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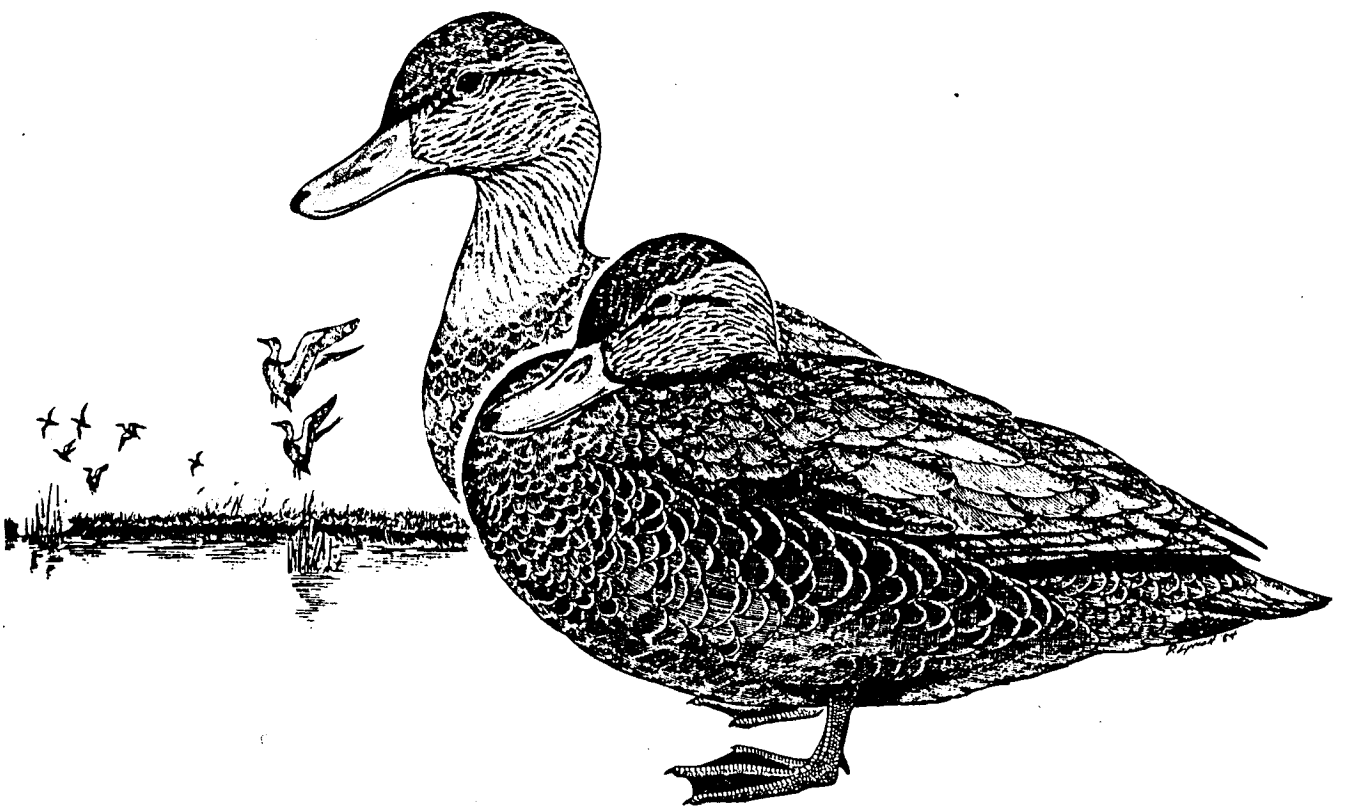
REFUGE MANAGEMENT ANALYSES: OBJECTIVES AND MANAGEMENT APPROACHES AT EDWIN B. FORSYTHE NATIONAL WILDLIFE REFUGE



Fish and Wildlife Service

U.S. Department of the Interior

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REFUGE MANAGEMENT ANALYSES: OBJECTIVES AND MANAGEMENT APPROACHES AT EDWIN B. FORSYTHE NATIONAL WILDLIFE REFUGE

by

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EXECUTIVE SUMMARY

Edwin B. Forsythe National Wildlife Refuge (hereafter referred to as the Refuge or Forsythe) is located on the Atlantic Ocean in southeastern New Jersey about 10 miles north of Atlantic City. It was created in 1984 by combining the former Brigantine and Barnegat National Wildlife Refuges. Both former Refuges were established under the authority of the Migratory Bird Conservation Act to preserve estuarine habitats important to the Atlantic brant and to provide nesting habitats for black ducks and rails. The most abundant habitat (over 30,000 acres) is estuarine marsh, most of which has been ditched in the past for mosquito control. Two large managed impoundments (1,400 acres) are another important feature of the Refuge. The marshes and impoundments provide habitat for a great diversity of migratory birds and resident wildlife.. Public use is an important aspect of the management program at Forsythe because of the recreational and educational opportunities it affords an expanding population, and the impacts of visitors on wildlife.

For the past 15 years, the Refuge has been operating with only a very old and general set of objectives pertaining to waterfowl, threatened and endangered species, public use, and research. The purpose of the workshop described in this report was for Refuge and Regional Office personnel to update the old objectives, and to discuss more specific objectives for the Refuge and general management strategies for achieving those objectives. It was anticipated that these objectives and strategies would form the basis for preparing Part 2 of a Refuge management plan (as described in the Management Planning section of the Refuge Manual--4RM3.13-14), and that more specific strategies for Part 3 of the management plan would be developed later by Refuge personnel.

Workshop participants first outlined a more specific set of objectives, with quantified measures of performance when possible, and then categorized them as either

high, medium, or low priority. The highest priority objectives were concerned with black ducks, Atlantic brant, snow geese, piping plovers, peregrine falcons, maintaining indigenous habitats and species, providing important interpretive information to visitors, deemphasizing nonwildlife-oriented recreation, and providing opportunities for scientific study and research in support of management planning.

Following the discussion of Refuge objectives, workshop participants listed factors that might be contributing to management deficits for each high priority objective pertaining to waterfowl, shorebirds, and threatened and endangered species, as well as management strategies that might be used to address those factors. Strategies for addressing high priority objectives concerning other wildlife and habitats and public use were also discussed. These strategies will be evaluated further by Refuge staff and the most promising ones will be addressed in greater detail in specific management plans (e.g., a public use plan).

Finally, participants suggested a number of surveys and research projects that might be conducted in support of management planning.

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We are indebted to these individuals for contributing the majority of the ideas and information contained in this report. In particular, we thank Curt Laffin for giving us the opportunity to conduct the workshop, and the staff at Edwin B. Forsythe National Wildlife Refuge for their hospitality. In preparing this report, we have attempted to retain both the content and sense of discussions at the workshop, but accept full responsibility for errors of fact or interpretation.

INTRODUCTION

BACKGROUND

Edwin B. Forsythe National Wildlife Refuge (hereafter referred to as the Refuge or Forsythe) is located on the Atlantic Ocean in southeastern New Jersey extending from Barnegat south to Absecon. It was created in 1984 by combining the former Brigantine and Barnegat National Wildlife Refuges, which are now referred to as divisions of Forsythe. Brigantine was established in 1939 under the authority of the Migratory Bird Conservation Act to preserve estuarine habitats important to the Atlantic brant (Branta bernicla) and to provide nesting habitats for black ducks (Anas rubripes) and rails. Barnegat was established in 1967 under the same authority, with the basic purpose of preserving estuarine feeding and resting habitat for ducks and brant. At present, the approved Refuge boundary contains 45,403 acres, of which about 76% (34,610 acres) has been acquired.

Forsythe is located entirely within the Atlantic Coastal Plain, with elevations ranging from sea level to 50 feet above mean sea level (ft msl). Estuarine marsh dominated by salt marsh cordgrass (Spartina alterniflora) and saltmeadow cordgrass (S. patens) is the most abundant habitat (Table 1). Most of the marsh has been ditched in the past for mosquito control. Palustrine forested wetlands on the Barnegat Division are dominated by red maple (Acer rubrum), oaks (Quercus spp.), black gum (Nyssa sylvatica), sweetgum (Liquidambar styraciflua), and occasional stands of Atlantic white cedar (Chamaecyparis thyoides). Grasslands occur mainly at the interface between the salt marsh and woodlands. Upland woodlands are dominated by pitch pine (Pinus rigida), red maple, and various oaks, while reverting grasslands contain forbs and grasses interspersed with sassafras (Sassafras

Table 1. Habitat types (acres) at Edwin B. Forsythe National Wildlife Refuge.

Habitat type	Brigantine Division	Barnegat Division	Forsythe Refuge
Wetlands			
Estuarine	21,279	8,981	30,260
Palustrine	--	460	460
Uplands			
Grassland	99	10	109
Woodland	1,830	1,434	3,264
Sand	264	142	406
Dredge Spoil	96	--	96
Administrative	10	5	15
Total	23,578	11,032	34,610

albidum), eastern red cedar (Juniperus virginiana), and winged sumac (Rhus copallina).

Two large (1,400 acres) managed impoundments are an important feature of the Brigantine Division. The West Pool (Figure 1), fed by Doughty Creek and springs, is managed as a fresh water impoundment. The East Pool is managed as a brackish impoundment, receiving water from the West Pool and through tide gates operated by Refuge staff. Additional fresh water areas at Brigantine include the experimental pool (spring-fed), a sand borrow pit, and a gravel pit. Three fresh water "stop ditch" impoundments are located on the Barnegat Division. These areas, totaling about 100 acres, were formed by plugging old mosquito control ditches and channels and are fed by upland streams.

These impoundments, particularly the East and West Pools, and the other wetlands at Forsythe provide important feeding, nesting, and resting habitat for a variety of waterfowl, other water birds, and several Federal or State threatened or endangered.

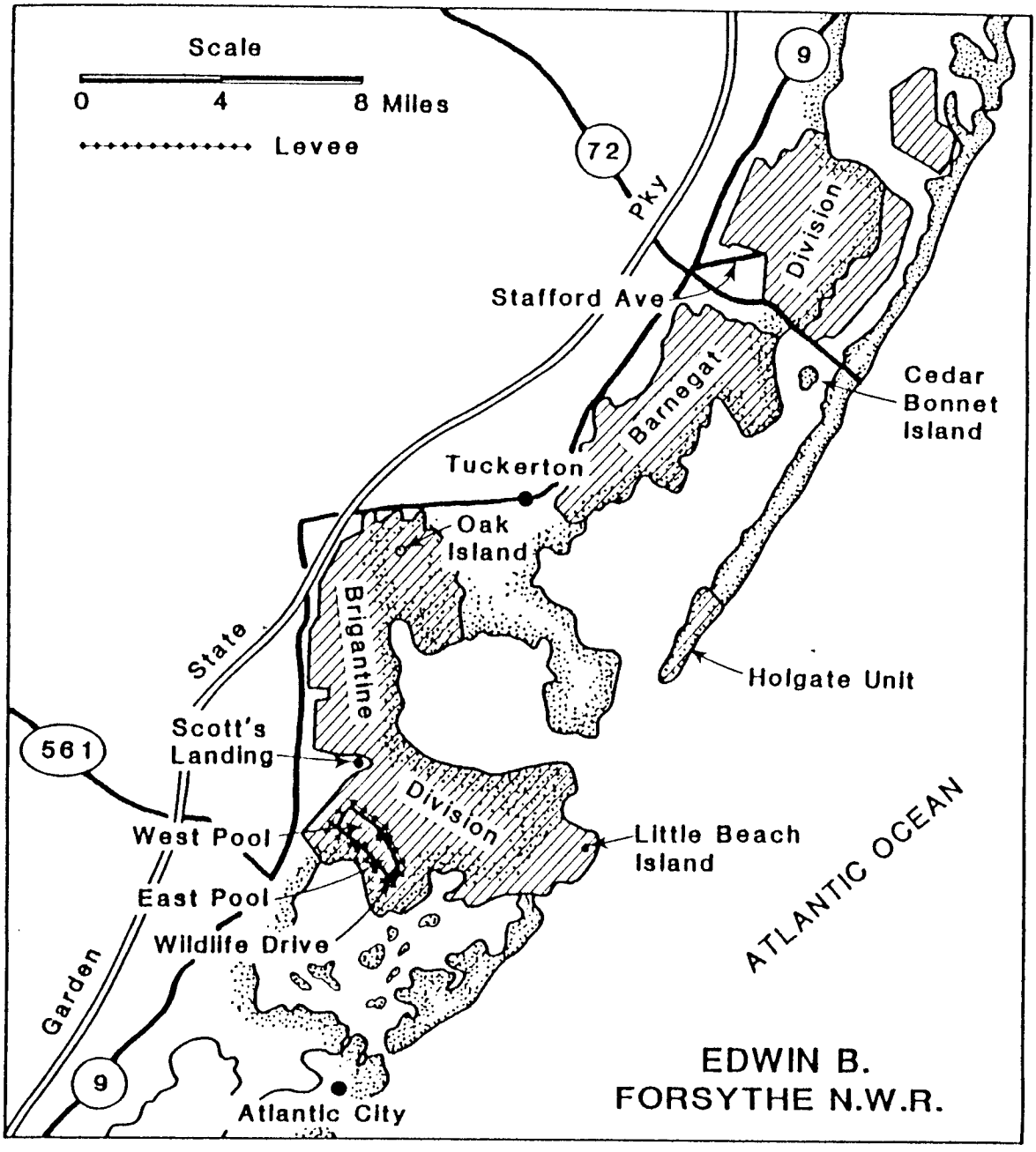

Figure 1. Edwin B. Forsythe National Wildlife Refuge.

From 1980 to 1985, an average of 33% of the Atlantic Flyway black duck population and 60% of the Atlantic brant population wintered in the coastal wetlands of New Jersey. In 1985, 20% of the State's wintering black ducks and 21% of the State's wintering brant werefound at Forsythe. The Refuge also provides significant wintering habitatfor mallards (Anas platyrhynchos), American wigeon (A. americana), canvasbacks (Aythya valisineria), and greater scaup (A. marila), and nesting habitat for mallards and black ducks.

Federal or State threatened or endangered species important at Forsythe include the piping plover (Charadrius melodus), peregrine falcon (Falco peregrinus), bald eagle (Haliaeetus leucocephalus), osprey (Pandion haliaetus) least tern (Sterna antillarum), and black skimmer (Rynchops niger). Piping plovers nest on the Holgate Unit of the Barnegat Division and on Little Beach Island at the Brigantine Division. In 1986, 7 breeding pairs produced an estimated 13 young at the Holgate Unit. Peregrine falcons are not native to Forsythe but use artificial nesting structures on the Refuge. They can be seen at Forsythe throughout the year and, in 1986, both Divisions had an active peregrine nest. Only the nest at Brigantine was successful, however, producing one young to flight stage. Bald eagles are occasional visitors to the Refuge. Ospreys nest on both Divisions and, in 1986, produced a total of 16 young. Least terns and black skimmers nest on the Holgate Unit and use other parts of the Refuge for feeding and resting.

Public use is an important aspect of the management program at Forsythe because of the recreational and educational opportunities it affords and its impacts on wildlife. Perhaps the most important of these is disturbance of nesting piping plovers at the Holgate Unit by pedestrians, off-road vehicles, and other recreationists. Although the Holgate Unit is a designated Wilderness Area, Refuge ownership, and thus Wilderness status, extends oceanward only to the mean high tide line. The riparian zone from this line to the water's edge is under the jurisdiction of the State, and recreationists make use of this corridor for a variety of activities. From 1984 to 1987, Service personnel erected fences and signs to protect all or parts of the plover's nesting habitat from disturbance, and, in 1986, the Township of Long Beach and the New Jersey Department of Environmental Protection closed portions of the beach to off-road

vehicle use during parts of the nesting season. Disturbance is still a problem, however, and Refuge personnel have prepared an Environmental Assessment in which the proposed action is for the Service to obtain and exercise management authority over the riparian zone. The Service is currently pursuing this option.

Other forms of public use at Forsythe include waterfowl hunting, trapping, salt water fishing, crabbing, wildlife observation and photography, and environmental education. Waterfowl hunting presently occurs on about 40% of the salt marsh habitat. Refuge personnel feel that, in addition to providing recreation, the hunting program can be an important tool for managing waterfowl. Trapping also occurs on both Divisions, but interest in recent years has been low because leg-hold traps are no longer legal in New Jersey. Fishing and crabbing occur at several locations around the Refuge. The two primary areas for wildlife observation are the Holgate Unit and an auto tour route around the East and West Pools. Most of the environmental education programs are conducted by the Outdoor Recreation Planner at the Brigantine Division. Considerable time and money are devoted to managing the public-use activities and ensuring their compatibility with the needs of wildlife.

WORKSHOP PURPOSE AND APPROACH

For the past 15 years, the Refuge has been operating with only a very general set of objectives pertaining to threatened and endangered species, waterfowl, public use, and research. The basic purpose of the workshop was for Refuge and Regional Office personnel to discuss more specific objectives for both Divisions of the Refuge and general management strategies for achieving those objectives. It was anticipated that these objectives and strategies would form the basis for preparing Part 2 of a refuge management plan (as described in the Management Planning section of the Refuge Manual--4RM3.13-14), and that more specific strategies for Part 3 of the management plan would be developed later by Refuge personnel. We served as facilitators and recorders for the discussions.

The initial step at the workshop was to outline a more specific set of objectives, with quantified measures of performance when possible. Participants then categorized

these objectives as either high, medium, or low priority, and developed general management strategies for achieving the high priority objectives. Finally, there was a discussion of research and monitoring activities that could provide information useful in assessing whether or not the objectives are being achieved.

REFINEMENT OF REFUGE OBJECTIVES

In the absence of a formal refuge management plan (although a number of specific management plans have been completed), Forsythe has been operating under the following general objectives:

1. preserve and manage the wetlands environment for waterfowl, shorebirds, and other wildlife as production, migration, and wintering habitat;
2. perpetuate existing habitat that is found to benefit rare or endangered species;
3. provide environmental education and wildlife-oriented recreation programs and facilities to the public; and
4. encourage scientific study and research by qualified organizations and individuals.

Initial discussions at the workshop focused on revising and refining these Refuge objectives to reflect resource capabilities and projected use demands over the next 3-5 years. Coordination with national objectives and the North American Waterfowl Management Plan was a primary concern when defining Refuge-specific objectives. Table 2 summarizes the refined objectives and the relative ranking assigned to each.

WATERFOWL AND SHOREBIRDS

Atlantic Brant

About 20% of New Jersey's wintering brant population uses the Refuge and immediate vicinity. Very little active management has been required other than protection of salt marsh habitat. The objective for Atlantic brant should be to provide habitat of sufficient quantity and quality to return 20% of the flyway population

Table 2. Refuge objectives and relative rankings.

Objective	Ranking
Waterfowl and Shorebirds	
Brant Provide habitat to return 20% of the flyway population (a minimum of 20,000 birds) to the breeding grounds in good reproductive condition.	High
Black duck - migration Provide habitat that could support 100,000 black ducks at peak migration with not more than 20% of the flyway population using the Refuge.	High
Black duck - wintering Maintain an orderly winter migration of black ducks and minimize mortality of ducks over-wintering on the Refuge.	High
Black duck - production Maximize the reproductive condition of black duck hens during spring migration and attain a 5-year average production of 1,000 black ducks (to flight stage).	High
Snow goose Manage snow goose populations so that the cumulative impact on the salt marsh (i.e., eat-out areas) is not more than 10% in any given year and the impact on production areas in the impoundments is minimized.	High
Other waterfowl - migration Maintain current numbers and diversity of other waterfowl (i.e., other than brant and black duck).	Medium
Other waterfowl - production Increase production of other indigenous waterfowl.	Medium
Shorebirds, wading birds, other water birds - nesting Maintain the current number of nesting pairs of shorebirds, wading birds, and other water birds (except gulls).	Medium

(Continued)

Table 2. (Continued)

Objective	Ranking
Shorebirds, wading birds, other water birds - production Maintain gull populations at levels that minimize impact on the production of other waterfowl, shorebirds, wading birds, and water birds.	High
Canada goose Maintain Canada goose populations at present levels.	Low
<u>Threatened and Endangered Species</u>	
Piping plover Increase the number of nesting pairs to 30 with an average of 1.5 fledglings per pair.	High
Peregrine falcon Maintain 2 nesting pairs with an average of 2 fledglings per pair.	High
Bald eagle Encourage the nesting of one pair.	Medium
Osprey Maintain 10-20 nesting pairs with an average of 1.2 fledglings per pair.	Medium
Black skimmer Maintain 400 nesting pairs with an average of 1.0 fledgling per pair.	Medium
Least tern Maintain 300 nesting pairs with an average of 1.0 fledgling per pair.	Mediu
<u>Other Wildlife and Habitats</u>	
Woodcock Increase production and maintain or improve migration habitat to attain an average of 0.5 singing males per stop on the survey route.	Medium

(Continued)

Table 2. (Concluded)

Objective	Ranking
Other resident wildlife Manage resident wildlife populations so that they do not adversely impact the habitat for species of primary interest.	Medium
Plant communities Maintain the diversity and quality of indigenous plants and plant communities.	High
<u>Public Use</u>	
Ensure that visitors enjoy high quality experiences through provision of: - clearly signed directions to and through the Refuge, - opportunities to observe wildlife and wildlife habitat, - feasible opportunities to observe management techniques that relate to interpretive messages, - uncrowded conditions, and - clean and efficiently functioning facilities.	High
Convey the following minimum information to each Refuge visitor: - name of the Refuge, - distinction between a National Wildlife Refuge and other public lands, and - highlights of Forsythe's contribution to wildlife and wildlands resources.	High
Relate interpretive messages to Refuge objectives and management strategies (4RM 3.16-3).	High
Ensure that public use activities and facilities meet legal mandates for compatibility.	High
<u>Scientific Study and Research</u>	
Provide opportunities for scientific study and research when such activities are compatible with wildlife objectives and support Refuge management.	Medium

(a minimum of 20,000 birds) to the breeding grounds in good reproductive condition. The portion of this objective concerning the number or percent of birds should be evaluated based on the mid-winter inventory adjusted for subsequent mortality. An index will have to be developed to evaluate reproductive condition.

Black Duck

Approximately 20% of the New Jersey black duck population winters on the Refuge or surrounding areas and a larger percentage uses the Refuge during migration. In addition, the Refuge has had an average production of over 500 black ducks over the last five years. Black ducks are of special concern to the Service because of their long-term population decline in the Atlantic Flyway. Separate objectives were discussed for migration, wintering, and production habitat.

Migration. The Refuge should provide habitat to support 100,000 black ducks at peak migration, with not more than 20% of the flyway population using the Refuge. The objective of 100,000 ducks is consistent with the current carrying capacity of about 3 ducks per acre over 30,000 acres of salt marsh. This objective can be evaluated based on the fall black duck survey.

Wintering. The Refuge should try to maintain an orderly southward migration of black ducks and minimize the mortality of ducks that overwinter on the Refuge. There was much discussion during the workshop concerning whether the Refuge is good winter habitat. In years when areas such as the impoundments freeze over relatively early, black ducks will continue to migrate southward. In years with a relatively late freeze (e.g., mid to late January), however, the ducks will not continue migrating and may suffer heavy mortality because ice and snow in the salt marsh prevent them from feeding.

Production. The Refuge should maximize the reproductive condition of black duck hens during spring migration (both hens that will nest at Forsythe as well as those that will migrate farther north before nesting) and attain a 5-year average Refuge production of 1,000 black ducks to flight stage by 1993. The actual production objective can be evaluated using brood surveys; evaluation of the reproductive condition objective will require developing an appropriate condition index.

Snow Geese

The primary concern with snow geese (Chen caerulescens) is the impact they have on black duck habitat in the salt marsh and impoundments. While some "eat-outs" provide diversity for shorebirds and other waterfowl, such as green-winged teal (Anas crecca), extensive impacted areas might reduce the ability of the Refuge to support migrating, wintering, and nesting black ducks. Therefore, the Refuge should manage snow goose populations so that the cumulative impact on the salt marsh is not more than 10% of the area in any given year and the impact on black duck production areas in the impoundments is as small as practically possible. This objective can be evaluated using annual aerial surveys by Refuge staff.

Other Waterfowl

The Refuge provides significant wintering habitat for a variety of other waterfowl including mallards, wigeon, canvasbacks, and scaup, and nesting habitat for mallards, gadwall (Anas strepera), blue-winged teal (A. discors), wood ducks (Aix sponsa), and several others. The Refuge should maintain the current number and diversity of other migrating and wintering waterfowl and should increase production of other indigenous waterfowl. Brood surveys and fall and winter surveys for peak waterfowl populations can be used to evaluate these objectives.

Shorebirds and Colonial Nesting Waterbirds

A variety of shorebirds and colonial nesting waterbirds use Forsythe. The Refuge should maintain the current number of nesting pairs of these birds, with the exception of gulls. Gulls, especially laughing (Larus atricilla) and herring gulls (L. argentatus), are a major predator on chicks of the piping plover (on Federal threatened species list) and the least tern and black skimmer (on State endangered species list). Therefore, the Refuge should maintain gull populations at levels that minimize impacts on the production of shorebirds and colonial nesting waterbirds.

Canada Geese

Canada geese (Branta canadensis) currently use the Refuge for migration and nesting but are not causing any adverse habitat impacts, as are the snow geese. The Refuge should therefore maintain Canada goose populations at present levels.

THREATENED AND ENDANGERED SPECIES

All of the Refuge objectives for Federal or State threatened or endangered species concern nesting and production. These objectives can be evaluated using various breeding bird surveys.

Piping Plover

The coastal population of piping plovers is on the Federal threatened species list. Over 10 pairs have nested on the Refuge during the past several years, and management of their limited nesting habitat is a prime Refuge concern. In 1986, an estimated 10-12 plovers were seen on Little Beach Island, but no nests or young were observed; in 1987, plovers nested and produced young on the island. At Holgate, breeding success in 1986 was limited, primarily by human disturbance, but 7 breeding pairs produced an estimated 13 young to flight stage. In future years, the Refuge should increase the number of nesting pairs to 30, with an average fledging rate of 1.5 young per pair.

Peregrine Falcon

Peregrines have nested at both Refuge divisions since 1980, and they prey heavily on species found within the surrounding salt marshes. The peregrine is designated as a Federal endangered species. In 1986, peregrines successfully fledged one young for the first time in 3 years. In the future, the Refuge should maintain two nesting pairs of peregrine falcons with an average of two fledglings per pair.

Bald Eagle

The bald eagle is listed as a Federal endangered species. Bald eagles have traditionally used roost sites on the Refuge, and several potential nest sites have been identified on wooded islands secluded in the salt marsh. The Refuge should encourage the nesting of one pair of bald eagles, with Oak Island being the most likely nesting site.

Osprey

The osprey is one of several species listed by the State of New Jersey as threatened or endangered. Presently, 10-20 pairs of osprey nest on the Refuge, with an average fledging rate of 1.2 young per pair. The Refuge should maintain the current number of nesting pairs and the fledging rate.

Black Skimmer

The black skimmer is listed by the State of New Jersey as endangered. During 1986, about 400 pairs of black skimmers established a colony at Holgate. Although the original colony was abandoned, a second nesting attempt produced about 400 young to flight stage. Black skimmers also nested on Refuge salt marsh islands during 1986; however, no production was observed from these colonies. The objective for black skimmers should be to maintain 400 nesting pairs on the Refuge and the fledging rate of 1.0 young per pair.

Least Tern

The least tern is also a State-listed endangered species. In 1986, least terns established two separate colonies at Holgate. The larger colony of about 100 pairs produced almost no young to flight stage because of serious gull predation; the smaller colony of 50 pairs suffered very little predatory loss of chicks and fledged 1 chick per pair. The Refuge should increase the number of least tern nesting pairs to 300 and maintain a fledging rate of 1.0 young per pair.

OTHER WILDLIFE AND HABITATS

A great variety of resident wildlife species and marine organisms use the habitats found at Forsythe NWR. The Refuge's overall objective is to maintain each of those species and habitats.

Woodcock

The woodcock (Scolopax minor) is a National Species of Special Emphasis that has bred in forest openings and early successional brush and forest stands at the Refuge. The Refuge objective should be to increase woodcock production and maintain or improve migration habitat to attain an average of 0.5 singing males per stop on the survey route.

Other Resident Wildlife

While there is a need to maintain the diversity of wildlife using the Refuge, there is always the danger that, if unmanaged, some wildlife populations may increase to the point where they negatively impact the habitat of more important species. This question is currently being addressed for white-tailed deer (Odocoileus virginianus) at Forsythe. Initial studies indicate that although deer may not be causing damage to current forest habitats, they may be inhibiting efforts to reestablish Atlantic white cedar. In general, the Refuge objective should be to manage all resident wildlife populations so that they do not impact the habitat for species of primary interest.

Plant Communities

The variety of wildlife using Forsythe is due to the amount and variety of habitats available. Some of these habitats are slowly being lost either through human disturbance, such as off-road vehicle use, or through natural processes, such as plant

succession. For example, succession is filling in forest clearings used by nesting woodcock and beach washovers used by piping plovers. The Refuge should maintain the diversity and quality of indigenous plant communities, even when the decrease in a community is due to natural processes.

PUBLIC USE

Public use of Forsythe has increased steadily since 1981 due to the influx of residents and tourists to southern New Jersey in general and the Atlantic City area in particular. Public use activities include consumptive wildlife-oriented recreation (e.g., migratory bird hunting, fishing), nonconsumptive wildlife-oriented recreation (e.g., wildlife observation, photography, hiking, nature study), and nonwildlife-oriented recreation (e.g., picnicking, sunbathing, swimming, waterskiing, boating). The Refuge staff also conducts educational and interpretive activities for students and other groups. Because of the importance of the Refuge for public use, much of the discussion during the workshop focused on how best to balance the primary goal of providing habitat and protection for wildlife with the desire to provide public use opportunities. All of the public use objectives were ranked as high priorities by workshop participants. First, the Refuge should ensure that visitors enjoy a high-quality experience by providing: (1) clear directional signs to and through the Refuge, (2) opportunities to observe wildlife and wildlife habitat, (3) opportunities to observe management techniques that relate to interpretive messages, (4) uncrowded conditions, and (5) clean and efficiently functioning facilities. Second, the Refuge should convey the following minimum information to each refuge visitor: the name of the Refuge, the distinction between a National Wildlife Refuge and other public lands, and the highlights of Forsythe's contribution to wildlife/wildlands resources. Third, the Refuge should relate interpretive messages to refuge objectives and management strategies (e.g., why people and off-road vehicles are restricted from the sand dunes during piping plover nesting season). And finally, the Refuge should ensure that public use activities and facilities meet legal mandates for compatibility. The primary focus would be to deemphasize nonwildlife-oriented recreation, especially where these activities disturb wildlife (e.g., sunbathing during plover nesting season, jogging on the wildlife drive). These objectives are difficult to evaluate because they concern people's attitudes and

subjective feelings. However, they can be qualitatively assessed based on visitor's suggestions or comments and could be quantitatively assessed with a formal survey such as the one conducted by Applegate (Applegate et al. 1982a,b; Applegate and Clark 1984).

SCIENTIFIC STUDY AND RESEARCH

After some discussion, workshop participants decided that, in general, the current objective for scientific study and research is sufficient. The objective was reworded slightly to state that the Refuge should provide opportunities for scientific study and research when such activities are compatible with wildlife objectives and support Refuge management.

MANAGEMENT STRATEGIES FOR HIGH PRIORITY OBJECTIVES

Following the discussion of Refuge objectives, workshop participants listed factors that might be contributing to management deficits for each high priority objective related to waterfowl, shorebirds, and threatened and endangered species, as well as management strategies that might be used to address those factors (Table 3). Strategies for addressing high priority objectives concerning other wildlife and habitats and public use were also discussed and are summarized in Table 4. The management strategies in Tables 3 and 4 should not be interpreted as the only activities that will be conducted by the Refuge; rather, they are activities that will be used in addition to current management practices to meet the highest priority Refuge objectives.

Because the workshop discussions were intended to provide information for developing Part 2 of a refuge management plan, the management strategies are fairly general. These strategies will subsequently be refined by the Refuge staff into specific management activities for Part 3 of the management plan. For example, modifying the waterfowl hunt was suggested as one strategy for reducing disturbance of Atlantic brant; specific suggestions for changing open hunting areas, designated sites, number of hunters per site, or maximum number of shells will be addressed in the waterfowl hunting plan.

Table 3. Proposed management strategies for addressing high priority objectives related to waterfowl, shorebirds, and threatened and endangered species.

Objective Category	Factors Limiting Output	Proposed Strategy
Waterfowl and Shorebirds		
Brant	Disturbance	Obtain riparian rights Modify hunting
	Limited population and use pattern surveys	Conduct population survey Conduct use pattern survey
	No condition index	Develop and monitor condition index
Black duck - migration	None	Continue present management Acquire designated lands
Black duck - wintering	Starvation	Draw down impoundments early Haze birds
Black duck - production	Inadequate brood habitat	Manage marshes Construct impoundments
	Predation -mammalian	Conduct spring trapping Contract trapping Conduct other predator control Improve nesting cover
	Predation - avian	Control gull populations

(Continued)

Table 3. (Continued)

Objective Category	Factors Limiting Output	Propose Strategy
	Inadequate nest cover	Renovate impoundments Develop dense nesting cover Experiment with timber management Develop small islands
	Inadequate census method for salt marsh	Develop method
Snow geese	Number of geese and sanctuary	Adjust hunting areas and timing Draw down or renovate impoundments Provide alternate food source Haze birds
	Monitoring	Conduct aerial survey
Shorebirds, etc. (gulls)	Number of gulls	Reduce gull populations
<u>Threatened and Endangered Species</u>		
Piping plover	Public use	Obtain riparian rights Fence and post areas Enforce restricted areas Interpret restrictions
	Limited habitat and succession	Create washovers Acquire and manage Cedar Bonnet Island
	Predation - mammalian	Conduct predator control Build predator exclosures

(Continued)

Table 3. (Concluded)

Objective Category	Factors Limiting Output	Proposed Strategy
	Predation - avian	Reduce gull populations Build predator exclosures
Peregrine falcon	Great horned owls	Move tower at Brigantine
	Few perches	Add perching structures
	Predation	Modify predator shields

WATERFOWL AND SHOREBIRDS

Atlantic Brant

Brant primarily use the salt marshes and open bays when they are at Forsythe. Sufficient habitat probably exists to meet the objective of returning 20% (or at least 20,000 birds) of the flyway population to the breeding grounds in good reproductive condition, as long as the birds don't burn excessive energy flying away from disturbances. Much of the disturbance could be eliminated by obtaining riparian rights and modifying some aspects of the waterfowl hunting program. Both of these factors are presently being addressed by Refuge staff. Quantifying the extent to which this objective is being achieved is a significant problem. Such quantification will require population surveys and use-pattern surveys, which are not easy to do over the large area of estuarine habitat. Also, a condition index will have to be developed and monitored for brant; this will involve measuring a condition index similar to that described in the literature, correlating that index with production, and then determining what level of the index constitutes "good reproductive condition." If the condition index of monitored brant is acceptable in any given year,

Table 4. Proposed management strategies for addressing high priority objectives related to other wildlife and habitats and public use.

Objective Category	Proposed Strategy
Other Wildlife and Habitats	
Plant communities	Evaluate/develop refuge management plans to maintain or restore indigenous habitats and species Inventory birds, plants, animals
Public Use	
Ensure a high-quality experience, convey minimum information, and relate interpretive messages to Refuge objectives	Improve entrance (need site design plan) Develop other interpretive exhibits Maintain/modify wildlife drive Review foot trails Evaluate use of fire lanes Control public access - provide better signing and interpretation Evaluate need for outdoor classroom and teacher workshops Develop leaflets and information packets Maintain waterfowl hunt Maintain volunteer program Evaluate gift catalog program and cooperative association
Ensure compatibility of public use	Eliminate public use at Holgate from April 15 to August 15 Evaluate bicycling, hiking, and jogging on trails and fire lanes - restrict these activities on wildlife drive Evaluate restrictions on wildlife observation activities on the Refuge with emphasis on the diked portion of the wildlife drive

then present management would be continued. If the index is below acceptable levels, there are few, if any, management actions that could be taken to improve the birds' condition in that year. However, activities could be initiated to improve habitat or reduce disturbance in subsequent years and thereby improve reproductive condition in the future.

Black Duck

Migration. The objective to support 100,000 black ducks at peak migration is consistent with the current Refuge carrying capacity of about 3 ducks per acre over the current 30,000 acres of salt marsh. Therefore, no additional management activities are required. Lands currently designated should be acquired in support of the North American Waterfowl Management Plan.

Wintering. The objective to maintain an orderly southward migration of black ducks and minimize mortality of overwintering ducks is not met only in years with a relatively late freeze. Such conditions occur every 7-10 years. In years when areas such as the impoundments freeze over relatively early, black ducks will continue to migrate southward. However, in years with a relatively late freeze (e.g., mid to late January), the ducks will not continue migrating and may suffer heavy mortality because the ice and snow covering the salt marsh prevents them from feeding. One strategy to encourage continued migration would be to draw down the impoundments relatively early (e.g., December) and thereby eliminate the feeding and open water resting habitat that may keep the birds at Forsythe. Some ditching and renovation of water control structures may be required to implement this strategy. If the impoundments could not be drawn down for some reason, or if the birds did not leave even after drawdown, hazing would be considered. In addition to these management activities, the Refuge should continue, or reinstitute, monitoring of bird condition to build on the baseline data collected by Costanzo (1988).

Production. Black ducks nest in a variety of habitats including salt, brackish, and freshwater marshes and upland areas (including dikes). Production losses are suspected to be due primarily to predation of incubating hens and chicks; often, nest failures due

to tidal flooding and human disturbance also contribute to the problem. In order to increase black duck production at Forsythe, management strategies were suggested for addressing inadequate brood habitat, predation, inadequate nesting cover, and inadequate census methods.

Workshop participants felt that there was inadequate brood habitat in tidal marshes, especially at the Barnegat Division. This situation could be improved by using Open Marsh Water Management (OMWM) techniques and by restoring or constructing small impoundments in the marsh. Nesting cover could be improved in a variety of ways. In the impoundments (starting with the East Pool), habitat renovation activities would include restoring nesting islands, improving circulation, cleaning ditches and channels, and creating permanent water areas. In the uplands, some research will be required to determine exactly where black ducks nest; however, establishing dense nesting cover and experimenting with timber/brush management were suggested as possible strategies to improve upland nesting cover. In the salt marsh, elevated islands need to be created to reduce nest failure from tidal flooding. OMWM practices could create low islands by digging "donuts" in the marsh; however, the center island would be at the same level as the marsh and therefore still prone to flooding. These islands could be "raised" by placing bales of hay on them. The Refuge manager has a preliminary determination from the Corps of Engineers that a bale of hay placed on such islands would not constitute "fill" and therefore would not violate any general permit conditions. Techniques being evaluated by the State of Delaware for creating nesting structure in salt marshes should also be considered.

Predation by mammals and birds affects black duck production at Forsythe. Because interest in commercial trapping is diminishing, the Refuge should consider hiring trappers, trapping in the spring, and other forms of predator control (e.g., shooting, poisoning). In terms of avian predation, the most effective strategy might be to reduce local gull populations. Improving nesting cover and brood habitat for black ducks, as described above, should also help reduce predation.

Finally, better census techniques will have to be developed in order to evaluate the extent to which the black duck production objective is being achieved. The Bennett method (Bennett 1967) of conducting brood surveys is not feasible in expansive salt

marshes with low duck densities because of the large number of observation platforms required; past efforts to use the method from the ground were not very successful.

Snow Geese

Limiting snow goose damage is a high-priority objective because of the large number of snow geese using the Refuge and the sanctuary they are provided in portions of the Refuge. One strategy that has been successfully used at Bombay Hook National Wildlife Refuge to address similar problems is to adjust hunting areas and times to keep geese out of high impact areas. Implementing such a strategy would require closing the tour route during hunting season if snow goose "eat-outs" became excessive in the impoundments or the surrounding salt marsh. A less intensive version of this strategy has been tried at Forsythe. Another option that has been tried by the Refuge is to draw down the impoundments before the snow geese arrive; the geese usually won't feed unless the roots of desirable plants are flooded. While this strategy may not always cause the geese to move, it has seemed to prevent further significant damage to vegetation in the impoundments. A potential problem with this strategy is that a mid-November drawdown to discourage goose feeding may conflict with providing migration habitat for black ducks arriving in late November. Impoundment renovation would have a similar effect on snow geese, without the potential impact on black duck migration, by providing deeper water for the ducks while keeping water off the vegetation so that the geese will not feed. Other potential strategies include attempting to provide an alternate food source (e.g., alfalfa) for the geese or hazing. Achieving the snow goose objective will also require periodic aerial surveys or photography to determine when snow goose damage has exceeded the specified limits.

Shorebirds and Colonial Nesting Waterbirds

Controlling gull populations was listed as a high-priority objective, primarily because of the impacts that predation by gulls has on other birds, including some of the threatened and endangered species. As such, strategies for this objective are discussed below.

THREATENED AND ENDANGERED SPECIES

Piping Plover

Piping plover production at Forsythe is limited by disturbance associated with various public use activities, loss of suitable nesting habitat through succession, and predation. Public use of beach areas disturbs plover nesting on the high beach as well as feeding in the intertidal zone. Disturbance of nest sites is currently controlled by fencing, posting, and law enforcement activities. Interpretation of posted areas should be increased, and enforcement of illegal public use on the Refuge should be continued. Disturbance of nesting and feeding sites could be best controlled by obtaining riparian rights (the intertidal zone) and controlling access to and use of these areas. The Refuge is considering acquiring these rights.

Suitable piping plover habitat is limited at Forsythe; early successional sand dunes and the beach are used for nesting, and intertidal areas are used for feeding. The suitability of nesting habitat decreases as later successional plant species naturally invade. To maintain this habitat, the Refuge might have to control vegetation to simulate washovers along the beach if early successional sand dunes are disappearing faster than storms are creating them naturally. In addition, the Refuge should acquire Cedar Bonnet Island and implement habitat development activities (e.g., control Phragmites), control illegal public use, solicit additional sand spoil (the island is a dredge spoil island), and provide an interpretive kiosk.

Predation losses can be reduced by building additional predator exclosures, conducting additional mammalian predator control programs, and, possibly, selectively reducing laughing gull and herring gull populations. Gull control should also help reduce predation on black skimmers, least terns, and black ducks.

Peregrine Falcon

In order to increase peregrine fledging to 2.0 young per nesting pair, the Refuge should reduce great horned owl (Bubo virginianus) predation by moving the Brigantine

nesting tower at least 1/2 mile farther from the treeline (as suggested recently by staff from the Peregrine Fund), and reduce mammalian predation by modifying predator shields on nesting tower support poles. Adding other nesting towers was not recommended because, under current guidelines, towers must be at least 5 miles apart as well as several miles from piping plover nesting areas. According to these criteria, the area is probably already at capacity for towers. It would also help to build additional perching structures around the Brigantine tower. Another factor that may be limiting peregrine falcon production is DDT residues, which is a problem the Refuge can do nothing about.

OTHER WILDLIFE AND HABITATS

Plant Communities

Maintaining or restoring indigenous habitats and species at Forsythe is an important but general objective, one that may be difficult to plan for because it involves interdependencies between traditional management plans. For example, efforts to restore Atlantic white cedar communities may involve clearing, planting, and burning activities in the timber management plan, and control of white-tailed deer, which browse on the seedlings, in the hunting management plan. Existing (and new) management plans should therefore be evaluated in the context of maintaining or restoring indigenous habitats. An initial step toward achieving this objective would be to inventory the birds, plants, and animals presently found at Forsythe.

Efforts to maintain and restore habitats and species should also take into account potential problems associated with habitat fragmentation. Fragmentation occurs when primary habitat patches become too small or too isolated from secondary habitat patches to support viable populations of target species. Excessive fragmentation of habitats can actually decrease the diversity of wildlife in an area.

PUBLIC USE

Because of the importance of public use on the Refuge, much of the discussion focused on strategies to provide public use opportunities that would not seriously impact the primary goal of providing habitat and protection for important wildlife species. The following sections briefly describe a variety of strategies that the Refuge might use to provide quality experiences and interpretation, and to deemphasize nonwildlife-oriented recreation; none of the strategies were discussed in sufficient detail at the workshop to allow participants to conclude whether or not they should be implemented. Refuge staff will have to further evaluate each strategy and then discuss the most promising ones in the public use plan.

Quality Experiences and Interpretation

Suggestions for improving interpretation and visitor use at Forsythe included:

1. Improve the main entrance at the Brigantine Division. This will likely require a site design plan, which should consider needs for a self-service exhibit, vehicle traffic and visitor safety, and alternate uses for the present headquarters building.

2. Develop additional interpretive exhibits at Cedar Bonnet Island (once acquired), the end of Stafford Avenue, Holgate, Scott's Landing, and the Barnegat Division entrance. Additional Refuge "You are here" signs could be posted, showing the visitor's location and where the visitors' center is located.

3. Maintain or modify the wildlife drive. Options such as shortening the drive across the cross-dike (if the peregrine falcon nesting tower is moved) and closing all or part of the drive during critical times would reduce disturbance of waterfowl using the impoundments and surrounding salt marshes. Upgrading the drive with increased interpretive signs and exhibits would provide the visitor with more information concerning the role that the Refuge plays in maintaining habitat for species of primary interest. Additional modifications of the wildlife drive are discussed in the following section concerning the deemphasis of nonwildlife-oriented recreation.

4. Review the needs for foot trails and the type of interpretation to be provided on each. In addition, the use of fire lanes for hiking, jogging, and wildlife observation should be evaluated and the possibility of closing these lanes considered.

5. Maintain public access at Scott's Landing and Stafford Avenue, but evaluate potential incompatible uses (e.g., crabbing from the dock); consider charging

user's fees at these sites; control access (e.g., restricted hours during the day or restricted seasons); and provide better signing and interpretation of compatible uses and any restrictions imposed.

6. Evaluate future needs for an outdoor classroom and associated teacher workshops.

7. Develop additional leaflets and information packets. A general Refuge leaflet, such as the one for Back Bay National Wildlife Refuge in Virginia, should be developed. It should include a Refuge map, the purpose of the National Wildlife Refuge system in general and Forsythe in particular, important habitats and wildlife, a guide to seasonal wildlife activity, and information on regulations and why they are necessary. New leaflets and improved interpretive approaches (e.g., new signs, low-frequency transmitters, tape units) for the wildlife drive should be considered. An information packet, including more detailed maps for the Brigantine Division, should be developed for deer hunters. This packet could be provided when the hunters receive their permit to hunt the Refuge. Similar packets might be useful for waterfowl hunters and fishermen; however, since these visitors do not need a special permit to use the Refuge, it would be more difficult to get the information to them. The Refuge might also consider developing a hunter orientation program, such as the one at Great Swamp National Wildlife Refuge, for people who want to hunt on the Refuge or any other interested individuals.

8. Develop a teacher/group leader information packet to augment the group leader orientations that the Refuge presently provides.

9. Maintain the waterfowl hunt, but try to provide an information packet in addition to hunting zone maps.

10. Maintain the present volunteer program, but consider additional sources of volunteers, such as Stockton College, and consider awards or some other form of recognition for volunteers. Also, it would be helpful if the Regional Office could compile and distribute a summary of guidelines and lessons learned from volunteer programs at other refuges.

11. Evaluate a gift catalog program and a cooperative association. A catalog program, such as the one at Minnesota Valley National Wildlife Refuge, would provide a mechanism for individuals to donate items (e.g., money, bird seed, binoculars) for environmental education, interpretation, and other Refuge programs. A cooperative association is an independent, nonprofit group that would maintain a sales outlet at the Refuge, with profits, from items such as field guides, used to support Refuge activities.

Compatibility of Public Use

Suggestions for deemphasizing nonwildlife-oriented recreation at Forsythe included:

1. Eliminate public use at Holgate from April 15 to August 15 by obtaining riparian rights (this means management rights, not fee title acquisition). The elimination of activities such as off-road vehicle use, sunbathing, and swimming during this period would prevent disturbance of nesting and feeding piping plovers. The reopening day could be a sliding window around August 15; that is, Holgate would be opened earlier than August 15 if plovers had early nesting success, and somewhat later otherwise. Some public use could possibly be allowed in the nonnesting season but would not be encouraged. Additional interpretation and public relations would be required to explain the reasons for the closure.

2. Evaluate bicycling, hiking, and jogging on the Refuge's trails and fire lanes, and prohibit bicycling and jogging on the wildlife drive. As discussed in the previous section, the Refuge should consider closing fire lanes and interpretive trails to bicyclists and joggers. Also, because joggers and bicyclists disturb waterfowl much more than visitors in cars, these activities should be prohibited on the wildlife drive, at least during periods of primary waterfowl use.

3. Evaluate potential restrictions on wildlife observation activities on the diked portion of the wildlife drive. Visitors in cars cause much less disturbance to waterfowl than pedestrians because the car acts as a blind. Therefore, the Refuge might consider restricting visitors to their cars, at least while on the diked portion of the wildlife drive. Such restrictions might be imposed at all times, only during nesting or other seasons, or on certain portions of the drive. If visitors are allowed to get out of their cars, the Refuge might require them to remain on the drive itself, as opposed to walking down the dike banks. As with all restrictions, the Refuge should provide interpretive information concerning the reasons for the restrictions.

SCIENTIFIC STUDY AND RESEARCH

Toward the end of the workshop, participants suggested a number of surveys and research projects that might be conducted in support of management planning. There was only limited discussion on each item, and no attempt was made to rank the suggestions.

WATERFOWL AND SHOREBIRDS

1. Conduct a black duck nest survey and habitat correlation to determine where black ducks are nesting. Jerry Langcore might be asked to help identify upland nesting areas.
2. Develop a brood census method appropriate for use in the salt marshes, and conduct a black duck brood census each year.
3. Determine the primary factors affecting black duck nest success and brood predation.
4. Determine the ecological impacts of snow goose eat-out areas, including negative impacts to black ducks and positive impacts to shorebirds.
5. Develop a condition index for black ducks and for Atlantic brant.
6. Develop a winter severity index to determine the likelihood of a late freeze-up. If this index were high in December of any year, impoundment drawdown or hazing might be used to move black ducks southward and prevent subsequent starvation mortality.
7. Determine whether impoundment renovations (e.g., improved circulation, subimpounding) might adversely affect use by migrating black ducks.
8. Monitor water quality, food supply, and habitat use for black ducks and Atlantic brant.
9. Conduct Atlantic brant population and production surveys.
10. Conduct black duck harvest surveys.
11. Monitor and document Canada goose and mute swan competition with black ducks.
12. Conduct some postseason banding of black ducks.

THREATENED AND ENDANGERED SPECIES

13. Study the effects of public use on piping plover production.
14. Determine the extent of predation on colonial nesting birds (perhaps on Little Beach Island).
15. Monitor and document gull population trends on Refuge islands.

OTHER WILDLIFE AND HABITATS

Some of the research studies and surveys listed below support management of a wide variety of species including waterfowl, shorebirds, threatened and endangered species, and resident species. They are listed here because they are general in nature.

16. Contract aerial photography and develop a vegetation cover-type map for both divisions of the Refuge.
17. Collect baseline data on vegetation and wildlife use in the impoundments prior to renovation activities. Conduct periodic surveys to determine changes in vegetation and wildlife use after Open Marsh Water Management and other renovation techniques are implemented.
18. Continue the white-tailed deer/vegetation study using exclosures.
19. Conduct a freshwater fish survey.

PUBLIC USE

20. Determine visitor use patterns and evaluate the effects of Refuge interpretive programs, similar to the surveys conducted by Applegate (Applegate et al. 1982a,b; Applegate and Clark 1984).
21. Determine the impacts of visitor use on species of primary importance. Such a study might compare waterfowl use of impoundments, and behavior before and after changes associated with the wildlife drive (e.g., shortening the route across the cross-dike, restrictions on jogging and bicycling).