct removal required would depend on the extent to which the population goal has been exceeded, and the anticipated harvest of geese during the regular season. Furthermore, the magnitude of removal needed would determine whether the management goal can be achieved in a single year, or over the course of several years. Regardless of the time required to reach the population goal, direct control would result in disposal and waste of potentially large numbers of birds if uses for carcasses could not be found.

Impacts associated with this alternative are similar to Alternative B. Based on the spring 2000 estimate of 813,900 birds, we estimate that an additional 116,000 birds must be removed from the population to supplement the 198,000 birds that are harvested annually (Table 4.3). The magnitude of this impact is subject to change, depending on the actual spring population size immediately prior to implementation of any control actions.

CMF Light Geese

Adoption of this alternative would result in a 50% reduction of the number of CMF light geese to the target level of 1.55 million birds, as measured by the winter index. Once achieved, a winter index of 1.55 million would correspond to a minimum of 2.48 million breeding light geese on breeding colonies in the eastern and central Arctic. Accounting for an additional 30% for non-breeding birds, the total number of light geese following population reduction would be approximately 3.2 million in spring. A 50% reduction of the CMF light goose population requires an annual removal of 1.41 million birds from the population (Rockwell and Ankney 2000). Control efforts implemented under this alternative would supplement regular season harvest to achieve a total annual removal of 1.41 million CMF light geese.

We estimated the impact of this alternative by subtracting the regular season harvest observed during 1997/98 from the total annual removal of birds needed to achieve our management goal (Table 4.5). We chose the 1997/98 hunting season as a baseline, because it preceded the season in which special light goose regulations were authorized in the Central and Mississippi Flyways. Implementation of this alternative would require agency personnel to annually remove an additional 654,569 CMF light geese in order to achieve a total annual removal of 1.41 million birds. Consequently, direct control could result in disposal and waste of potentially large numbers of birds if uses for carcasses could not be found.

Table 4.5. Estimation of the number of Central/Mississippi Flyway light geese that would need to be removed on an annual basis by direct agency control in order to achieve a 50% reduction in number of geese.

	Regular season harvest (1997/98 season)			Number of birds that need to be removed to achieve goal[2]
	Lesser snow	Ross's	Light geese[1]	
Central Flyway	348,989	12,174	361,163	
Mississippi Flyway	238,993	8,125	247118	
Canada[3]	132,318	14,832	147,150	
Total	720,300	35,131	755,431	654,569

[1] Lesser snow and Ross's geese combined.
[2] Target harvest level (1.41 million birds) minus CMF light goose harvest observed during 1997/98.
[3] Manitoba and Saskatchewan, combined.

Because a large proportion of Ross's geese migrate to the Pacific Flyway, control activities implemented in the Central and Mississippi Flyways would impact Ross's geese to a much smaller degree than they would impact lesser snow geese. As discussed under Alternative B, the ratio of Ross':lesser snow geese in the regular season harvest in the Central and Mississippi Flyways is 92:8 and 97:3, respectively. It is likely that personnel conducting control efforts would encounter Ross's and lesser snow geese in the same proportion they are encountered by hunters. Therefore, we assume the ratio of Ross':lesser snow geese in the segment of birds removed by agency personnel would be similar to the ratio observed in the regular season harvest.

Western Population of Ross's geese

Under this alternative we expect an increase in the number of Ross's geese that migrate from the central Arctic to the Pacific Flyway. This growth will continue as long as initial population control efforts for central arctic light geese are focused solely on birds wintering in the Central and Mississippi Flyways. However, growth of the WPRG would be offset somewhat by the continued eastward shift in the wintering range of Ross's geese that breed in the central Arctic. If light goose control efforts in the Central and Mississippi Flyways are not sufficient to halt habitat deterioration on breeding grounds in the central Arctic, it may become necessary to remove a certain number of Ross's geese that migrate to the Pacific Flyway. The actual number of Ross's geese to be removed in the Pacific Flyway cannot be determined at this time. The magnitude of removal would depend on the population size when control is deemed necessary. As discussed previously, strategies to reduce the number of Ross's geese should consider the geographic distribution of wintering Wrangel Island lesser snow geese, which should not be subjected to increased harvest.

Pacific Flyway Population of lesser snow geese

At the current rate of population growth, the number of breeding lesser snow geese in the western Arctic will reach 0.8 million by 2005 and one million by 2010. As mentioned previously, the majority of western Arctic birds migrate to the Pacific Flyway. Although studies have not been conducted, extensive goose damage to vegetation has not been reported on breeding areas in the western Arctic. However, as population size and bird density increases on colony sites, geese likely would begin to impact western breeding habitats in a manner similar to birds in the eastern and central Arctic.

This alternative would retain the option of implementing direct control of lesser snow geese in the Pacific Flyway if damage to western Arctic breeding habitats becomes evident and the number of western Arctic birds cannot be controlled through normal hunting seasons. The actual number of birds that may need to be removed cannot be determined at this time. Hines et al. (1999) recommended stabilization of the number of western Arctic birds at current levels (i.e., approximately 0.5 million). If we adopt Hines et al.'s recommendation, the number of birds removed would be the difference between 0.5 million birds and the size of the population when control is deemed necessary. The regular season harvest of lesser snow geese in the Pacific Flyway was approximately 45,000 birds in 1999/00. This level of annual harvest should be considered as part of the total number of birds targeted for removal from the population. Direct control measures should not be implemented in traditional wintering areas of Wrangel Island lesser snow geese.

Wrangel Island lesser snow geese

Given the current status of this population, we do not anticipate that control efforts would be needed in the foreseeable future. The population of Wrangel Island lesser snow geese has averaged less than 100,000 birds since the 1980s. We expect the size of this population to remain within historical bounds under this alternative.

4.2.4 Alternative D. Seek direct light goose population control on breeding grounds in Canada.

This alternative would achieve light goose population reduction and stabilization through direct control on breeding areas in Canada. We do not have the authority to implement direct population control measures in Canada. Therefore, this alternative would require consultation with the Canadian government in order to urge implementation of such measures, which may or may not involve assistance from U.S. wildlife agency personnel. During the past several years we have held direct consultations with the Canadian Wildlife Service on the issue of light goose management. Participation of both agencies in the Arctic Goose Joint Venture has provided an additional avenue of discussion of light goose issues. As discussed under Alternative C, failure to collect carcasses from wetlands following direct control could increase the likelihood of outbreaks of avian botulism, which are often associated with the presence of dead animal carcasses (Rocke and Friend 1999). The impacts of this alternative on individual light goose populations are discussed below.

Greater snow geese

Adoption of this alternative would result in a reduction of the population to 500,000 birds. Impacts of the alternative on geese are the same as those outlined in Alternatives B and C. The exact magnitude of direct removal would depend on the extent to which the population goal has been exceeded at the time of implementation, and the anticipated harvest of geese during the regular season. Furthermore, the magnitude of removal needed would determine whether the management goal can be achieved in a single year, or over the course of several years. Regardless of the time required to reach the population goal, direct control could result in disposal and waste of potentially large numbers of birds if uses for carcasses could not be found.

CMF Light Geese

Adoption of this alternative would result in a 50% reduction of the number of CMF light geese to the target level of 1.55 million birds, as measured by the winter index. Once achieved, a winter index of 1.55 million would correspond to a minimum of 2.48 million breeding light geese on breeding colonies in the eastern and central Arctic. Accounting for an additional 30% for non-breeding birds, the total number of light geese following population reduction would be approximately 3.2 million in spring.

The impact of this alternative on CMF light geese is the same as that outlined under Alternative C (Table 4.3). To review, implementation of this alternative would require agency personnel to annually remove 654,569 light geese on eastern and central Arctic breeding areas. Such removal would supplement regular season harvest and result in a total annual removal of 1.41 million birds. Consequently, direct control could result in disposal and waste of potentially large numbers of birds if uses for carcasses can't be found.

Western Population of Ross's Geese

The breeding range of the WPRG and CMF Ross's geese overlap with each other in the central Arctic. Under this alternative we expect that Ross's geese of both populations would be removed from breeding areas by agency personnel. Control efforts likely would focus on breeding areas where habitat damage is evident. Therefore, direct control of Ross's geese that would have migrated to the Pacific Flyway would help achieve the management goal of protecting breeding habitat from goose destruction.

Pacific Flyway Population of lesser snow geese

At the current rate of population growth, the number of breeding lesser snow geese in the western Arctic will reach 0.8 million by 2005 and one million by 2010. As mentioned previously, the majority of western Arctic birds migrate to the Pacific Flyway. Although studies have not been conducted, extensive goose damage to vegetation has not been reported on breeding areas in the western Arctic. However, as population size and bird density increases on colony sites, geese likely would begin to impact western breeding habitats in a manner similar to birds in the eastern and central Arctic. At such time, direct control may become necessary.

This alternative would retain the option of implementing direct control of lesser snow geese in the western Arctic if it becomes evident they are damaging breeding habitats and that the number of western Arctic birds cannot be controlled through normal hunting seasons. The actual number of birds that may need to be removed cannot be determined at this time. Hines et al. (1999) suggested stabilization of the number of western Arctic birds at current levels (i.e., approximately 0.5 million). If we adopt their recommendation, the number of birds removed would be the difference between 0.5 million birds and the size of the population when control is deemed necessary. The regular season harvest of lesser snow geese in the Pacific Flyway was approximately 45,000 birds in 1999. This level of annual harvest should be considered as part of the total number of birds targeted for removal from the population.

Wrangel Island lesser snow geese

Given the current status of this population, we do not anticipate that control efforts would be needed in the foreseeable future. The population of Wrangel Island lesser snow geese has averaged less than 100,000 birds since the 1980s. We expect the size of this population to remain within historical bounds under this alternative.

4.3 Impacts on Habitat

4.3.1 Alternative A. No Action.

Greater snow geese

Management of greater snow geese under the No Action alternative would result in a continued increase in population size. The breeding range of greater snow geese has expanded only slightly during the past 30 years, resulting in increased density of birds on existing colonies. Without any management action to stabilize population size, we expect that bird densities on breeding colonies would continue to increase. The geographical extent of the breeding range, and the likelihood of habitat degradation on new sites, would become greater as the population increases. However, this expansion likely would not occur until significant habitat damage has occurred on existing colony sites.

The geographic extent of the main spring staging area for greater snow geese has expanded from a 40 km portion of the St. Lawrence valley to more than 400 km. We expect continued expansion of spring staging areas as the goose population increases. As mentioned in section 3.2.2, it appears that the capacity of some bulrush marshes in the St. Lawrence Valley to provide food resources for geese may have been reached and that they can no longer accommodate the increasing number of snow geese (Giroux et al. 1998). As the goose population continues to increase, the carrying capacity of natural marshes would be exceeded and further habitat degradation would occur. Increased use of cordgrass marshes likely would occur, as would the potential for habitat degradation in such habitat. Concurrently, we expect an increase in goose damage to agricultural crops in spring, especially in hayfields and winter cereal crops.

During the past 15 years, the length of the fall staging period in southern Quebec has become shorter, and more geese are flying directly to the U.S. without stopping in Quebec. As the goose population increases, we expect the length of the fall staging period in Quebec would continue to shorten, and the number of snow geese that fly directly to the U.S. in fall would increase. Earlier fall arrival of snow geese in the U.S. likely would increase goose impacts on agricultural crops and natural marshes. These impacts would be magnified if the total population increases as well.

CMF Light Geese

This alternative would result in a continued increase in CMF light geese and expansion of the geographic range in which they breed, migrate, and winter. As the number of geese found on arctic and subarctic breeding areas increases, the amount of habitat degradation on such areas would increase as well. The mechanism by which light geese cause habitat degradation, and descriptions of the known extent of such degradation, were provided in Chapter 3.2.1.

Information from long-term studies conducted in the La Perouse Bay portion of Hudson Bay provide our best estimate of goose impacts on breeding habitats under the No Action alternative. Using data from Jano et al. (1998), we determined that the rate of salt marsh vegetation decline in La Perouse Bay during 1984-93 was approximately 159 hectares/year (393 acres/year; Fig. 4.2). Assuming this rate of vegetation decline has continued since 1993, we estimate that by 2005 an additional 1,900 hectares (4,693 acres) of salt marsh vegetation will have been destroyed by geese in La Perouse Bay. By the year 2010, the cumulative loss of salt marsh vegetation since 1993 would increase to 5,150 hectares (12,720 acres).

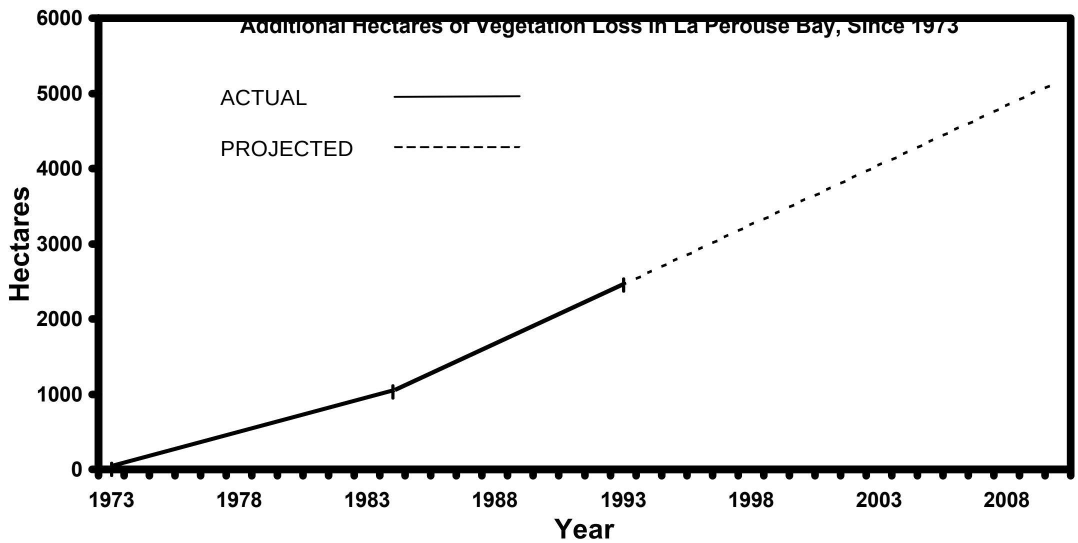

Fig. 4.2. Projection of additional hectares of salt marsh vegetation that would be lost at La Perouse Bay in the absence of light goose population control. Losses indicate additional habitat lost after monitoring began in 1973. Actual loss of vegetation was determined by comparison of satellite imagery from 1973, 1984, and 1993. Projected losses assume the same rate of loss that occurred during 1984-93 (calculated from data in Jano et al. 1998).

Habitat losses due to impacts of light geese in the eastern and central Arctic are not restricted to La Perouse Bay. Vegetation surveys conducted during 1993-95 indicate that destruction of vegetation and loss of habitat are widespread along the western and southern coasts of Hudson Bay and James Bay (Kerbes et al. 1990; Abraham and Jefferies 1997). The Hudson Bay Lowlands salt marsh ecosystem, for example, lies within a 1,200 mile strip of coastline along west Hudson and James Bays. This area contains approximately 54,700 hectares (135,000 acres) of coastal salt marsh habitat; of which 35% is considered destroyed, 30% is damaged, and 35% is overgrazed (Abraham and Jefferies 1997). Under the No Action alternative, habitats currently categorized as damaged or overgrazed would be further impacted and eventually would be destroyed.

Many light geese that breed at higher latitudes of the eastern and central Arctic migrate through the Hudson and James Bay coastlines during spring migration. Therefore, even if the number of breeding birds at southern colonies were reduced, there would be heavy use of such habitats by geese migrating northward. The geographic extent of goose breeding colonies would expand as geese seek out food resources in less disturbed areas. As geese destroy salt marsh habitat they would move inland to exploit other habitats, which tend to degrade more quickly under the influence of geese (R. Rockwell, personal communication). The coastline has undergone a rate of isostatic uplift of between 0.5 to 1.2 meters per century (0.2 – 0.5 inches/year; Hik et al. 1992) upon being released from the weight of glaciers. Istostatic uplift will create new salt marsh habitat as new land is exposed. However, the rate of new habitat creation would be too slow to keep up with the rate of habitat degradation caused by light geese. Vegetation in newly-exposed areas would be consumed by geese, thus preventing establishment of vegetation communities.

Under the No Action alternative, we expect that increasing numbers of lesser snow and Ross's geese in the central Arctic (e.g. Queen Maude Gulf Migratory Bird Sanctuary) would magnify the extent of habitat damage that has already occurred (see section 3.2.1). Plant communities within light goose breeding colonies would continue to be converted to exposed peat, and eventually would erode to bare soil. Loss of vegetation at colony sites likely would lead to desertification, with little chance of recovery of plant communities. In the absence of population control, expansion of CMF light goose wintering and migration ranges within the conterminous United States would continue. Use of traditional migration routes and stopover areas likely would decline as the birds deplete local resources more quickly and earlier in each respective season. Goose damage to agricultural crops such as winter wheat likely would increase.

Western Population of Ross's geese

Under the No Action alternative, the size of the WPRG would continue to increase. The breeding range of the WPRG overlaps that of CMF light geese in the central Arctic. Therefore, the anticipated impacts of increased numbers of Ross's geese are identical to those outlined above for CMF light geese.

Pacific Flyway Population of lesser snow geese

Presently, extensive damage to vegetation has not been reported on light goose breeding areas in the western Arctic. However, field vegetation studies have not been in place to document whether or not any significant impacts have occurred. At the current rate of population growth, the number of breeding lesser snow geese in the western Arctic will reach 0.8 million by 2005 and one million by 2010. As population size and bird density increases on colony sites, we believe that geese may begin to impact breeding habitats in a manner similar to birds in the eastern and central Arctic.

Wrangel Island Lesser Snow Geese

The population of Wrangel Island lesser snow geese has averaged less than 100,000 birds since the 1980s. Spring weather on Wrangel Island has a profound influence on productivity of geese and may limit population growth. There are no indications that this population is impacting breeding habitats. Given the static nature of the trend of this population, it is unlikely that large-scale habitat damage by geese would occur in the near future under the No Action alternative.

4.3.2 Alternative B. (PREFERRED ACTION) Modify harvest regulation options and refuge management.

Greater snow geese

Adoption of this alternative would result in a reduction of the population to 500,000 birds. Under current habitat conditions, achievement of this population level would prevent birds from exceeding the short-term ability of breeding habitats on Bylot Island to support them (Masse et al. *in press*). Information on the long-term carrying capacity of habitats on Bylot Island is not available, though it is likely to be at a lower level than the short-term carrying capacity (Masse et al. *in press*). We cannot fully assess the effects on other breeding areas due to the lack of information on their carrying capacity. However, we assume that geese would be less likely to exceed carrying capacities of such areas, or would be brought down closer to them, at lower population levels.

Reduction of the population would help prevent the carrying capacity of marshes on migration areas in the St. Lawrence Valley from being further exceeded. However, the influence of geese on natural marshes would not be eliminated. Instead, the low-level steady state described by Giroux and Bedard (1987) would be maintained. Similarly, goose damage to agricultural crops would be alleviated somewhat, but not eliminated.

CMF Light Geese

Adoption of this alternative would result in a 50% reduction of the number of CMF light geese. Such a reduction would likely decrease the rate of habitat destruction that is occurring on Arctic and subarctic habitats. Because habitats that are already destroyed may never recover, or will take decades to recover, remaining geese would still exploit remaining plant communities. However, due to a much smaller goose population, the pressure on such habitats would be alleviated somewhat. Because light geese migrate and winter in large flocks, localized damage to agricultural crops would likely continue even at lower population levels. However, the overall extent of damage should be reduced because fewer sites would be visited and/or fewer birds are present to consume crops.

Western Population of Ross's geese

The breeding range of the WPRG overlaps that of CMF light geese in the central Arctic. Therefore, the anticipated habitat impacts of this alternative with respect to the WPRG are identical to those outlined above for CMF light geese.

Pacific Flyway Population of lesser snow geese

Presently, extensive damage to vegetation has not been reported in western arctic breeding areas. However, field vegetation studies have not been in place to document whether or not any significant impacts have occurred. As population size and bird density increases on colony sites, we believe that geese may begin to impact breeding habitats in a manner similar to birds in the eastern and central Arctic. This alternative would allow implementation of population control measures if damage to western arctic habitat becomes evident.

Wrangel Island lesser snow geese

There are no indications that this population is impacting breeding habitats. Given the static nature of the trend of this population, it is unlikely that these geese would cause large-scale habitat damage in the near future. Consequently, we do not anticipate that reduction measures would be necessary for this population.

4.3.3 Alternative C. Implement direct light goose population control on wintering and migration areas in the U.S.

Implementation of this alternative would result in the same level of population reductions discussed under Alternative B. Therefore, impacts to habitats for all light goose populations are the same as in Alternative B.

4.3.4 Alternative D. Seek direct light goose population control on breeding grounds in Canada.

Implementation of this alternative would result in the same level of population reduction discussed under Alternative B. Therefore, impacts to habitats for all light goose populations are the same as in Alternative B.

4.4 Impacts on Other Species

4.4.1 Alternative A. No Action.

Under this alternative, most light goose populations likely would increase in size and geographic range and would come into contact with other species more frequently. On the breeding grounds, light geese would seek out and exploit new areas and detrimentally alter habitats, thus adversely affecting other species that currently depend upon those habitats. We probably would continue to observe declines in local populations of other migratory birds in the Hudson Bay and James Bay salt marsh ecosystem as remaining habitats become so degraded that they are rendered unsuitable (see Chapter 3.3.4). Mammalian species, especially herbivores, which depend on those habitats would also be negatively affected. In addition, light geese would continue to compete with and displace individuals of other migratory bird species from favored habitats during winter and migration, jeopardizing their ability to survive and reproduce.

On the wintering grounds and in migration stopover areas, the incidence of avian cholera and mortality among other migratory bird species likely would increase due to transmission of the disease by growing light goose populations. The increasing number and expanding geographic distribution of avian cholera outbreaks represent a serious threat to waterfowl and other bird populations that are susceptible to the disease (Chapter 3.4). Transmission of avian cholera is enhanced by the gregarious nature of most waterfowl species and by high densities of birds that result from habitat limitations, especially in winter and spring (Friend 1999). As light goose populations grow, there would be increased likelihood of contraction of cholera by numerous waterbird and raptor species. Documented cases of cholera die-offs involving hundreds of thousands of birds in a single event point to the reasonable likelihood that larger die-offs would occur as light goose populations expand. Under the No Action alternative, we expect that waterfowl species such as pintail, mallard, white-fronted geese, and Canada geese would be affected by cholera outbreaks. Populations of sandhill cranes that migrate, stage, and winter with light geese would also be affected.

4.4.2 Alternative B. (PREFERRED ACTION) Modify harvest regulation options and refuge management.

Other waterfowl and crane hunting seasons, excluding falconry, would be closed during periods of the regular season when new methods of take are authorized for light geese. Furthermore, all waterfowl and crane hunting seasons, excluding falconry, must be closed in order to implement a conservation order for light geese. Therefore, impacts of this alternative on non-target species would be minimized. Establishment or expansion of a hunt program for light geese on a particular refuge may increase disturbance levels within hunted impoundments. However, because light geese would be the only legal species for citizens to take, the impacts to non-target species would be minimized. Implementation of this alternative would result in authorization of the use of electronic calls to take light geese. Field experiments indicate that use of electronic calls has little or no impact on non-target species (Olsen and Afton 2000). Only 4 of 463 geese shot using electronic calls under experimental conditions were non-target species (Canada and white-fronted geese). The majority of non-target species taken were clearly the result of misidentification by hunters. Such take likely would have occurred under normal hunting conditions even if electronic calls were not being used (Olsen and Afton 2000). Therefore, we believe the impact of additional methods of take on non-target species would be minimal.

Increasing hunting pressure on light geese on migration and wintering areas may result in breaking up of dense flocks of geese. Reduction in light goose density may reduce the risk of triggering an avian cholera outbreak, thereby reducing the risk of exposure to other avian species that winter, stage, and migrate with light geese. Further, any reduction in the populations may alleviate pressures on other avian species using the same habitats, particularly on the breeding grounds.

Alteration of refuge habitat programs to address light goose management will impact other species as well. Removal of light goose roosting areas via water level drawdowns will displace some waterbird species to other impoundments that have sufficient water. However, drawdowns would benefit species that are attracted to mudflat habitat (e.g. shorebirds). Reduction of agricultural crops would remove a food supply utilized by species other than light geese. However, the overall benefits to other species of replacing monocultures of agricultural habitat with more natural habitats would likely far outweigh possible negative impacts of removing the agricultural food supply.

4.4.3. Alternative C. Implement direct light goose population control on wintering and migration areas in the U.S.

The potential impacts of this alternative on non-target species are dependent on methods utilized to remove light geese from the population. If light geese are live-trapped, impacts to non-target species would be minimal because they can be released if they are caught incidental to trapping light geese. Lethal methods of capture, excluding removal by sharpshooters, are non-selective and may impact non-target species if they are found within target flocks of light geese. However, permits for light goose population reduction specifically prohibit agencies from taking any actions under the permit that would adversely affect non-target species. Light goose control efforts logically would focus on flocks where the prevalence of non-target species is low.

4.4.4 Alternative D. Seek direct light goose population control on breeding grounds in Canada.

The potential impacts of this alternative on non-target species are dependent on methods utilized to remove light geese from the population. If light geese are live-trapped, impacts to non-target species would be minimal because they can be released if they are caught incidental to trapping light geese. Lethal methods of capture, excluding removal by sharpshooters, are non-selective and may impact non-target species if they are found within target flocks of light geese. Light goose control efforts logically would focus on flocks where the prevalence of non-target species is low.

4.5 Impacts on Special Status Species

4.5.1 Alternative A. No Action.

Impacts of this alternative on special status species would be similar to those outlined in section 4.4.1 for other species. On the wintering and migration areas, incidences of avian cholera and mortality among other migratory bird species likely would increase due to transmission of the disease by light geese. Disease threat would also increase for threatened species such as bald eagles. Of concern is the possibility of increasing exposure of avian cholera to the endangered whooping crane population, which also migrates through some of the same areas as CMF light geese. A major avian cholera outbreak could affect recovery efforts for whooping cranes if substantial numbers of individuals contract the disease. Under this alternative, protection of endangered whooping cranes would be continued through implementation of the Contingency Plan for Federal-State Cooperative Protection of Whooping Cranes (Federal-State Contingency Plan Committee 2000).

4.5.2 Alternative B. (PREFERRED ACTION) Modify harvest regulation options and refuge management.

Other waterfowl and crane hunting seasons, excluding falconry, would be closed during periods of the regular season when new methods of take are authorized for light geese. Furthermore, all waterfowl and crane hunting seasons, excluding falconry, must be closed in order to implement a conservation order for light geese. Light geese would be the only legal species that could be taken during special regulatory actions. Therefore, impacts of this alternative on special status species would be minimized. We have initiated Section 7 consultation on our proposal in compliance with the Endangered Species Act. Results of this consultation will be available to the public when completed.

Under this alternative, protection of endangered whooping cranes would be ensured through implementation of the Contingency Plan for Federal-State Cooperative Protection of Whooping Cranes (Federal-State Contingency Plan Committee 2000). The contingency plan provides a mechanism for designating appropriate response options and reporting requirements whenever whooping cranes are confirmed as sick, injured, or dead, or when they are healthy but in a situation where they face hazards, such as shooting/hunting activities or contaminants and disease. Spring migration pathways of whooping cranes overlap those of light geese in the Central Flyway (Fig. 3.24). Peak migration of cranes through important stopover areas along the Platte River and other portions of Nebraska occur during April (Fig. 3.25). In 2000, Nebraska held their light goose conservation order during March 11-April 15. Selection of such dates reduces potential impacts to whooping cranes. During the past two years, no whooping cranes have been shot incidental to efforts intended to increase harvest of light geese. As discussed in section 4.4.2, this alternative would reduce the risk of avian cholera outbreaks and subsequent impacts on special status species.

Impacts of altering refuge habitat programs on special status species would be similar to those outlined in section 4.4.2 for other species. Considerations for the presence of special status species would be made prior to making changes to habitat programs on a particular refuge. Changes in habitat management would not be made on a particular refuge if special status species would be negatively impacted.

4.5.3. Alternative C. Implement direct light goose population control on wintering and migration areas in the U.S.

The potential impacts of this alternative on non-target species are similar to those outlined in section 4.4.3 for other species. Permits for light goose population reduction specifically prohibit agencies from taking any actions under the permit that would adversely affect non-target species. Control efforts would not be implemented if special status species would be negatively impacted.

4.5.4. Alternative D. Seek direct light goose population control on breeding grounds in Canada.

The potential impacts of this alternative on non-target species are dependent on methods utilized to remove light geese from the population. If light geese are live-trapped, impacts to non-target species would be minimal because they can be released if they are caught incidental to trapping light geese. Lethal methods of capture are non-selective and would result in potentially large impacts to non-target species if they are found among light geese on breeding colonies. Light goose control efforts logically would focus on colony sites where the prevalence of special status species is low.

4.6 Socioeconomic Impacts

The economic impact estimates associated with changes in both consumptive and non-consumptive expenditures identify the gross economic impacts associated with each of the alternatives. As such, they represent (for a given set of assumptions) a conservative, high-end estimate of the net economic effects of changes in light goose-related expenditures. From a multi-state or national perspective, changes in light goose expenditures simply result in a transfer or reallocation of resources from one type of expenditure pattern to another. For example, if one particular alternative results in a decrease of expenditures on light goose hunting, there would most likely be an increase in expenditures on other activities. A person who formerly hunted light geese may switch to duck hunting or some other type of hunting activity. Other people may devote more time and expenditures to other, non-hunting activities. Consequently, the project alternatives basically result in a change in expenditure patterns; overall spending at the national or multi-state level may remain about the same, but each particular pattern of expenditures results in different business or industrial sectors gaining or losing.

Perhaps the most noticeable effect of any change in the level of expenditures would be in sparsely populated rural areas where a business (or businesses) depends specifically on non-resident hunters spending money to hunt light geese in the area. Changes in hunting opportunities may noticeably decrease the number of hunters coming into a particular area with the resultant effect on hunting related expenditures. Consequently, for a particular town or county, there may be a decrease in hunting related expenditures that may not be offset by expenditures on other activities within the area. Since this project is national in scope, it is not feasible to document the economic impact of the alternatives on all areas that may be potentially affected by the project. The economic impact estimates that follow identify the potential or gross impacts of changing expenditures associated with light goose hunting.

4.6.1 Alternative A. No Action.

In the absence of population control measures we expect that light goose populations would continue to increase throughout Arctic and subarctic regions. As bird densities increase on breeding areas, additional habitats would be degraded and their ability to support geese would decrease. In addition, the incidence of avian cholera among light geese and other species is likely to increase throughout the Flyways, particularly at migration stopover sites. Losses to other species such as pintails, white-fronted geese, sandhill cranes, and whooping cranes, may be great. This may result in reduced hunting, bird-watching, and other opportunities. In addition, agencies would incur costs of salvaging carcasses following disease outbreaks. Salvage operations often cost $1/bird (M. Samuel, U.S. Geological Survey, personal communication); therefore, costs for collecting carcasses could amount to several hundred thousand dollars. Goose damage to winter wheat and other agricultural crops would continue and worsen. Habitat damage in the Artic would eventually trigger density-dependent regulation of the population, which likely would result in increased gosling mortality and may cause the population to decline precipitously. However, it is not clear when such population regulation would occur and what habitat, if any, would remain to support the survivors. Such a decline may result in a population too low to permit any hunting, effectively closing light goose hunting seasons. The length of the closures would largely depend on the recovery rate of the breeding habitat, which likely would take decades. Subsistence hunting of light geese may also be affected if a particular goose colony near a native community declined to very low levels. This scenario of overpopulation followed by population decline forms the basis for analysis of the economic impact of the No Action alternative.

<u>Consumptive uses</u>

Previously, we estimated that the total economic impact of light goose hunting in the U.S. was $146 million (Chapter 3.5.1). This impact was the result of expenditures on trip and equipment-related expenditures. Closure of light goose hunting in a particular Flyway likely would influence trip-related expenses to a greater degree because equipment purchased could be used to hunt other waterfowl species. We assume that hunters would take fewer trips per year if light goose hunting was closed. Trip-related expenditures represent approximately 44% of all annual expenditures of migratory bird hunters (U.S. Dept. Interior 1997). We assume that trip-related expenditures for light goose hunting are the same proportion of total expenditures as are those for all migratory bird hunting. Therefore, we estimate the total economic impact of trip-related expenditures for light goose hunting in the U.S. to be approximately $64.8 million. We used the geographic distribution of light goose harvest to estimate the economic impact of trip-related expenditures in each Flyway (Table 4.6). Such expenditures represent the economic losses that would result from closure of light goose hunting in each Flyway.

The potential economic impacts for each Flyway under the No Action alternative assume that population levels would reach sufficient levels to cause severe habitat damage and decline of light goose populations. Clearly, all light goose populations are not at the same stage of development in relation to these potential events. The current situation with regard to CMF light geese is the most serious. Severe habitat damage has occurred on CMF breeding grounds and the effects of overpopulation are already being documented on certain portions of the breeding range. Therefore, the Central and Mississippi Flyway regions face the most immediate threat of closures to light goose hunting. However, we have no information to guide us in determining the timeframe in which such closures may occur.

Table 4.6. Potential economic impact of closure of light goose hunting in each Flyway, based on losses of trip-related expenditures by hunters.

	Flyway				
	Atlantic	Mississippi	Central	Pacific	U.S.
Percent of U.S. light goose harvest	5.1	35.9	52.6	6.4	100.0
Total annual economic impact resulting from loss of trip-related expenditures ($ million)[1]	$ 3.3	$23.3	$34.1	$4.1	$64.8[2]

[1] Total economic impact of trip-related expenditures for light goose hunting in the U.S. ($64.8 million) multiplied by proportion of total U.S. harvest of light geese occurring in each Flyway.
[2] Total economic impact of light goose hunting in the U.S. ($146 million) multiplied by the proportion of total expenditures related to trip-related expenses (0.44).

A precipitous decline in a particular light goose population may negatively impact subsistence use of geese near native communities. As mentioned previously, the annual light goose harvest per subsistence hunter has remained fairly constant on the Hudson Bay coast during the past several decades, despite large increases in light goose abundance (see section 3.5.3). Therefore, subsistence harvest likely would not be affected until light goose population levels declined much below those observed during the same time period. There is no information available to guide us in determining the degree of population decline that would affect subsistence harvest. However, it is likely that severe habitat deterioration on a particular colony site would reduce the number of geese available to subsistence hunters near a neighboring community. Subsistence hunting would then rely on birds migrating from other areas during fall migration. Native harvest of light geese on migration and wintering areas in the U.S. may also be affected by severe declines in light goose populations. Although light geese concentrate in larger flocks during migration and winter, there may be fewer total flocks available to subsistence hunters following a population crash.

Non-consumptive uses

Approximately 19.1 million people participate in non-consumptive uses (e.g., observe, photograph, etc.) of waterfowl in the U.S. each year, and spend $3.3 billion on trip- and equipment-related expenses (U.S. Department of the Interior 1997, Teisl and Southwick 1995). The total annual economic impact of non-consumptive uses of waterfowl in the U.S. is approximately $9.8 billion (Teisl and Southwick 1995). Information on the percentage of non-consumptive usage that can be attributed to light geese in each Flyway is not available. Therefore, the economic impact of non-consumptive uses of light geese is not known.

However, we do not expect the No Action alternative to affect non-consumptive users of light geese to the same extent as consumptive users. Although a population decline may force closure of light goose hunting seasons, remaining birds would still be available for non-consumptive uses. Birds would continue to utilize traditional migration routes and winter areas, although at reduced numbers.

Current estimates of crop damage due to light geese are incomplete because most farmers do not report damage. The incidence of crop damage likely would increase as light goose populations expand, and we would expect a concurrent increase in farmers' reporting of such damages. However, we have no information to guide us in determining the potential magnitude of financial losses. In Quebec, government payments to farmers that experience crop damage due to light geese have been as high as $560,000 in some years. Damages to farms in the U.S. may approach such levels as light goose numbers increase.

4.6.2 Alternative B. (PREFERRED ACTION) Modify harvest regulation options and refuge management.

Under this alternative, States would be allowed to implement new regulations for light geese during the regular season of 107 days, as well as be able to implement a conservation order. In order to implement new regulations during the regular season, all other waterfowl and crane hunting seasons, excluding falconry, must be closed. New regulations include new methods of take such as electronic calls and unplugged shotguns. Many hunters may choose to purchase electronic calls, and most would purchase additional shotgun shells; however, we believe the total economic impact due to these purchases would be minor.

A conservation order for light geese would allow States to authorize citizens to take light geese when all waterfowl and crane hunting seasons, excluding falconry, are closed. A conservation order would allow new methods of take, require no bag limits, and would provide liberal shooting hours to take light geese. States would be allowed to implement a conservation order during any time period. We assume that little or no additional economic impact would result from invoking a conservation order prior to and including the normal hunting season closing date of March 10. However, economic impacts would result from extending a conservation order beyond the normal March 10 closing date.

We estimated the potential economic impact of a conservation order in each Flyway by calculating the percent increase in days in which light geese could legally be taken beyond the normal 107-day season. We used light goose harvest in each State to weight the potential number of additional days citizens would take trips to take light geese in that State. We then calculated a weighted percent increase in total days for each Flyway. To estimate the economic impact of additional days, we multiplied the weighted percent increase in days to the economic impact of trip-related expenses for taking light geese in each Flyway (Table 4.7). Information from conservation orders held in the Central and Mississippi Flyways during 2000 were

Table 4.7. Potential economic impact of trip-related expenditures during an extended time in which to take light geese in each Flyway.

	Flyway				
	Atlantic	Mississippi	Central	Pacific	U.S.
Percent of U.S. light goose harvest	5.1	35.9	52.6	6.4	100.0
Total annual economic impact of trip-related expenditures (million)[1]	$ 3.3	$23.3	$34.1	$4.1	$64.8[2]
Weighted proportional increase in time frame in which light geese may be taken[3]	0.54	0.23	0.41	0.23	na[4]
Economic impact of additional days (million)[5]	$1.8	$5.4	$14.0	$0.9	$22.1

[1] Total economic impact of trip-related expenditures for light goose hunting in the U.S. ($64.8 million), multiplied by proportion of total U.S. harvest of light geese occurring in each Flyway.
[2] Total economic impact of light goose hunting in the U.S. ($146 million) multiplied by the proportion of total expenditures related to trip-related expenses (0.44).
[3] Additional days beyond March 10 in which take of light geese is authorized in each State, weighted by light goose harvest in each State. Proportion increase calculated by number of days beyond 107 days.
[4] Not estimated.
[5] Total economic impact of trip-related expenditures in Flyway, multiplied by proportional increase in time frame in which light geese can be taken in Flyway.

used to determine the exact number of extra days in which take of light geese was allowed. For the Atlantic and Pacific Flyways, we assumed that southern States would authorize the take of light geese for an additional 21 days, and northern States would add 60 days. This assumption is reasonable given our experience in the Central and Mississippi Flyways, and the fact that light geese depart southern wintering areas fairly early in spring.

Implementation of this alternative would preserve the long-term health of light goose populations by slowing the rate of habitat degradation and avoiding a potential population crash, especially in the mid-continent region. Damage to agricultural crops would also be reduced. Non-consumptive users of light geese may be slightly affected by lower overall populations. However, light geese would continue to migrate in relatively large flocks and visit traditional migration and wintering areas. Therefore, we believe the short-term economic impact of this alternative on non-consumptive users would be minimal, and the long-term economic impact would be positively enhanced due to maintenance of healthy populations.

Avoidance of precipitous population declines would preserve subsistence uses of light geese. The annual light goose harvest per subsistence hunter has remained fairly constant on the Hudson Bay coast during the past several decades, despite large increases in light goose abundance. Therefore, we believe that reduction of a particular population to a level that has been observed in recent decades, and which habitats can better sustain, will have little short-term effect on subsistence hunting. Furthermore, we believe the long-term prospects for subsistence hunting will be preserved if light goose populations are maintained at levels that habitats can support.

4.6.3 Alternative C. Implement direct light goose population control on wintering and migration areas in the U.S.

Under this alternative, population reduction would be achieved through direct action by agency personnel. Additional days in which to take light geese beyond traditional hunting seasons would not be made available to citizens. In the absence of additional days, there would be no additional economic impacts resulting from trip-related expenditures by people pursuing light geese. As with Alternative B, implementation of this alternative would preserve the long-term health of light goose populations by slowing the rate of habitat degradation and avoiding a potential population crash, especially in the mid-continent region. Closure of normal light goose hunting seasons, and associated negative economic impacts, would be avoided. Damage to agricultural crops would also be reduced.

The impacts of Alternative C on subsistence use of light geese are similar to those outlined in Alternative B. We believe that reduction of a particular population to a level that has been observed in recent decades, and which habitats can better sustain, will have little short-term effect on subsistence hunting. Furthermore, we believe the long-term prospects for subsistence hunting will be preserved if light goose populations are maintained at levels that habitats can support.

Non-consumptive users of light geese may be slightly affected by lower overall populations. However, light geese would continue to migrate in relatively large flocks and visit traditional migration and wintering areas. Therefore, we believe the short-term economic impact of this alternative on non-consumptive users would be minimal, and the long-term economic impact would be positively enhanced due to maintenance of healthy populations.

Direct population control operations have not previously been conducted for light geese; therefore, cost estimates are not available. Costs of capturing Canada geese for purposes of population reduction in Minnesota averaged $10/bird (Keefe 1996). Additional costs of processing captured birds for donation to food banks averaged another $6.80/bird, for a total of $16.80/bird (Keefe 1996). However, these costs represent capturing of birds during their flightless period after the nesting season. Capturing light geese with rocket nets on wintering sites likely would be inefficient (R. Cox, U.S. Geological Survey, personal communication), therefore we estimate the cost would increase to at least $20/bird. The total expense would be dependent on the magnitude of removal required at the time direct control was implemented. For example, a one-time agency removal of 116,000 greater snow geese from the population (see Table 4.3), to achieve the management goal of 500,000 birds, would cost approximately $2.3 million. Agency removal of 655,000 CMF light geese from the population (see Table 4.5) would cost approximately $13.1 million/year for several years until management goals were achieved.

The cost to agencies of using chemical agents to reduce light goose populations would be dependent on the specific chemical used. Currently, the most likely chemical control agents available for control of light geese are DRC-1339, Avitrol, and alpha chloralose. The average total cost per bird for using DRC-1339 or Avitrol to kill geese would be approximately $2.96 and $2.82, respectively (J. Cummings, U.S. Dept. of Agriculture, unpublished data). Birds killed using DR-1339 or Avitrol must be collected and destroyed or buried due to chemical residues in carcasses. This would represent a waste of the goose resource and could potentially be met with negative public reaction. A one-time agency removal of 116,000 greater snow geese from the population using DRC-1339 or Avitrol would cost agencies up to $343,000. Agency removal of 655,000 CMF light geese from the population would cost up to $1.9 million/year for several years until management goals were achieved.

Birds captured through immobilization with alpha chloralose could be utilized for human consumption after a 30-day live holding period to allow chemical residues to be expelled from the bodies of geese. The added costs of holding live birds for a 30-day period prior to processing for human consumption would raise the agency cost of using alpha chloralose to approximately $15.26/bird (J. Cummings, U.S. Dept. of Agriculture, unpublished data). Processing of carcasses for consumption would add $6.80/bird (Keefe 1996), thus raising the total agency cost to $22.06/bird. The magnitude of negative public reaction would likely be reduced if birds were utilized for consumption after being captured with the aid of alpha chloralose. However, the total cost to agencies would be significantly higher than using other chemical agents. A one-time agency removal of 116,000 greater snow geese from the population using alpha chloralose would cost agencies approximately $2.6 million. Agency removal of 655,000 CMF light geese from the population would cost $14.5 million/year for several years until management goals were achieved.

4.6.4 Alternative D. Seek direct light goose population control on breeding grounds in Canada.

As with Alternative C, this alternative would achieve population reduction through direct action by agency personnel. Additional days in which to take light geese beyond traditional hunting seasons would not be made available to citizens. In the absence of additional days, there would be no additional economic impacts resulting from trip-related expenditures by people pursuing light geese. Implementation of

Alternative D would preserve the long-term health of light goose populations by slowing the rate of habitat degradation and avoiding a potential population crash, especially in the mid-continent region. Closure of normal light goose hunting seasons, and associated negative economic impacts, would be avoided. Damage to agricultural crops would also be reduced.

The impacts of Alternative D on subsistence use of light geese are similar to those outlined in Alternative B. We believe that reduction of a particular population to a level that has been observed in recent decades, and which habitats can better sustain, will have little short-term effect on subsistence hunting. Furthermore, we believe the long-term prospects for subsistence hunting will be preserved if light goose populations are maintained at levels that habitats can support.

Non-consumptive users of light geese may be slightly affected by lower overall populations under this alternative. However, light geese would continue to migrate in relatively large flocks and visit traditional migration and wintering areas where non-consumptive uses take place. Therefore, we believe the short-term impact of this alternative on non-consumptive users would be minimal, and the long-term impact would be positively enhanced due to maintenance of healthy populations in the future.

The agency costs of implementing this alternative depend on the timing of when direct control would occur. Control during the nesting period utilizing sharpshooters on colony sites would be constrained to a 20-day incubation period when geese confine their movements to the immediate vicinity of nest sites. Movements of family groups after hatching would make shooting of birds much less efficient. It is estimated that a team of 10 sharpshooters could remove nesting birds from the population at a cost (U.S. dollars) of approximately $1.45/bird (R. Alisauskas, unpublished data). However, this cost estimate assumes that birds would not be recovered after they were killed. This would represent a waste of the goose resource and could potentially be met with negative public reaction. The magnitude of negative public reaction would likely be reduced if birds were collected and utilized for consumption after being killed. Costs of collecting dead birds from nesting colonies are not available; however, we assume that collection and transportation costs would add at least $2/bird. Although information is not available to guide us, we assume that the processing of carcasses in Arctic communities would be 40% higher than the $6.80 estimated by Keefe (1996) in the U.S. Thus, the total agency cost of killing and processing birds in the Arctic would be approximately $13/bird. For example, removal of 655,000 CMF light geese from breeding colonies could cost agencies $8.5 million/year for several years.

Chemical control of light geese in Canada would be most effective during migration when birds are still concentrated in large flocks. Costs for chemical control would be similar to those outlined under Alternative C. Chemical control on arctic breeding areas would be most effective after the nesting period when geese forage in larger flocks. However, geese likely would not be found in flocks as large as those that occur during migration and winter. Therefore, chemical control would be less efficient on the breeding grounds. Furthermore, the cost of applying chemicals in the Arctic would be higher. Information is not available to guide us in projecting exact costs for chemical control in the Arctic. However, we assume that costs in the Arctic would be 40% higher than those on migration and wintering areas. A one-time agency removal of 116,000 greater snow geese from the population using DRC-1339 or Avitrol would cost agencies up to $480,000; whereas use of alpha chloralose would cost approximately $3.6 million.. Agency removal of 655,000 CMF light geese from the population using DRC-1339 or Avitrol would cost up to $2.7 million/year for several years until management goals were achieved. Use of alpha chloralose for CMF light geese in the Arctic would cost $20.2 million/year for several years until management goals were achieved.

4.7 Waste and Disposal of Geese

Previously, we identified the need to prevent waste of the light goose resource under each management alternative. Although the concept of waste is more applicable to alternatives that call for reduction of light goose populations, some readers may consider the No Action alternative to be a waste of the goose resource if a population crash occurs. Problems associated with disposal of goose carcasses varies by alternative.

4.7.1 Alternative A. No Action.

As mentioned above, some readers may consider this alternative to be a waste of the goose resource if a population crash occurs. The degree of waste depends on the time required for the potential crash to occur. A prolonged decline in a particular population may result in small numbers of birds dying over several years. Remaining carcasses likely would be consumed by scavengers as they became available. However, a rapid population crash would likely result in a large number of carcasses that would overwhelm the ability of scavengers to consume them. This represents a potential waste of the goose resource.

4.7.2 Alternative B. (PREFERRED ACTION) Modify harvest regulation options and refuge management.

We believe this alternative has the best potential to prevent waste of the light goose resource. Light geese removed from the population by citizens participating in a conservation order would be taken to individuals' homes and processed for consumption. Alternatively, individuals may also donate geese to food shelters. Agencies would not incur any costs for collection and disposal of carcasses.

4.7.3 Alternative C. Implement direct light goose population control on wintering and migration areas in the U.S.

The potential for waste of the light goose resource under direct agency control is dependent on whether uses for goose carcasses can be found. Conditions of the permit for light goose control would require that agencies must utilize such birds by donation to public museums or public institutions for scientific or educational purposes, by processing them for human consumption and distributing them free of charge to charitable organizations, or by burying or incinerating them (Appendix 4). We believe that burying or incinerating carcasses would represent a waste of the goose resource.

Birds removed by killing with DR-1339 or Avitrol must be collected and destroyed or buried due to chemical residues in carcasses that make them unfit for human consumption. This would represent a waste of the goose resource and could potentially be met with negative public reaction. Furthermore, costs to agencies of collecting and burying or incinerating carcasses would be high. Waste of carcasses could be prevented if birds were captured with alpha chloralose and held for 30 days prior to processing for human consumption. However, agency costs would be substantially higher under this option (see section 4.6 for costs). The magnitude of light goose removal under Alternative C may make it difficult to prevent a portion of carcasses from being wasted. For example, agency removal of 655,000 CMF light geese every year for several years could overwhelm facilities that are available to accept carcasses.

4.7.4. Alternative D. Seek direct light goose population control on breeding grounds in Canada.

The potential for waste of the light goose resource is higher if control is conducted in remote northern breeding areas. Agency costs for light goose control on northern breeding areas are higher, due to higher logistical costs of fieldwork in the Arctic. Therefore, the option of not collecting carcasses after population reduction occurs may have to be considered in order to reduce overall costs. We believe this would represent a waste of the resource that likely would be met with negative public reaction. As with Alternative C, the potential for waste of birds removed using the chemicals DR-1339 or Avitrol exists under Alternative D. Use of alpha chloralose would reduce waste, but would be much more expensive in northern breeding areas if birds had to be held in captivity for 30 days.

The magnitude of light goose removal under Alternative C may make it difficult to prevent a portion of carcasses from being wasted. For example, agency removal of 655,000 CMF light geese every year for several years could overwhelm facilities that are available to accept carcasses.

4.8 Cumulative Impacts

4.8.1 Alternative A. No Action.

Under the No Action alternative, we expect population increases to continue and damage to habitats to worsen and expand into new areas. Cumulative impacts to habitats, especially in sensitive tundra habitats, will be more persistent as the degree of damage increases with repeated exposure to goose feeding activities. Repeated incidences of light goose damage to agricultural crops may reach the point where farmers demand compensation for financial losses. Over time, we expect that cumulative impacts to other species that utilize the same habitats as light geese will become more evident. Higher light goose populations will increase the likelihood of disease outbreaks that would impact light geese as well as other susceptible species. Furthermore, it is possible that the No Action alternative would eventually lead to a decline in one or more light goose populations as a result of overpopulation. Such declines may force managers to restrict or close light goose hunting seasons, and subsistence hunting may be negatively impacted. Cumulative impacts to non-consumptive users would become evident if a population crash causes a reduction in the size and density of flocks, which may force citizens to travel longer distances to see remnant flocks.

Cumulative impacts also would occur if the No Action approach were adopted in situations where other wildlife species have became overabundant. For example, some local populations of resident Canada geese have become overabundant and are resulting in increasing numbers of conflicts with human activities. Continued use of the “no action” approach would likely increase the number of conflicts. Continued inaction for all situations where wildlife has become overabundant would likely cause significant cumulative impacts to habitats and conflicts with human activities would increase.

4.8.2 Alternative B. (PREFERRED ACTION) Modify harvest regulation options and refuge management.

This alternative would return light goose populations to levels that we believe are more compatible with the ability of natural habitats to support them. The cumulative impacts to habitats would be that the rate of damage from light geese would be slowed. However, it is likely that habitats in the Arctic and subarctic that are already damaged would take decades to recover, if recovery is even possible. Cumulative impacts under Alternative B may result in special regulations being alternately implemented and suspended for various light goose populations depending on the status of the population in relation to the management goal. With regard to habitat management on refuges, the cumulative impacts under Alternative B would be a reduction in the acreage of agricultural habitats in favor of more natural habitats. This impact should benefit a variety of species that tend to be absent from agricultural habitats.

Utilization of actions similar to Alternative B for other wildlife species that have become overabundant would have positive cumulative impacts. Populations would be maintained at levels more compatible with the ability of natural habitats to support them. Wildlife agencies would not incur additional costs associated with population control because they would not be directly involved in removal of animals from the population.

4.8.3 Alternative C. Implement direct light goose population control on wintering and migration areas in the U.S.

Cumulative impacts of direct population control under Alternative C differ from control under Alternative B. Due to high costs to agencies, direct population control likely would be implemented only when a particular population has greatly exceeded management goals. Therefore, control efforts may be less frequent under Alternative C in an effort to improve cost-efficiency. However, if approaches similar to Alternative C were used in by agencies in response to overabundance of other wildlife species, the cumulative financial costs would be prohibitively high. Costs for wildlife population control would consume greater proportions of agency budgets, and financial allocations to other management activities would have to be reduced.

4.8.4. Alternative D. Seek direct light goose population control on breeding grounds in Canada.

Cumulative impacts of direct population control under Alternative D are similar to those under Alternative C. However, the magnitude of financial cost would be much greater due to the high cost of conducting control efforts in remote breeding areas. Costs for wildlife population control on northern breeding areas would consume even higher proportions of agency budgets, thus resulting in more drastic reductions in financial allocations to other management activities.

4.9 Impacts on Historical and Cultural Resources

The geographic extent of light goose breeding, migration and wintering areas is continental in scope and encompasses a variety of historical sites and cultural resources. The management alternatives analyzed in this document do not involve construction of new buildings, excavations, or other activities that normally disturb historical sites or cultural resources. Therefore, we expect no impacts to historical or cultural resources under any of the alternatives.

4.10 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* directs Federal agencies to incorporate environmental justice in their decision making process. Federal agencies are directed to identify and address as appropriate, any disproportionately high and adverse environmental effects of their programs, policies, and activities on minority or low-income populations. Impacts of the four management alternatives on subsistence users of light geese were discussed in section 4.6. To review, adoption of the No Action alternative would likely negatively affect native subsistence harvest of light geese if arctic habitat degradation severely reduced or eliminated availability of light geese near a native community. Native harvest of light geese on migration and wintering areas in the U.S. may also be affected by severe declines in light goose populations. Although light geese concentrate in larger flocks during migration and winter, there may be fewer total flocks available to subsistence hunters following a population crash. Subsistence harvest of light geese per hunter has remained fairly constant in recent decades, despite large increases in light goose abundance. Population control using Alternatives B, C, and D would return light goose population levels to those observed in recent decades. Therefore, we do not anticipate any negative impacts to subsistence harvest of light geese by natives under Alternatives B, C, or D. None of the alternatives would create any environmental pollution. No minority or low-income populations would be displaced by any of the alternatives.

Table 4.8. Summary of environmental consequences of light goose management alternatives .

Issue	Alternative A. No Action.	Alternative B. (PREFERRED). Modify harvest regulation options and refuge management.	Alternative C. Direct control of light goose populations on wintering and migration areas in U.S.	Alternative D. Direct control of light goose populations on breeding areas in Canada.
Light goose populations	Allowed to increase, which may lead to crash.	Reduced to management goal levels. Efficient use of removed birds.	Reduced to management goal levels. Potential for waste of birds removed.	Reduced to management goal levels. Potential for waste of birds removed.
Existing light goose harvest regulations	No change from current policies and procedures.	Remain in place, subject to modification if new regulations implemented.	No change from current policies.	No change from current policies.
New light goose regulations	None.	Implement new methods of take and conservation order	Creation of new U.S. agency permit for population control.	No new U.S. regulations.
Habitat	Continued degradation of breeding, migration, and wintering habitat.	Reduction or halting of habitat degradation	Reduction or halting of habitat degradation.	Reduction or halting of habitat degradation.
Agricultural crop depredations	Increased depredations.	Reduced depredations	Reduced depredations.	Reduced depredations.
Refuge hunting programs	No change from current policies and procedures.	Creation or expansion of hunt programs on certain refuges	No change from current policies and procedures.	No change from current policies and procedures.

Table 4.8. (Continued)

Issue	Alternative A. No Action.	Alternative B. (PREFERRED). Modify harvest regulation options and refuge management.	Alternative C. Direct control of light goose populations on wintering and migration areas in U.S.	Alternative D. Direct control of light goose populations on breeding areas in Canada.
Refuge habitat management	No change from current policies and procedures.	Decrease in agricultural habitats on some refuges; alteration of roost area water levels as appropriate.	No change from current policies and procedures.	No change from current policies and procedures.
Waste and disposal of birds	Potential waste of goose resource if population crashes.	No waste of birds No disposal necessary.	Potentially large waste of goose resource if no uses can be found. Potentially high costs to agencies.	Potentially large waste of goose resource if no uses can be found. Potentially very high costs to gencies.
Other species	Increased exposure to avian cholera outbreaks. Degradation of habitat near light goose nesting colonies.	Reduced likelihood of exposure to avian cholera outbreaks. Slowing of arctic habitat degradation. Benefit from reduction of agricultural habitats.	Reduced likelihood of exposure to avian cholera outbreaks. Slowing of arctic habitat degradation.	Reduced likelihood of exposure to avian cholera outbreaks. Slowing of arctic habitat degradation.
Special status species	Potential increased exposure to avian cholera outbreaks.	Reduced likelihood of exposure to avian cholera outbreaks.	Reduced likelihood of exposure to avian cholera.	Reduced likelihood of exposure to avian cholera.

Table 4.8. (Continued)

Issue	Alternative A. No Action.	Alternative B. (PREFERRED). Modify harvest regulation options and refuge management.	Alternative C. Direct control of light goose populations on wintering and migration areas in U.S.	Alternative D. Direct control of light goose populations on breeding areas in Canada.
Socioeconomic	Increased potential for closure of light goose hunting season. Smaller impact on non-consumptive uses of light geese versus consumptive uses. Potential cost to agencies high if cholera outbreaks require clean-up operations. Negative impact on subsistence hunting if goose populations crash.	Maintenance of light goose hunting seasons. Increased economic impact associated with conservation order. Maintenance of quality of non-consumptive uses. Low cost to agencies. Little or no effect on subsistence harvest.	Maintenance of light goose hunting seasons. Maintenance of quality of non-consumptive uses. No increased economic impact. High agency costs. Little or no effect on subsistence harvest.	Maintenance of light goose hunting seasons. Maintenance of quality of non-consumptive uses. No increased economic impact. High agency costs. Little or no effect on subsistence harvest.
Cultural resources	No impact.	No impact.	No impact.	No impact.
Cumulative impacts	Increases in other wildlife populations may cause damage to other habitats and increased conflicts with humans.	Other wildlife populations kept at levels at which habitats can support them. No increased agency costs.	Increased number of control programs for other species at potentially high cost to agencies.	Increased number of control programs for other species at potentially high cost to agencies.