PART II: RECOVERY

RECOVERY OBJECTIVE

The objective of this revised recovery plan is to ensure the long-term viability of the Atlantic Coast piping plover population in the wild, thereby allowing removal of this population from the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12). The Atlantic Coast piping plover population may be considered for delisting when the following recovery criteria have been met:

Criterion 1: Increase and maintain for five years a total of 2,000 breeding pairs, distributed among four recovery units as specified below:

Recovery Unit:	*Minimum Subpopulation:*
Atlantic Canada	400 pairs
New England	625 pairs
New York-New Jersey	575 pairs
Southern (DE-MD-VA-NC)	400 pairs

Attainment of these targets for each recovery unit will increase the probability of survival and recovery of the entire population by (1) contributing to the population total, (2) reducing vulnerability to environmental variation (including catastrophes), and (3) increasing likelihood of interchange among recovery units. Attainment of the subpopulation goals stipulated above are particularly important for the Atlantic Canada and the Southern recovery units because of their current small numbers (under 200 pairs each), sparse distribution over relatively large geographic areas, and potential to substantially contribute to the viability of the entire Atlantic Coast population.

Criterion 2: Verify the adequacy of a 2,000-pair population of piping plovers to maintain heterozygosity and allelic diversity over the long term. This may be accomplished through implementation of recovery task 3.8 (page 95). Despite a high probability that this criterion can be satisfied, the potential risks associated with loss of genetic diversity justify documentation of N_e/N.

Criterion 3: Achieve five-year average productivity of 1.5 fledged chicks per pair in each of the four recovery units described in criterion 1. Data to evaluate progress toward meeting this criterion should be obtained from sites that collectively support at least 90% of the recovery unit's population. The population viability analysis in Appendix E shows that a population of only 2,000 pairs would remain highly vulnerable to extinction unless average productivity is sustained above 1.5 chicks per pair. However, since the PVA is based on several assumptions that *may* underestimate survival rates for some or all recovery units and/or the percentage of one-year-old adults that breed, this productivity figure may be revised downward if (1) it is demonstrated that survival rates are higher in some regions, and (2) a scientifically credible stochastic model that incorporates the best available estimates of survival and other demographic variables shows that lower productivity rates will assure a 95% probability of survival for 100 years (see task 3.5). Adjustments to this criterion may be applied to the population as a whole or to one or more of the four recovery units, as supported by observed productivity and population trend data.

Criterion 4: Institute long-term agreements among cooperating agencies, landowners, and conservation organizations that will ensure protection and management sufficient to maintain the population targets and average productivity for each recovery unit as specified in criteria 1 and 3. In addition to protection and management, these agreements should provide for adequate monitoring to effectively detect declines in productivity or population declines caused by decreasing survival rates. Agreements may allow for less than full protection of some piping plovers if it can be assured that these individuals are surplus to the maintenance of an evenly distributed, 2,000-breeding-pair population, with an average productivity of 1.5 chicks per pair (or an adjusted productivity rate as per criterion 3) in each recovery unit.

Criterion 5: Ensure long-term maintenance of wintering habitat, sufficient in quantity, quality, and distribution to maintain survival rates for a 2,000-pair population. This criterion may be satisfied through formal agreements or identification of sites free from significant recognizable threats.

Table 7 outlines the recovery tasks needed to meet these recovery criteria, and the Recovery Tasks section describes each task in detail.

Table 7. Recovery Task Outline

1. Manage breeding piping plovers and habitat to maximize survival and productivity.

    1.1 Monitor status and management of Atlantic Coast piping plovers.
        1.11 Monitor population trends, productivity, and distribution in each recovery unit.
        1.12 Monitor plover breeding activities at nesting sites to identify limiting factors.
    1.2 Maintain natural coastal formation processes that perpetuate high quality breeding habitat.
        1.21 Discourage development that will destroy or degrade plover habitat.
        1.22 Discourage interference with natural processes of inlet formation, migration, and closure.
        1.23 Discourage beach stabilization projects.
        1.24 To compensate for disruption of natural processes, create and enhance nesting and feeding habitat, especially in the vicinity of existing stabilization projects.
            1.241 Encourage deposition of dredged material to enhance or create nesting habitat.
            1.242 Discourage vegetation encroachment at nesting sites.
            1.243 Draw down or create coastal ponds to make more feeding habitat available.
    1.3 Reduce disturbance of breeding plovers from humans and pets.
        1.31 Reduce pedestrian recreational disturbance.
            1.311 Fence and post areas used by breeding plovers, as appropriate.
            1.312 Implement and enforce pet restrictions.
            1.313 Prevent disturbance from disruptive recreational activities on beaches where breeding plovers are present.
        1.32 Reduce disturbance, mortality, and habitat degradation caused by off-road vehicles, including beach-raking machines.
        1.33 Provide wardens and law enforcement officers to facilitate protective measures and public education.
    1.4 Reduce predation.
        1.41 Remove litter and garbage from beaches.
        1.42 Deploy predator exclosures to reduce egg predation where appropriate.
        1.43 Remove predators where warranted and feasible.
    1.5 Protect piping plovers and their breeding habitat from contamination and degradation due to oil or chemical spills.
    1.6 Develop mechanisms to provide long-term protection of plovers and their habitat.
        1.61 Provide intensive protection of breeding piping plovers on national wildlife refuges.
        1.62 Seek long-term agreements with landowners.
        1.63 Acquire important habitat if and when it becomes available.
        1.64 Ensure that any Section 10 permits issued contribute to Atlantic Coast piping plover conservation.

2. Monitor and manage wintering and migration areas to maximize survival and recruitment in the breeding population.

    2.1 Monitor known and potential wintering sites.
        2.11 Monitor abundance and distribution of known wintering plovers.
        2.12 Survey beaches and other suitable habitat to determine additional wintering sites.
        2.13 Identify factors limiting the quantity and quality of habitat or its use by piping plovers at specific wintering sites.

TABLE 7 (cont.)

2.2 Protect essential wintering habitat by preventing habitat degradation and disturbance.
- 2.21 Protect habitat from impacts of shoreline stabilization, navigation projects, and development.
- 2.22 Protect wintering habitat from disturbance by recreationists and their pets.
- 2.23 Protect piping plovers and their wintering habitat from contamination and degradation due to oil or chemical spills.
- 2.24 Apprise resource/regulatory agencies of threats to wintering piping plovers and their habitats.
- 2.25 Evaluate and update lists of essential wintering habitat as data become available.
- 2.26 Provide for long-term protection of wintering habitat, including agreements with landowners and habitat acquisition.

2.3 Protect piping plovers during migration.
- 2.31 Identify important migration stop-over habitat.
- 2.32 Identify and mitigate any factors that may be adversely affecting migratory stop-over habitat or its use by piping plovers.

3. Undertake scientific investigations that will facilitate recovery efforts.

3.1 Investigate the wintering ecology of piping plovers.
- 3.11 Characterize wintering habitat.
- 3.12 Determine the spatial and temporal use of wintering habitat.
- 3.13 Evaluate foraging behavior and resources for specific microhabitats at wintering sites.
- 3.14 Investigate the effects of human disturbance on wintering plovers.

3.2 Refine characterization of plover breeding habitat.
- 3.21 Compare plover foraging resources along Atlantic Coast breeding habitat.
- 3.22 Determine moisture-related requirements for plovers and their chicks.
- 3.23 Evaluate impacts of artificial inlet closure and other beach stabilization projects on piping plover breeding habitat suitability.

3.3 Monitor levels of environmental contaminants in piping plovers.

3.4 Develop and test new predator management techniques to protect nests and chicks.
- 3.41 Develop and test conditioned aversion techniques.
- 3.42 Extend testing of artificial coyote territories to exclude red foxes.
- 3.43 Evaluate threats from ghost crabs and develop appropriate control techniques.
- 3.44 Develop and test electric fences.

3.5 Analyze population trends and productivity rates to monitor plover survival rates.

3.6 Determine temporal distribution of plover mortality.

3.7 Develop a metapopulation model that will estimate extinction probability for the Atlantic Coast piping plover population.

3.8 Estimate effective population size for the Atlantic Coast piping plover population.

3.9 Develop safe techniques for marking plovers.

4. Develop and implement public information and education programs.

4.1 Develop new and updated piping plover information and education materials.

4.2 Establish a network for distribution of information and education materials.

5. Review progress towards recovery annually and revise recovery efforts as appropriate.

RECOVERY TASKS

1. Manage breeding piping plovers and habitat to maximize survival and productivity.

Experience over the last eight years has shown that piping plover populations can increase dramatically in response to intensive protection efforts. These efforts are time-consuming, costly, and sometimes require temporary restrictions on off-road vehicles and/or restrictions on artificial dune building and other coastline stabilization projects, but they are generally highly effective.

Most U.S. Atlantic Coast piping plover management programs have been coordinated by the State wildlife agencies with integral participation from Federal and local agencies, other State agencies, and private organizations and individuals. In North Carolina, where approximately 80% of plover nesting activity currently occurs on Federal lands, the U.S. Fish and Wildlife Service is the primary coordinating agency. In some cases, such as Massachusetts, networks of cooperators who implement protection measures have become very large, and forums for discussion of beach management issues are active (see discussion on page 52). It is anticipated that these cooperator networks and meetings of affected groups will continue to play an integral role in the plover recovery effort. While the main focus of coordination efforts is expected to remain at the State level, the need for some planning among "stakeholders" (cooperators and affected parties) at the recovery-unit level is also anticipated.

A summary of current and needed management activities on breeding sites is provided in Appendix C. Piping plover habitat is extremely dynamic, and factors affecting breeding success, such as types and numbers of predators, can change quickly, modifying protection needs. It is especially likely that additional protection needs will be identified for sites in New York and North Carolina, and at any site where intensified monitoring to identify limiting factors has been recommended.

Management and protection of piping plovers on Federal lands is especially important. Plover management on Federal lands directly affects breeding success of approximately 32% of the current U.S. Atlantic Coast population. In addition, protection on Federal lands furnishes leadership by example to non-Federal land managers.

1.1 Monitor the status and management of Atlantic Coast piping plovers, both population-wide and at specific nesting sites. Reliable ongoing monitoring will be crucial to ensuring that plover protection efforts are contributing effectively and efficiently to the species' recovery. At a recovery-unit level (task 1.11), annual monitoring of numbers, location, and productivity will provide measures of overall progress towards recovery and facilitate identification of areas where additional priority should be accorded to management and protection. Site-specific monitoring (task 1.12) to identify factors that may be limiting plover abundance and/or productivity will ensure that site protection needs have been accurately identified and management is being effectively implemented.

1.11 Monitor population trends and effects of management through annual surveys of population abundance, distribution, and productivity in each recovery unit. An annual inventory of the numbers, location, and productivity of breeding pairs provides information on population trends, changes in distribution, recruitment, and other population parameters (also see task 1.12). Survey efforts in most Atlantic Coast States improved significantly between 1986 and 1989 and have now become fairly standardized. Expanded efforts to assure complete counts of breeding pairs on all sites are still needed in North Carolina and New York; increased standardization of data collection methodology and quality control of surveys are also needed in New York. Productivity data have been obtained for more than 80% of U.S. Atlantic Coast plovers since 1991, and seven States have collected productivity data for more than 90% of all pairs that nested during the last eight seasons. Productivity data from an increased percentage of pairs is needed in New York and Virginia, while North Carolina should continue to maintain productivity data collection rates attained in 1993-1995.

In 1991 and 1994, all States and Provinces conducted window censuses (see page 20) over a nine-day period in late May and early June. A window census was also conducted in the U.S. in 1995, and all States and Provinces are planning a coordinated window census as part of the upcoming 1996 International Piping Plover Breeding Census. Because the window census reduces the probability of double-counting birds that renest during the season, it is the most precise index of population trends. The USFWS recommends that highest priority be given to this census in the future, although "traditional" State censuses should also be continued if resources allow.

Dates for future window censuses are as follows:

1996 - June 1 to June 9
1997 - May 31 to June 8
1998 - May 30 to June 7
1999 - May 29 to June 6
2000 - May 27 to June 4

Every effort should be made to visit all sites occupied in recent years by plovers during the standard census window. If a site cannot be surveyed during the window, it should be surveyed as soon thereafter as possible; counts from sites surveyed after the window should be so noted in the State report. If time permits, sites that have not been occupied in recent years should also be surveyed during the window, with priority on the most suitable habitat.

Where sites are intensively monitored during the window, the highest count of pairs known to be simultaneously active on the site during the window period should be used; if a pair leaves the site early in the window, monitors should communicate with any biologists who intensively monitor adjacent sites to avoid double counts. If hatch dates of pairs that are detected after the window are such that the pair must have been on site during the window, these pairs may also be included in the window count, since they could not have been counted on another site. Data on other pairs recorded on a site before and after the window may be useful for site evaluation purposes, but should not be added to the State or provincial window census total.

While recognizing the constraints on available personnel in Atlantic Canada, the recovery team has urged that the window census be conducted annually there, especially in view of the apparent decline in plover numbers between 1991 and 1994. If necessary, the Canadian census window should be expanded and biologists from the U.S. should be recruited to assist with the Canadian census.

The population size criterion of the Atlantic Coast piping plover recovery goal (recovery criterion 1) is based on a count of "breeding pairs." Breeding pairs of piping plovers may be counted towards this goal if good evidence of breeding activity is observed. This may include observations of territoriality and courtship, even if no

nests or chicks are located, and may likewise include observations of nests and chicks, even if only one adult is seen. However, unmated territorial adults should not be counted, and care must be exercised to prevent counting incubating adults and their non-tending mates as separate pairs.

For the purposes of measuring productivity, plovers are considered fledged if they attain 25 days of age or are seen in flight (whichever comes first; see discussion on page 24). Data on chick survival for periods less than 25 days are useful for site management purposes, but should not be included in State averages reported to the USFWS. Exceptions may occur where a "correction factor," based on a number of years of good site-specific data, has been developed and its use has been approved by the USFWS. Landowners and beach managers must also recognize that many 25-day-old plover chicks are incapable of flight and therefore remain vulnerable to mortality from off-road vehicles (see task 1.32).

1.12 **Monitor plover breeding activities at nesting sites to identify factors that may be limiting abundance of nesting plovers and/or productivity.** In addition to nesting pair counts and productivity, monitoring of breeding sites should include other information important to determination of site protection needs. Whenever possible, data collection should include:

- Dates when monitoring began and ended
- Nesting chronology (dates when plovers were first and last seen on the site, nest establishment dates, dates when unfledged chicks are present on the site)
- Locations of nests and brood foraging territories
- Known and suspected causes of nest and chick loss
- Indices of predator abundance
- Locations of commonly used foraging areas during each stage of the breeding cycle
- Available information about use of the site by post-breeding or migrating plovers, other shorebirds, and other rare species

Goldin (1994a) provides a detailed discussion of site monitoring and data collection methodology[1]. Excellent examples of annual summaries of plover monitoring data are provided by Hoopes (1994), Rimmer (1994), Bottitta *et al.* (1993), Hake (1993), and others.

1.2 Maintain natural coastal formation processes that perpetuate high quality breeding habitat. Barrier beach habitats preferred by piping plovers are storm-maintained ecosystems; habitat protection must recognize and seek to perpetuate its natural dynamism. Barrier beaches absorb wind and wave forces of coastal storms, thereby providing storm protection to property and other resources on nearby mainland areas (Coastal Barriers Task Force 1983, Massachusetts Barrier Beach Task Force 1994). Not coincidently, many rare species, including piping plovers, northeastern beach tiger beetles, seabeach amaranth, least terns, common terns, black skimmers, and Wilson's plovers, are dependent on the habitat maintained by these coastal storm events (see Appendix B).

Two Federal agencies, the U.S. Army Corps of Engineers and the Federal Emergency Management Agency (FEMA), manage major programs affecting barrier beach dynamics. The Corps maintains harbors and navigation channels in coastal waters, constructing and maintaining jetties, groins, and breakwaters; suitable material (uncontaminated sand of desirable particle size) dredged during channel and harbor maintenance is also used to nourish nearby beaches. Permits issued by the Corps are also required for dredging and beach nourishment conducted by the States, local governments, or private parties. FEMA provides grants for repair of storm related damage in coastal areas and hazard mitigation in areas vulnerable to flooding, and administers the National Flood Insurance Program. FEMA also provides funds for the restoration of "engineered beaches," constructed and maintained in conformance with certain design criteria. Section 7 of the ESA provides both FEMA and the Corps with opportunities to make major contributions to conservation of plover habitat. In addition, expenditures within units of the Coastal Barrier Resources System by the Corps, FEMA, and other Federal agencies may be restricted by the requirements of the Coastal Barriers Resource Protection Act (see page 48).

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1.21 **Discourage construction of structures or other developments that will destroy or degrade plover habitat.** To the greatest extent possible, conflicts between rare species and property protection should be avoided by directing construction of houses, resorts, parking lots, and other facilities to areas of low vulnerability to flooding and erosion. This, in turn, will avert the need to stabilize shorelines to protect property. In addition to degrading physical suitability of plover habitat, beach development also increases the likelihood of disturbance to plovers through associated recreational activity.

Beach development should be discouraged through conservation easements, acquisition, zoning, and other means. When beach development cannot be avoided, the following protections should be implemented: (1) construction should take place outside the nesting season, (2) developers and others should be forewarned that subsequent plans to stabilize the shoreline will result in additional habitat degradation and that these impacts may affect evaluation of permits under the jurisdiction of the Corps or State coastal management agencies, and (3) property owners should tailor recreational activity on the beach to minimize disturbance of territorial and nesting plovers, their eggs, and chicks.

Impacts of shoreline developments are often greatly expanded by the attendant concerns for protecting access roads. It may be possible to substantially reduce the overall impacts of shoreline property protection on habitat by rethinking how access is provided. Planners should weigh the economic and environmental costs of maintaining overland access, and compare them with costs and environmental effects of alternative modes of access, including boat services, scheduled ferries, and emergency air evacuation.

Fragmentation and degradation of plover breeding habitat caused by construction of walkways, piers, and other structures should also be avoided.

1.22 **Discourage interference with natural processes of inlet formation, migration, and closure.** Sandspits associated with inlets and recently closed inlets comprise a large proportion of Atlantic Coast piping plover habitat. Rock jetties severely degrade plover habitat by destroying the intertidal zone and robbing sand from the

down-drift shoreline, resulting in eroded beaches that may be less suitable for breeding plovers. While this might be partially offset by habitat accretion on the up-drift side of the structure, these artificially stabilized areas could also be subject to accelerated plant succession that decreases their suitability over time.

Inlet stabilization may also contribute to net losses of plover habitat by preventing the formation of new inlets. Cape Lookout National Seashore in North Carolina serves as a prime example of an area where existing and relatively recently closed inlets comprise a large proportion of habitat currently occupied by breeding plovers. The natural inlet formation and closure process maintains availability of habitat; as succession of vegetation causes loss of habitat on the oldest former inlets, new habitat is formed at new and recently closed inlets. Stabilization of existing inlets through dredging would perpetuate habitat on the immediately adjacent spits, but is likely to result in a substantial net loss of habitat as currently occupied former inlets become progressively more heavily vegetated. Even on spits adjacent to a maintained inlet channel, a net loss of plover habitat may occur if inlet migration is forestalled, since recently sedimented areas often constitute prime plover nesting and foraging areas (L.K. Gantt, U.S. Fish and Wildlife Service, *in litt.* 1995).

The creation of an "artificial overwash" when the Corps closed Pikes Inlet on Long Island, New York in 1993 appears to have created prime nesting habitat that attracted 14 pairs of piping plovers in 1994, and 19 pairs in 1995. However, biologists have expressed concern that artificial habitat formed in this way may be susceptible to accelerated succession that will decrease its long-term carrying capacity compared to what it might have been if the inlet had been allowed to persist, migrate, and eventually close on its own (Elias-Gerken and Fraser 1994; S.W. Morgan, U.S. Fish and Wildlife Service, *in litt.* 1995) .

1.23 **Discourage beach stabilization projects including snowfencing and planting of vegetation at current or potential plover breeding sites.** Snowfencing and plantings of American beach grass (*Ammophila breviligulata*), sea oats (*Uniola paniculata*), and other vegetation accelerate the processes that degrade habitat and should be avoided. Installation of snowfences and "planting" of discarded Christmas trees in blowouts, overwashes, or elsewhere on the beach should also be avoided. To

the extent possible, the natural processes of overwash and blowouts that perpetuate characteristics of preferred habitat should be allowed to continue unimpeded. For more detail, see pages 36-37.

1.24 **To compensate for disruption of natural process, create and enhance nesting and feeding habitat, especially in the vicinity of existing stabilization projects such as jetties, groins, and other artificial beach stabilization projects.** While preventing development of areas subject to erosion should be the first line of defense in barrier beach protection, a comprehensive beach management policy must also recognize that many current erosion and sedimentation problems are the consequence of past property and/or inlet "protection" efforts. Many of these problems are indicative of complex natural sand movement patterns in interaction with updrift erosion/ sedimentation control projects. Correcting these situations to best protect habitat of rare wildlife requires maintenance of natural long-shore sand budgets and minimization of interference with natural patterns of sand accretion and depletion. Because they appear to mimic natural sand transport and deposition processes, sand-bypass systems may offer opportunities to reduce impacts of erosion while potentially enhancing the habitat of species such as piping plovers that favor accreting beaches; however, long-term monitoring of impacts on the beach ecosystem, including piping plovers and other shorebirds, is needed to confirm or disprove this hypothesis.

1.241 **Encourage deposition of dredged material to enhance existing nesting habitat or create new nesting habitat.** Near-shore (littoral drift) disposal of dredged material also appears to be beneficial for perpetuating high quality piping plover habitat. However, monitoring of habitat characteristics before and after selected projects is needed, particularly in cases of large operations occurring on sites where piping plovers nest or are deemed likely to nest following the disposal operation. For example, pre- and post-deposition beach profiles and faunal studies were compared after approximately 50,000 cubic yards of dredged material from the Ocean City Inlet were piped over Assateague Island and released on the ocean side in 1990. This study did not reveal any effects on the benthic infauna or topography that could be attributed to this small dredged material disposal operation (USFWS 1991b).

On-shore disposal of dredged material for beach nourishment is often recognized as an activity with potential to benefit piping plover nesting habitat. However, conditions must be placed on disposal operations to prevent inadvertent impacts to breeding plovers (Melvin *et al.* 1991). Sand deposition, laying of sand transport pipes, and use of machinery to spread the sand can cause serious disturbance, even direct mortality, to nesting birds. Therefore, on-shore activities must be scheduled during seasons when birds are not present. In some cases, beach nourishment can be conducted during the plover breeding season in areas that the birds are not currently using. In addition, dredged material must be clean sand or gravel of appropriate grain size and must be graded to a natural slope. Dozens of informal consultations between the USFWS and the Corps regarding impacts of appropriately conditioned beach nourishment proposals have culminated in determinations that the proposed projects will not adversely affect piping plovers.

While beach nourishment generally benefits piping plovers in the short term, especially where beaches are seriously eroded, there are situations where nourishment of eroding beaches impedes overwash that would otherwise create and maintain ephemeral pools and bayside mudflats, also preferred plover feeding habitats. See, for example, concerns expressed by Loegering and Fraser (1995), discussed briefly on page 37 of this plan. Individual situations must be evaluated to determine and weigh the probable adverse and beneficial effects of natural erosion on plover habitat suitability. In addition, potential impacts of beach nourishment on other sensitive beach-dwelling species, including seabeach amaranth and northeastern beach tiger beetles, should be carefully considered in areas where these species may be present.

1.242 **Discourage vegetation encroachment at nesting sites.** In some areas, especially those where natural processes that set back succession of vegetation are impeded by coastal management practices, land managers should consider remedial efforts to remove or reduce vegetation that is encroaching on piping plover nesting and foraging habitat or obstructing movement of chicks from oceanside nesting areas to bayside feeding flats.

Mechanical scarification of back-dune areas has been successfully used to maintain habitat suitability at Maschaug Pond, Rhode Island (C. Raithel *in litt.* 1994). In addition, a small-scale vegetation removal experiment was conducted at Cape Hatteras National Seashore in 1993. The results were encouraging, with piping plovers and other shorebirds using the treated area for nesting and foraging immediately (J. Nicholls *in litt.* 1994). This program was expanded during the next two seasons, and in 1995, it encompassed approximately 90 acres at Cape Point and 20 acres at Hatteras Spit (Collier and Lyons *in* NPS 1995).

1.243 **Draw down or create coastal ponds where feasible to make more feeding habitat available.** Drawdown of coastal ponds and impoundments during the breeding season could create productive feeding habitat as well as increase suitable nesting sites. Trustom Pond and Quicksand Pond in Rhode Island are two examples of sites where artificial breaching of coastal ponds is carefully timed to enhance piping plover feeding habitat (USFWS 1987b, Goldin 1994b). Water levels on the North Wash Flats impoundment at Chincoteague National Wildlife Refuge in Virginia are also being managed to enhance plover nesting and feeding habitat. Site-specific breach and drawdown programs should be initiated on an experimental basis at selected sites along the plover's coastal range to encompass the migration and breeding period. Experimental pool/pond creation (with careful monitoring) should be attempted in areas where brood foraging areas may be limited, such as at the Currituck NWR in North Carolina and the Wild Beach at the Chincoteague NWR in Virginia. Results of these experimental projects should be incorporated as appropriate into long-range management strategies. Such projects may also create opportunities for studying moisture requirements of piping plovers (see task 3.22) by comparing pre- and post-project habitat use and survival of chicks.

1.3 **Reduce disturbance of breeding plovers from humans and pets.** Disturbance by humans and pets is a continuing threat to Atlantic Coast plovers, whose habitat is a favorite recreation ground for millions of people. Various management techniques can mitigate impacts of beach

recreation on piping plovers, but must be implemented annually as long as the demand for beach recreation continues.

Appendix G contains guidelines for managing recreational activities in piping plover breeding habitat to avoid take under Section 9 of the Endangered Species Act. These guidelines, developed by the Northeast Region of the USFWS with assistance from the U.S. Atlantic Coast Piping Plover Recovery Team, represent the USFWS's best professional advice to beach managers and landowners regarding the management options that will prevent direct mortality, harm, or harassment of piping plovers and their eggs due to recreational activities. However, some Federal land managers have endangered species protection obligations under Section 7 of the ESA or under Executive Orders 11644 and 11989 that go beyond adherence to these guidelines (see pages 47 and 48). Other land managers can also make valuable contributions to the piping plover recovery effort and protection of the beach ecosystem through voluntary implementation of stronger protection measures than those specified in Appendix G.

1.31 **Reduce pedestrian recreational disturbance.** Disturbance from pedestrians can be reduced but not entirely eliminated through intensive management. Various management strategies have been devised to mitigate the impacts of very high demand for pedestrian recreation. Implementation of these strategies may involve different amounts of human effort and provide varying levels of benefits to piping plovers.

Common strategies include limiting the number of access points to the beach, since concentrations of beachgoers tend to occur closest to parking areas. Several land management agencies prohibit boat landings on all or part of their beaches to prevent disturbance to feeding plovers and other shorebirds and/or to prevent boaters from walking through adjacent nesting areas. These types of protection measures should be determined on a site-by-site basis; factors that should be considered include the configuration of habitat on the site as well as types and amounts of ongoing recreational activity. On many national wildlife refuges, where protection of wildlife is the paramount purpose of Federal ownership, complete closures of plover habitat during the breeding season should be continued.

1.311 **Fence and post areas used by breeding plovers as appropriate.** Unless a beach is closed to public entry or use is extraordinarily light, posting of

nesting areas is recommended to prevent obliteration of scrapes, crushing of eggs, and repeated flushing of incubating adults. Signs and posts should be carefully designed to discourage perching of potential avian predators. Experience at many Atlantic Coast beaches has shown that use of symbolic fences (one or two strands of light-weight string tied between posts) substantially improves compliance of beachgoers with signs and decreases people's confusion about where entry is prohibited.

Appendix G indicates that a 50-meter buffer distance around nests is adequate to prevent harassment of the majority of incubating piping plovers. However, data from various sites distributed across the plover's Atlantic Coast range indicate that larger buffers may be needed in some locations (see Table 3). Even in situations where they are not strictly required to avoid take, larger buffers may also contribute to recovery, for example by allowing chicks to spend more uninterrupted time feeding and perhaps fledge sooner and/or gain more weight prior to migration.

On portions of beaches that receive heavy human use in April, May, and June, areas where territorial plovers are observed should be symbolically fenced to prevent disruption of territorial displays and courtship. Since nests can be difficult to locate, especially during egg-laying, this will also prevent accidental crushing of undetected nests. Although not currently recommended as necessary to avoid take, fencing or signing of prime feeding areas to exclude or reduce numbers of pedestrians can also contribute to the survival and well-being of unfledged chicks. This may be especially beneficial at times of unusually hot weather, at times and locations where pedestrian activity is very intense, and/or at times when newly hatched chicks are present.

1.312 **Implement and enforce pet restrictions.** Unleashed pets, primarily dogs, are known to chase piping plovers, destroy nests, and kill chicks. A study conducted on Cape Cod found that the average distance at which piping plovers were disturbed by pets was 46 m, compared to 23 m for pedestrians. Furthermore, the birds reacted to the pets by moving an average of 57 m,

compared with 25 m when the birds were reacting to a pedestrian. The duration of the disturbance behavior stimulated by pets was also significantly greater than that caused by pedestrians (Hoopes 1993).

Pets should be leashed and under control of their owners at all times from April 1 to August 31 on beaches where piping plovers are present or have traditionally nested. Pets should be prohibited on these beaches from April 1 through August 31 if, based on observations and experience, pet owners fail to keep pets leashed and under control. A half-page information sheet entitled "Why Dogs and Plovers Don't Mix" has been prepared by The Nature Conservancy, Rhode Island Office[1].

1.313 **Prevent disturbance from fireworks, kite-flying, ball-playing, and other potentially disruptive activities on beaches where breeding plovers are present.** Fireworks are highly disturbing to piping plovers and should be prohibited on beaches where plovers nest from April 1 until all chicks are fledged. In addition to the possibility of direct injury caused by the explosions or debris, piping plovers and terns will often abandon their nests and broods during fireworks displays, exposing eggs and chicks to weather and predators (Howard *et al.* 1993; R. Powell, The Nature Conservancy, *in litt.* 1994). If a flightless chick were to become permanently separated from its parents during the confusion, mortality would be almost certain. An August 1993 fireworks display in New Jersey caused permanent abandonment of a least tern colony located more than 250 m away (C.D. Jenkins *in litt.* 1993); a 1994 fireworks display caused temporary abandonment and displays of distress by a tern colony located more than 3/4 mile away (C.D. Jenkins pers. comm. 1994).

In addition to adverse effects from the noise and lights of the pyrotechnics, commercial fireworks displays often draw large crowds that may pose threats to nearby plovers (W. Donato and S.W. Morgan, U.S. Fish and Wildlife Service, *in litt.* 1995). When fireworks displays can be situated to avoid

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1 Copies available from U.S. Fish and Wildlife Service, Weir Hill Road, Sudbury, MA 01776, Attn: Anne Hecht.

disturbance from the pyrotechnics, careful planning should still be conducted to assure that spectators will not walk through and throw objects into plover nesting and brood-rearing areas. Sufficient personnel must also be on-site during these events to enforce plover protection measures and prevent use of illegal fireworks in the vicinity of the birds.

Given plovers' aversion to kites (see page 40), prohibition of kite flying within 200 m of nesting or territorial adult or unfledged juvenile piping plovers between April 1 and August 31 is recommended.

Hazards to plovers from ball-playing are exacerbated by tendencies for stray balls to land in closed areas where they can smash nests and where efforts to remove them can disturb territorial or incubating birds. These activities should be prohibited within hitting and throwing distance of piping plover nesting areas.

1.32 **Reduce disturbance, mortality, and habitat degradation caused by off-road vehicles, including beach-raking machines.** Minimum protection measures to prevent direct mortality or harassment of piping plovers, their eggs, and chicks on beaches where vehicles are permitted are recommended in Appendix G. Since restrictions to protect unfledged chicks often impede vehicle access along a barrier spit, a number of management options affecting the timing and size of vehicle closures are presented; some of these options are contingent on implementation of intensive plover monitoring and management plans by qualified biologists. It is recommended that landowners seek review of and concurrence with such monitoring plans from either the USFWS or the State wildlife agency.

Appendix D summarizes the current status of off-road vehicle use on current and potential plover breeding sites along the U.S. Atlantic Coast. Management strategies that substantially reduce off-road vehicle impacts have been implemented at many plover breeding sites since 1986. Threats from inadequate management continue at some U.S. sites, however, and need to be addressed.

In Atlantic Canada, off-road vehicles are prohibited on most beaches, but violations occur in many locations. Communications from the Atlantic Piping Plover Working Group (R. Chiasson, *in litt.* 1993) urged the Solicitor General of New Brunswick to increase enforcement of the New Brunswick Trespass Act and requested that the Minister of Environment and Lands, Newfoundland and Labrador, prohibit all-terrain vehicles on beaches occupied by plovers. Continuation and expansion of these efforts is strongly recommended.

A half-page information sheet entitled "Why Vehicles and Plovers Don't Mix" has been prepared by TNC's Rhode Island Office[1].

1.33 **Provide wardens and law enforcement officers to facilitate protective measures and public education.** On many sites, patrolling to ensure that beachgoers stay out of fenced areas and adhere to other plover protection measures is conducted by biologists who also monitor birds, but non-biological staff and volunteers have made invaluable contributions to plover conservation both by deterring disturbance and by providing opportunities for public education. Wardens are particularly important on heavily used beaches during the peak recreational season. Manuals for volunteer wardens have been prepared by Dougherty and Motivans (undated), Halifax Field Naturalists (1992), and Goldin (undated).

Law enforcement agents play a crucial role in educating landowners, user groups, and others about their legal responsibilities with regard to protection of threatened and endangered species. Enforcement personnel are also trained to conduct thorough investigations into potential violations of the ESA and other wildlife conservation statutes. The local USFWS law enforcement office should be informed *immediately* whenever evidence of suspected take of piping plovers is encountered.

1.4 Reduce predation. Predation is a major factor limiting plover productivity at many Atlantic Coast beaches. As discussed on pages 41-42, natural threats from predation have been exacerbated by many human activities in the coastal zone. In addition, the cumulative impacts on piping plovers from predation, habitat loss, and human disturbance and small population

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size decrease the plover's ability to withstand predation. Due to the magnitude of predation threats to plovers and limitations associated with all currently available solutions, it is strongly recommended that on-site managers employ an integrated approach to predator management that considers a full range of management techniques.

An ecosystem approach to reducing impacts of predation would argue in favor of redressing the human-abetted changes in types and numbers of predators, as well as environmental changes (for example in the predators' food sources) that foster unnatural numbers of some predators. Wherever feasible, such approaches are encouraged. However, many highly prolific predators are now so firmly entrenched in and around many plover nesting areas that results from this type of approach may be ineffective and/or temporary.

Some land managers, such as the National Park Service, may need to re-evaluate and clarify their policies on the management of predator populations and/or habitat where predation might be limiting local piping plover populations. In particular, policies that prohibit management of native predator populations even when human-abetted factors have caused substantial increases in their natural abundance may be counterproductive to the overall goal of protecting "natural" ecosystems.

Although most activities to reduce impacts of predation have been implemented by on-site biologists, U.S. Department of Agriculture's Animal Damage Control (USDA-ADC) biologists and State wildlife agency furbearer biologists have made important contributions to the planning and, in some cases, implementation of predator management activities. Professional trappers have played a key role in some predator-removal programs.

A discussion of scientific studies recommended to test experimental methods of reducing impacts of predation is included under task 3.4.

1.41 Remove litter and garbage from beaches. Beach litter and garbage attract predators such as skunks and gulls that are known to prey on piping plover nests and/or chicks. Beachgoers should be discouraged from leaving or burying trash or food scraps on the beach. Trash cans on the beach should be emptied frequently to reduce attractiveness and availability of their contents to scavenging predators.

Emptying cans in the evening instead of leaving them overnight is preferable. Fish-cleaning stations should be located well away from plover breeding areas.

Although removal of trash from the beach reduces predation threats, beach-raking should not be conducted during the nesting season. Beach-cleaning machines can crush plover nests and chicks, and they remove the plovers' natural wrackline feeding habitat. Trash should be selectively removed from the beach, but natural materials, including shells and seaweed, should be left intact.

1.42 **Deploy predator exclosures to reduce egg predation where appropriate.** Current guidelines for the use of predator exclosures to protect piping plover eggs are contained in Appendix F. Exclosures are a valuable tool for countering human-abetted predation threats to piping plover eggs, but they are not appropriate for use in all situations, nor do they provide any protection for mobile plover chicks, which generally leave the exclosure within one day of hatching and move extensively along the beach to feed.

First trials of wire fences to prevent predation of piping plover nests on the Atlantic Coast occurred in 1987, when seven exclosures were used on four sites. Over 70 nests on 14 sites were exclosed in 1988, and in 1989 State plover coordinators reported use of exclosures to protect nests of 141 pairs of plovers along the U.S. Atlantic Coast (USFWS 1989a). By 1993, exclosures were deployed in every State and at least three Canadian Provinces in the plovers' Atlantic Coast breeding range.

Rimmer and Deblinger (1990) found that 24 of 26 nests (92%) protected by exclosures hatched at least one egg, while only six of 24 (25%) unexclosed nests hatched at a Massachusetts site over four years. Melvin *et al.* (1992) reported 90% (26/29) hatching of exclosed nests versus 17% (4/24) for unexclosed nests at six sites on Outer Cape Cod, Massachusetts. Information on 211 exclosures used in eight States and three Canadian Provinces in 1990 was evaluated to assess the effectiveness of various designs and construction techniques (Deblinger *et al.* 1992, Vaske *et al.* 1994).

Although exclosures are contributing to improved productivity and population increases in some portions of the plover's Atlantic Coast range, problems have been noted in some localities. Loegering (1992) reported loss of six nests in exclosures without tops in Maryland in 1988, but nest loss stopped after string tops were added. Van Schoik (The Nature Conservancy, *in litt.* 1993) documented loss of 12 nests over just a few days on Jones Beach Island, New York to common crows (*Corvus brachyrhynchos*) that entered exclosures covered with parallel rows of string; no further losses occurred when net tops were installed. Cross (1991) found that exclosed nests hatched significantly more often than unexclosed nests over three years on three sites in Virginia, but hatch rates were not significantly improved at all sites or in all years; furthermore, two instances of foxes depredating adult plovers occurred in the vicinity of exclosures. Foxes or coyotes systematically depredated 5-10 exclosures at each of three widely separated sites in 1995 (USFWS files). Several instances of adult plover entanglement in string or net tops, with and without attendant mortality, have been reported (USFWS files). Predator exclosures have been associated with abandonment of snowy plover (*Charadrius alexandrinus*) nests on California beaches, where fox track patterns suggest that the birds were subjected to intense harassment by foxes (M. Parker, U.S. Fish and Wildlife Service, pers. comm. 1994). Other potential risks associated with exclosures include vandalism or disturbance of the birds by curiosity seekers. Therefore, exclosures must be carefully constructed, monitored, and evaluated by qualified persons.

1.43 **Remove predators where warranted and feasible.** Lethal and non-lethal means of predator control have been used with mixed success to protect piping plovers on Atlantic Coast beaches. Fox trapping has been credited with the substantially increased plover abundance and productivity on Little Beach Island in New Jersey (D. Beall, U.S. Fish and Wildlife Service, pers. comm. 1990), but has produced limited results at the Chincoteague NWR in Virginia (USFWS 1993b). Trapping of feral cats at a number of nesting sites has reduced threats from these non-native and very efficient plover chick predators.

Removal of predators should be pursued where feasible and warranted and where trapping can be conducted efficiently. Situations that may especially warrant predator removal include those where non-native predators such as feral cats and Norway rats

are present, where predators have been introduced to islands, where range extensions have been human-abetted, or where high rates of chick predation (which cannot be countered with predator exclosures) are occurring.

Herring, great black-backed, and ring-billed gulls pose a special threat to breeding plovers because they not only depredate nests and chicks, but also usurp plover nesting sites. These now numerous gulls have greatly expanded their range and numbers, especially along the U.S. portion of the Atlantic Coast, as a result of human-supplied food sources (primarily dumps and fish offal). Gulls should be prevented from establishing and expanding nesting colonies at plover nesting areas, and existing gull colonies at plover nesting sites should be removed.

1.5 **Protect piping plovers and their breeding habitat from contamination and degradation due to oil or chemical spills.** Oil/chemical spill emergency response plans should provide for protection of known plover breeding areas. In the event of a spill in the vicinity of a piping plover nesting or feeding area, efforts should be made to prevent oil/chemicals from reaching these beaches. Clean-up operations should be prompt, but special care must be exerted to prevent accidental crushing of and/or excessive disturbance to nests or chicks by clean-up personnel and equipment.

If piping plovers or their habitat sustain injury due to oil/chemical spills or leaks, the responsible parties should clean the areas to their original condition or the Federal government (U.S. Coast Guard) should do it as part of the Federal clean-up effort; appropriate claims should also be filed under the Natural Resource Damage Assessment (NRDA) regulations to recover damages and undertake relevant restoration work. Since 1991, restoration costs awarded under the NRDA regulations for piping plovers believed lost as a result of two Atlantic Coast oil spills have been received by Federal and State governments, and restoration work to remedy injury from these spills is underway.

1.6 **Develop mechanisms to provide long-term protection of plovers and their habitat.** Removal of the Atlantic Coast piping plover population from the protection of the ESA will require long-term protection to assure protection and management sufficient to maintain a highly productive recovered population (see recovery criterion 4). Long-term protection will be needed on both Federal and non-Federal lands, since even if Federal lands attain their full

capacity of approximately 635 pairs estimated in 1993, protection of plovers and habitat to support more than 950 additional pairs on non-Federal lands must also be ensured.

Development of long-term protection mechanisms may trigger additional opportunities for participation of various stakeholders in discussions of management options. Discussions of tradeoffs among various protection strategies and allocation of responsibilities across available habitat may be appropriate if it appears that a productive recovered population can be maintained with lower levels of protection than that initially required to attain delisting criteria 1 and 3.

1.61 **Provide intensive protection of breeding piping plovers on national wildlife refuges.** Wildlife protection, especially the preservation, restoration, and enhancement of threatened and endangered species and migratory birds, is the primary goal of national wildlife refuges (USFWS 1982). Piping plover habitat on national wildlife refuges has been accorded highly intensive protection, including closures during the nesting season where appropriate, to minimize adverse effects of disturbance. In some cases where human activity is extremely low or where plover use is unusually sparse, other protection measures short of closure are being used. These protection programs should be continued and should be periodically evaluated to ensure that they are providing sufficient plover protection.

1.62 **Seek long-term agreements with landowners.** Prototype agreements should be worked out at sites where there is a history of intensive and successful piping plover protection, a high degree of commitment to the piping plover protection program, and where experienced on-site shorebird biologists can provide expertise to devise and test alternative types of agreements. Possible candidate sites for prototype agreements might include the Cape Cod National Seashore (administered by the NPS) and Crane Beach (managed by The Trustees of Reservations) in Massachusetts; Goosewing Beach (owned by TNC) in Rhode Island; and Assateague Island National Seashore (NPS) in Maryland. Ingenuity will be required to develop agreements that are flexible enough to respond to the changeable nature of habitat conditions and site-specific threats and avoid unnecessary restrictions on other beach uses, yet also ensure adequate protection for piping plovers.

1.63 **Acquire important habitat if and when it becomes available.** Federal and State conservation agencies and private conservation organizations should continue efforts to acquire piping plover habitat as it becomes available. Piping plover habitat lies within approved acquisition boundaries of several national wildlife refuges, including Rachel Carson NWR in Maine, Trustom Pond NWR in Rhode Island, Stewart McKinney NWR in Connecticut, and Chincoteague and Fisherman Island NWRs in Virginia. The USFWS and other organizations should also undertake further efforts to identify other important sites that may become available for acquisition, and the USFWS should continue to monitor excess Federal lands for plover habitat and apply for it as it becomes available.

1.64 **Ensure that any Section 10(a)(1)(B) permits issued contribute to Atlantic Coast piping plover conservation.** Section 10(a)(1)(B) of the ESA provides for permits that have the potential to contribute to the conservation of listed species. Appendix H contains guidelines for the preparation and evaluation of conservation plans for piping plovers on the Atlantic Coast pursuant to this section of the ESA. These guidelines are intended to: (1) guide potential applicants in developing plans that minimize and mitigate the impacts of take and (2) assist the USFWS in evaluating the impacts of any proposed conservation plans on the recovery of the Atlantic Coast piping plover population. The Section 10 permit process may be a valuable mechanism for developing the long-term protection agreements called for in delisting criterion 4, especially in areas where significant population growth has already occurred and productivity exceeds 1.5 chicks per pair.

2. Monitor and manage wintering and migration areas to maximize survival and recruitment into the breeding population.

The population viability analysis conducted by Melvin and Gibbs (Appendix E) shows that probability of persistence of the Atlantic Coast piping plover population is highly sensitive to changes in survival rates. Since piping plovers spend 55-80% of their annual cycle associated with wintering areas, factors that affect their well-being on the wintering grounds can substantially affect their survival and recovery. Piping plover wintering areas are also used by many other shorebirds; their protection will contribute to the conservation of a richly diverse and important ecosystem.

Most sightings of banded birds from the Atlantic Coast breeding population have been made on the southern Atlantic Coast (see Wintering Distribution section, page 14). However, sightings of Atlantic Coast birds in the Florida Keys and on the Gulf Coast (16% of sightings) as far west as Texas and the large number of wintering birds unaccounted for during southern Atlantic Coast surveys lend credence to suggestions that more Atlantic Coast piping plovers than previously surmised may depend on Gulf Coast wintering habitat. Since the draft Revised Recovery Plan for Piping Plovers Breeding on the Great Lakes and Northern Great Plains (USFWS 1994a) contains recovery tasks for Gulf Coast wintering habitat, this plan focuses primarily on protection of wintering habitat on the southern Atlantic Coast; however, implementation of these protections involves overlap of responsibilities for the two populations. Likewise, tasks recommended in the Great Lakes/Northern Great Plains draft revision may be equally crucial to recovery of the Atlantic Coast breeding population.

Monitoring and protection tasks for migrating and wintering piping plovers are included in subtasks below, while research needs associated with wintering areas are included under task 3.1 and its subtasks. New information gained from research efforts must be promptly incorporated into protection efforts.

The USFWS recommends integration of the monitoring and protection tasks specified below into State action plans. State action plans that include all shorebirds or entire coastal systems may be effective vehicles for piping plover protection, as long as explicit attention is focused on the management and protection of Federally listed species such as the piping plover. State action plans should include the following components:

(1) Monitoring -- Several key sites per State should be selected for annual monitoring to serve as indices of population fluctuations.

(2) Identification of protection and management needs -- Management plans should be developed and implemented for sites with special protection and management needs.

(3) Education needs -- The need for volunteer meetings or workshops for regulatory agencies should be considered. For example, a 1991 workshop was held in North Carolina specifically for representatives of the regulatory agencies to inform them of the plover's habitat needs and ecology, as well as requirements to protect and consult on this species.

(4) Recognition of important sites -- Special recognition of key sites should be encouraged.

2.1 Monitor known and potential wintering sites. Recent wintering surveys have identified many new wintering sites, but there is a need for better information about spatial and temporal use patterns, habitat trends, and threats. This can be advanced through a continuing monitoring program.

2.11 Monitor abundance and distribution of known wintering plovers through periodic wintering surveys. A comprehensive rangewide survey (i.e., International Census) of wintering sites patterned after Haig and Plissner (1993) should be conducted at intervals of approximately five years to assess population trends, discover additional wintering sites, and determine relative site importance. Major wintering sites along both the Atlantic and Gulf Coast should be surveyed annually to provide additional information on site importance and to assess population fluctuations on a site-by-site basis. An improved understanding of the species' overall distribution, habitat use patterns, and site fidelity will facilitate assessment of impacts of proposed projects during ESA Section 7 consultations and State project reviews, development of management plans, and prioritization of protection programs. Suggested guidelines for conducting piping plover surveys in Atlantic Coast wintering habitat are found in Appendix I.

2.12 Survey beaches and other suitable habitat to determine additional wintering sites. Two surveys during the 1980's along with the 1991 International Census have provided important insight into plover winter distribution. To date, however, only 63% of the known adult population has ever been accounted for during the winter period. The recovery team believes that discovery of major new wintering sites on the southern Atlantic Coast (North and South Carolina, Georgia, and the east Coast of Florida) is unlikely. Surveys to locate more sites should focus on Louisiana, Texas, the Caribbean, and the Mexican Gulf Coast, where coastal islands and bay systems have been less fully surveyed to date owing to their relative inaccessibility. A second International Piping Plover Wintering Census was conducted in January 1996, and data, now under compilation, may contribute information on new sites.

2.13 Identify factors limiting the quantity and quality of habitat or its use by piping plovers at specific wintering sites. Potential direct and indirect threats to wintering plovers and their habitat have been identified, but a better understanding of the exact mechanisms and degree of impacts on the birds is needed. Some of this information will be obtained through formal scientific investigations (discussed in tasks 3.11 through 3.14), but much information can and should be acquired through monitoring the response of habitat and birds to various factors, including natural coastal formation processes, dredging and other channel maintenance, and recreational activities. Careful documentation of all observations is a key component of such monitoring. Opportunities to incorporate monitoring into plans for Federal activities subject to Section 7 of the ESA, such as dredging and discharges regulated by the Corps, should be sought. For example, a 1994 biological opinion regarding the reopening of Packery Channel, between Mustang and North Padre Islands, Texas, recommended that the Corps conduct pre- and post-project monitoring of the area's tidal amplitude, size of intertidal flats, salinity, vegetation, and invertebrate populations (R. Perez, U.S. Fish and Wildlife Service, *in litt.* 1994).

2.2 Protect essential wintering habitat by preventing habitat degradation and disturbance. All known wintering areas (listed in Appendix K of this plan and in Appendix 3 of the draft Revised Recovery Plan for Piping Plovers Breeding on the Great Lakes and Northern Great Plains) are currently considered essential to piping plover conservation. Probability of extinction of both Atlantic Coast and inland populations is extremely sensitive to changes in survival rates (Appendix E and Ryan *et al.* 1993). Furthermore, recovery of the three breeding populations is contingent on availability of wintering habitat for more than double the current number of piping plovers (USFWS 1994a and this document). As information needed to accurately estimate carrying capacity of wintering habitat becomes available in the future, it may be possible to identify habitat that is not considered essential to plover conservation (see task 2.25); however, for now all known wintering sites are considered essential habitat and should be protected.

2.21 Protect habitat from direct and indirect impacts of shoreline stabilization, navigation projects, and development. Coastal development projects should be carefully assessed with regard to piping plovers. Recommendations from USFWS (under the ESA and the Coastal Barrier Resources Act, if the latter is applicable)

and/or State agencies should focus on avoiding or minimizing adverse impacts to wintering habitat. Where adverse effects cannot be avoided, agencies should document impacts so that cumulative effects on this species' habitat can be assessed.

2.22 **Protect wintering habitat from disturbance by recreationists and their pets.** Piping plover wintering sites are highly variable in their amount of recreational activity and its proximity to areas used by plovers. Where a site-specific evaluation determines that recreation poses a threat to plovers, appropriate protection measures should be implemented. Among Atlantic Coast wintering sites, those in Florida currently face the greatest threats from human disturbance.

Nicholls (1989) found an average of 3.5 people and 0.7 off-road vehicles per km at sites without piping plovers compared with 1.4 people and 0.2 vehicles per km within the plover's Atlantic Coast wintering range. On the Gulf Coast, recreational activity was also higher at non-plover sites (6.5 people and 0.4 vehicles per km) than sites where Nicholls found plovers (0.7 people and 0.2 vehicles per km). However, these differences were not statistically significant on either the Gulf or Atlantic Coast (J. Nicholls, *in litt.* 1989), and more information about the mechanisms and effects of disturbance on wintering plovers and their habitat is needed (see task 3.14). As information becomes available, it should be incorporated into conservation efforts.

2.23 **Protect piping plovers and their wintering habitat from contamination and degradation due to oil or chemical spills.** Contamination from oil or chemical spills or leaks poses a significant threat to wintering piping plovers. Efforts must be made to minimize the likelihood of such events in the vicinity of plover wintering areas. Oil/chemical spill emergency response plans should provide for protection of known plover wintering areas, as should State plover, shorebird, or coastal ecosystem protection plans. In the event of a spill in the vicinity of a known piping plover wintering area, surveys should be conducted and efforts should be made to prevent oil/chemicals from reaching plover use areas, and restoration efforts should begin expeditiously. If piping plovers or their habitats do sustain injury due to oil/chemical spills or leaks, appropriate claims should be filed under the NRDA regulations to recover damages and undertake relevant restoration work.

2.24 **Apprise resource and regulatory agencies of threats to wintering piping plovers and their habitats.** Periodic workshops should be held to inform resource management and regulatory agencies about threats, research and management needs, etc. A coordinated approach to conservation of plover wintering areas should be encouraged.

2.25 **Evaluate and update lists of essential wintering habitat as data become available.** As new plover wintering areas are discovered and data needed to assess the carrying capacity, essential characters, and juxtaposition of wintering habitats become available, the current lists of essential wintering habitat (see task 2.2 and Appendix K) should be expanded or refined as appropriate.

2.26 **Provide for long-term protection of wintering habitat, including agreements with landowners and habitat acquisition.** Wintering areas deemed important (essential) should be protected through management plans and/or written agreements. Conservation easements and acquisition of wintering sites should be considered. Priority should be accorded to important sites facing the most imminent threats of permanent habitat loss or degradation.

2.3 **Protect piping plovers during migration.** Although piping plover migration patterns are poorly understood, it is likely that migration involves considerable expenditure of the bird's energy that may affect survival and/or productivity. Although monitoring and protection of breeding and wintering sites are currently higher priorities than active protection during migration, further investigations and protection measures may be warranted in the future.

2.31 **Identify important migration stop-over habitat.** Appendix B identifies many breeding sites where concentrations of post-breeding and migrating plovers are observed, and the importance of a few stop-over sites, such as several North Carolina sites, has been recognized. However, regular monitoring of plover breeding sites usually ceases with the fledging of chicks, and monitoring of wintering sites is often timed to coincide with peak use (late fall and early winter) rather than migration periods. Even when surveys are conducted during migration periods, data collection is usually limited to counting the number of plovers observed. Collection of

information on turn-over rates is hampered by the lack of marked birds, but should be noted whenever banded or otherwise identifiable birds are encountered.

2.32 **Identify and mitigate any factors that may be adversely affecting migratory stop-over habitat or its use by piping plovers.** Further investigations into factors that may affect the well-being of plovers during migratory stop-overs may facilitate their protection, particularly on sites that receive relatively heavy plover use and/or face threats that may affect their suitability as stop-over habitat.

3. Undertake scientific investigations that will facilitate recovery efforts.

Research efforts over the last fifteen years have substantially increased our understanding of piping plover protection needs and facilitated conservation efforts; however, major gaps remain. Activities related to censusing to determine population trends, surveys to locate new breeding or wintering areas, and monitoring to determine abundance, productivity, and causes of nest or chick loss are basic components of on-site management and are included in tasks 1 and 2.

One factor that will affect experimental design for many Atlantic Coast piping plover research projects is the current lack of a safe method of marking individual birds. Beginning in 1982, several research projects using color-banding of Atlantic Coast piping plovers were initiated to facilitate determination of survival rates, dispersal, and other research objectives. Task 1.12 in the 1988 recovery plan called for the development and implementation of a coordinated color-banding and marking program, and such a scheme was deployed in coordination with the Great Lakes and Northern Great Plains Recovery Team. In late 1989, however, following receipt and analysis of information regarding piping plovers with injuries that appeared to be related to the use of bands and legflags, the Northeast Region of the USFWS placed a moratorium on the use of these devices (J. Gillett and R. Lambertson, U.S. Fish and Wildlife Service, *in litt.* 1989 and 1990). Although biologists have continued to report sightings of birds banded prior to 1990, this moratorium has impeded efforts to expand information about piping plover survival rates, dispersal patterns of breeding birds, and many important aspects of plover wintering ecology. Additional discussion of this matter is included under task 3.9.

3.1 **Investigate the wintering ecology of piping plovers.** Research currently in progress on the Texas Coast will provide much valuable information on piping plover wintering ecology.

However, the Texas coastal system is complex, and habitat selection and use may be somewhat different from other areas along the Atlantic and Gulf Coasts. Possible research sites on the Atlantic Coast and Florida Keys include:

- Rachel Carson's Estuary/Cape Lookout National Seashore in North Carolina,
- Deveaux Bank in South Carolina,
- Tybee/Little Tybee Island/Williamson Island in Georgia,
- Cumberland Island National Seashore in Georgia,
- Ward's Bank/Talbot Island in Florida, and
- Ohio Key/Woman's Key/Boca Grande Key in the Florida Keys.

Several sites on the Florida Gulf Coast would serve as suitable research sites, including:

- Marco Island/Sand Dollar Island in Collier County,
- Lee County sites (Estero Island, Cayo Costa State Park, North Captiva Island, Bunches Beach), and
- Pinellas County sites (Honeymoon Island, Three Rooker Bar, Caladesi Island).

3.11 **Characterize wintering habitat.** Research is needed to identify winter foraging and roosting habitat characteristics along the Atlantic Coast. Features should be identified on both the local (e.g., substrate type) and landscape level (e.g., the availability or diversity of microhabitats in coastal complexes). Information on habitat characteristics and use will help in locating new and protecting existing wintering sites.

3.12 **Determine the spatial and temporal use of wintering habitat.** Analysis of data from aerial photographs using computerized Geographic Information Systems may provide insight about the relative importance of the proximity of foraging and roosting habitat. Time budget analyses and observations of marked birds may also yield more information on the spatial and temporal (tidal, year-to-year, wind-influenced) use of habitat, whether or not there are prime and alternate feeding and roosting sites, and importance of sites during weather and tidal extremes.

3.13 Evaluate and compare foraging behavior and resources for specific microhabitats at wintering sites. Research on foraging efficiencies and prey availability (and possibly fecal sampling and analysis) needs to be conducted on the Atlantic Coast to determine relative importance of different microhabitats, e.g., sandflats, mudflats, sandy mudflats, beach. It may also be desirable to include Florida Gulf Coast sites in such studies.

3.14 Investigate the effects of human disturbance on wintering plovers. The degree to which human disturbance and off-road vehicles affect the distribution, habitat use, energetics, and survival of wintering piping plovers needs further study (Melvin *et al.* 1991); investigation of the mechanisms by which human activities affect the birds is also needed.

3.2 Refine characterization of plover breeding habitat. Information about important characteristics of Atlantic Coast piping plover breeding habitat has been substantially advanced through a number of formal research projects, as well as through high quality documentation of plover breeding activities at many intensively monitored sites. However, further study is needed to facilitate more rigorous projection of carrying capacity from habitat characteristics.

There are also unanswered questions about potential differences in plover habitat requirements within the breeding range (1,500+ miles) of the Atlantic Coast population. In particular, it is presently unclear whether the apparent coincidence of nesting plovers sites in the southern part of the range with access to lightly vegetated bayside intertidal areas and ephemeral pools is indicative of greater dependency of breeding plovers on these habitats at lower latitudes (Loegering and Fraser 1995, Elias-Gerken 1994, Elias-Gerken and Fraser 1994) than is seen in New England. Elucidation of this issue would greatly facilitate decisions about what types of protection measures are most likely to benefit plovers in the New York-New Jersey and Southern recovery units.

Two aspects of habitat characterization that have been identified as high priorities for further research are discussed in tasks 3.21 and 3.22. Some researchers have also suggested that the presence/absence of overwintering ghost crab populations results in different habitat use patterns across the plover's range (see task 3.43). Because they occur in important habitats,

effects of artificial inlet closure and other beach stabilization projects on suitability of plover habitat should also be carefully evaluated (task 3.23).

3.21 Compare plover foraging resources along the Atlantic Coast breeding habitat. Several studies (Loegering 1992, Goldin 1993b, Hoopes 1993, Elias-Gerken 1994) have focused on plover foraging ecology, analyzing data on habitat use (time budgets), foraging rates, and invertebrate abundance. Loegering and Fraser (1995) and Elias-Gerken (1994) have further suggested that plover requirements for foraging resources may be more specialized south of New England. However, because terms and definitions used to categorize habitat types and protocols for sampling foraging rates and invertebrate abundance varied among the studies, it is difficult to compare results. More important, these differences confound application of results from these intensive studies to a variety of management issues at other sites along the coast, including estimates of carrying capacity and decisions about habitat protection priorities, both within and among sites. A study is needed that uses a consistent protocol to compare the abundance and availability of prey in different habitats at a geographically dispersed set of sites along the Atlantic Coast. Ideally, this research would encompass portions of the study areas of the studies cited above, as well as other selected sites distributed along the plovers' Atlantic Coast range, including Canada. Such a study should also evaluate sites to determine whether the use of off-road vehicles (at any time of year) affects the types and/or numbers of invertebrates present during the plover breeding season.

3.22 Determine requirements of breeding plovers and their chicks for moisture and other factors that may affect thermal regulation, hydration, and salt excretion. Several studies, reports, and other communications from the southern end of the plover's breeding range (Coutu *et al.* 1990, Wolcott and Wolcott 1994, Collazo *et al.* 1995, Lyons and McGrane 1995) have suggested that heat and lack of moisture may affect chick survival and constrain habitat suitability, especially in North Carolina. Research is needed to elucidate effects of moisture and heat on habitat suitability, carrying capacity, and productivity.

3.23 Evaluate impacts of artificial inlet closure and other beach stabilization projects on piping plover breeding habitat suitability. As noted on pages 6, 11, and 37 and

under task 1.2 and its subtasks, piping plovers nest and forage in storm-maintained habitats, including sandspits, overwashes, and blowouts, and the species' survival and recovery as well as the well-being of other early succession beach-dwelling species is dependent on the maintenance and perpetuation of these habitat characteristics. However, inlets have been artificially closed in the past (for example, at Westhampton Beach, Long Island, New York in 1962, 1980, and 1993 (Cashin Associates 1993)). An "Interim Breach Management Plan" has recently been formulated to expeditiously close any future storm-created inlets that might occur in the barrier islands between Fire Island Inlet and the eastern end of Shinnecock Bay on Long Island (U.S. Army Corps of Engineers 1995). Other beach stabilization projects, such as snowfencing and vegetation planting, are sometimes implemented despite their deleterious effects on plovers and their habitat. Additional information is needed to more fully determine the type, extent, and duration of impacts on plover habitat suitability from these types of coastal modifications and to facilitate more complete analysis of impacts on regional plover populations. Such studies should also seek to define possible project modifications that will minimize adverse impacts on piping plovers, other Federally-listed species, and the beach ecosystem. Studies may also facilitate creation and enhancement of nesting and feeding habitat to mitigate unavoidable adverse effects of artificial beach stabilization (see task 1.24).

3.3 Monitor levels of environmental contaminants in piping plovers. To date, very limited testing has been conducted to assess contaminant levels in piping plovers that might affect survival or reproductive success (see Reasons for Listing and Continuing Threats, page 44). Some unhatched eggs and dead chicks from several Massachusetts and New York sites have been collected for this purpose, but no assessment has yet been performed. Concern in New England is focused primarily on comparison of samples from the vicinity of Buzzards Bay (near the site of a major Superfund clean up) with samples from elsewhere. As abandoned eggs and/or chicks that are not needed for law enforcement investigations become available, they should be collected for potential contaminants assessment. A protocol for collecting, handling, and shipping samples was developed by USFWS environmental contaminants specialists and endangered species biologists for use in New York in 1995[1]. Egg removal and

[1] Copies may be obtained from USFWS, Weir Hill Road, Sudbury, Massachusetts 01773, Attn: Anne Hecht; however, use of this protocol should only be made following coordination with local USFWS or State environmental contaminants and endangered species biologists.

salvaging of dead chicks should only be done by individuals possessing proper authorizations as provided for in 50 CFR 17.21 and 17.31. Sites with the greatest potential for contaminant problems should also be identified and given priority for assessment. Samples should be assessed for standard organochlorine compounds and, in locations where there is reason to believe they may be present at levels sufficient to affect plovers, for heavy metals.

All sampling should be opportunistic, based on availability of eggs that are known to be substantially beyond their expected hatch date. Eggs should never be removed from the beach as long as there is any realistic chance that they might hatch. In the case of unhatched eggs from a partially hatched clutch, eggs should not be collected until at least 72 hours after the known hatch date of the other eggs. Full clutches should not be collected unless it is known that 40 or more days have elapsed since the last egg was laid. Collection of abandoned clutches should only be done after substantial monitoring over at least five days has established that the adults are not going to return *and* that the on-site biologist has conferred with a State or USFWS endangered species biologist. The widespread use of predator exclosures to protect nests hinders scavenging of eggs that fail to hatch.

3.4 Develop and test new predator management techniques to protect nests and chicks. Although a number of techniques to reduce predation, described under tasks 1.41-1.43, are currently in use, all have disadvantages and limitations on their applications. Predator exclosures are labor-intensive, may increase susceptibility of nests to vandalism or abandonment, may contribute to injuries to incubating adults, and afford no protection to chicks. Predator removal is labor-intensive and sometimes controversial, and results are often temporary. Trapping methods are not available for all species, such as Norway rats, crows, and ghost crabs. Removal of trash and litter from the beach eliminates one of many factors that attracts predators to the beach, but will not redress major imbalances in the numbers or ranges of predators in the coastal zone. A number of potential predator management techniques have been suggested and others may be proposed in the future (see following tasks). Assistance from the USDA-ADC and from State wildlife agency furbearer biologists should be sought on these matters.

3.41 Develop and test conditioned aversion techniques. Proposals to test conditioned taste aversion on red foxes in Maryland (MacIvor 1991) and Virginia (Cross 1992) were not implemented due to difficulties obtaining permission to field test the

proposed aversive compound, emetine. Pros and cons of other aversive techniques, including electrified exclosures, trap and release, and use of such techniques in conjunction with predator birth control (to prevent conditioned adults from reproducing) are briefly discussed by Melvin (1993). While there appear to be many obstacles to development of effective aversion techniques that can be efficiently applied in the field, there are substantial potential advantages to be realized from an aversive technique that can reduce predation on both eggs and chicks and that might be conducted at times when plovers are not present.

3.42 **Extend testing of artificial coyote territories to exclude red foxes.** Cross (1993) tested the use of coyote scent marks (scats and urine) to deter red foxes from two plover habitats in Virginia. Lack of statistically significant differences in fox activity in experimental and control areas caused the author to conclude that this technique may not be very promising. However, differences detected on the beach site that is most like other Atlantic Coast plover nesting areas and the occurrence of heavy rains during much of the study period suggest that another trial is warranted, perhaps at another site. Protocols described by Cross (1993) might be replicated at a site where fox activity is high and wild coyotes are absent.

3.43 **Evaluate threats from ghost crabs and develop control techniques, if appropriate.** Several studies (e.g., Cross 1991, Loegering *et al.* 1995) have cited ghost crabs as potentially important predators of piping plovers on Assateague Island, Maryland and Virginia. Other biologists have raised questions about whether ghost crabs may also be an important factor limiting plover nest site selection and/or productivity from North Carolina to New Jersey. Preliminary research conducted in Virginia (Wolcott and Wolcott 1994) was designed to gather information on ghost crab-piping plover interactions and habitat factors affecting ghost crab distributions and abundance, with the intent of eventually testing alternative methods of reducing impacts of ghost crab predation on plovers. Results of the 1994 field work suggest that the extent of direct ghost crab predation on piping plovers may be less significant than previously thought, although responses of adult plovers to ghost crabs indicate that the presence of ghost crabs may deter plovers from using some habitats, and may thereby cause indirect impacts on plover productivity. Testing of correlations

between plover use of high energy beaches and occurrence of overwintering ghost crab populations may help elucidate this issue.

3.44 **Develop and test electric fences.** With assistance from USDA-ADC specialists, plover biologists in Maine have experimented with use of electric fences around exclosures to deter "smart predators" that have learned to dig under or climb into exclosures (Maine Audubon Society 1995). These small electric fences must be carefully constructed to avoid any potential harm to plovers and other non-target species. Assistance should be sought from ADC, use should be carefully monitored, and results should be documented.

Mayer and Ryan (1991) found that electric fences enclosing areas of 0.4-2.4 hectare reduced mammalian predation of piping plover nests and chicks in North Dakota. Experience on the Atlantic Coast, however, has found that large electric fences are very difficult to deploy and maintain in coastal areas where salt air corrodes battery terminals and where predators will often wade around fences through the surf zone (C. Hebert and E. Moses, U.S. Fish and Wildlife Service, pers. comm. 1993). If electrification techniques that are less susceptible to corrosion can be devised, further experimentation with electric fences around nesting sites may be warranted.

3.5 **Analyze population trends and productivity rates to monitor plover survival rates.** As noted under delisting criterion 3 (page 58), the PVA (Appendix E) is based on assumptions that may underestimate survival rates for some or all recovery units or the percentage of one year old adults that breed. Although lack of safe marking techniques currently precludes direct measurement of survival rates, they can be estimated using population trend and productivity data; these survival rates and other demographic variables can then be used in stochastic model to verify productivity rates needed to assure a 95% probability that the population will persist for 100 years. Accomplishment of this task is contingent on high quality data on the number of breeding pairs and productivity (see task 1.11).

3.6 **Determine temporal distribution of plover mortality.** Extinction probabilities for piping plovers are highly sensitive to changes in survival rates, but times, locations, and causes of post-fledging mortality are poorly understood. Determining where in the annual cycle (e.g., post-breeding, migration, winter, pre-breeding, breeding) mortality occurs and under what

circumstances, as well as the sexes and age classes of affected birds, would greatly facilitate efforts to increase survival of fledged birds. However, lack of safe marking techniques (see discussion under tasks 3.0 and 3.9) and information on migration patterns and wintering locations of the majority of Atlantic Coast plovers (see tasks 2.1 and 2.3) will constrain efforts to better understand plover mortality.

3.7 Develop a metapopulation model that will estimate extinction probability for the Atlantic Coast piping plover population. A metapopulation model would more realistically simulate actual population dynamics than the single population model developed by Melvin and Gibbs (Appendix E). This type of model could be especially useful to biologists assessing the impacts of site-specific or regional projects for ESA Section 7 consultations. Such a model would also contribute to evaluation of applications for permits under Section 10(a)(1)(B) of the ESA.

3.8 Estimate effective population size for the Atlantic Coast piping plover population. An estimate of the ratio of effective population to total population (N_e/N) for the Atlantic Coast piping plover is needed to evaluate the adequacy of the recovery goal to prevent loss of heterozygosity and allelic diversity over the long term. Determination of N_e/N is of particular concern with regard to piping plovers, because their very sparse distribution results in highly non-random mating. One possible approach would involve refinement of the current Atlantic Coast piping plover demographic model to incorporate mating/distribution patterns, followed by computer simulations to estimate the rate of loss of hypothetical alleles over various time periods. Other approaches should be considered, as appropriate.

3.9 Develop safe techniques for marking plovers. As discussed under task 3, the lack of safe techniques to individually mark piping plovers complicates many aspects of piping plover research. Development of a technique for marking birds so that they can be individually identified from a distance would be especially useful to many potential research projects. It is crucial, however, that marking not interfere with the birds' normal behaviors, increase risk of predation, or cause injuries. Experimentation with new techniques must be conducted cautiously, and may need to include pre-testing on non-listed surrogate species.

Dr. S.M. Haig, research biologist with the National Biological Survey and Great Lakes and Northern Great Plains Recovery Team Leader (*in litt.* 1994), has initiated efforts to develop

population-specific molecular markers for breeding populations that could be used to trace the origin of wintering birds, and perhaps facilitate other research.

4. Develop and implement public information and education programs.

Millions of beach recreationists encounter Atlantic Coast piping plover nesting and wintering areas each year. The responses of these beach users to signs and symbolic fences requesting that they avoid certain areas and/or modify their behavior (for example, by leashing pets or not using kites) can directly affect the productivity and fitness of piping plovers on those beaches. Public information and education (I&E) efforts play a key role in obtaining compliance of beachgoers with plover protection measures that, in turn, affect the birds' recovery. Central messages to the beach-going public include: (1) respect areas fenced or posted for protection of plovers and other rare beach species; (2) do not approach or linger near piping plovers or their nests; (3) if pets are permitted on beaches used by plovers, keep the pets leashed; and (4) don't leave or bury trash or food scraps on beaches, as garbage attracts predators that may prey upon plover eggs or chicks.

Due to the important role of I&E in the plover recovery effort, the USFWS developed an Information and Education Plan for the Piping Plover, Atlantic Coast Population (USFWS 1989b). This plan identifies audiences, materials and forums, strategies for reaching audiences, distribution plans and responsibilities, and costs. I&E materials about piping plovers developed by the USFWS since 1986 include:

Brochures - in English (updated in 1994) and Spanish (1991)
Posters (1986, now out of print)
Postcards (reprinted in 1994)
Public service announcements - radio and television (1990)
Environmental education lesson plans - target audience 5th through 7th grade, includes a scripted slide show (1993)
Interpretive signs

Additionally, the Canadian Wildlife Service; the National Park Service; State, Provincial, and local governments; and private organizations have produced a large array of high quality I&E materials about piping plovers, including posters, brochures, public service announcements, press packages,

and interpretive signs in English and French. A 16-minute piping plover video was produced in 1990 by the National Fish and Wildlife Foundation.

Expanded efforts to increase public awareness of protection needs of piping plovers, other rare beach species, and the beach ecosystem are needed.

4.1 Develop new and updated piping plover information and education materials. There is a continuing need to develop new piping plover I&E materials to reach new target audiences, take advantage of advancing media, and stimulate continuing public interest and awareness. In addition, all materials must be kept reasonably current regarding the status of the species and protection efforts. At present, there is a need to integrate more information into plover I&E materials about the role of piping plover conservation efforts in protecting the beach ecosystem and about the plight of other rare beach-dwelling species. An updated video is needed, and might be efficiently produced in conjunction with updated public service advertisements. Three line drawings purchased by the USFWS in 1986 and a fourth drawing donated by the artist (Julie Zickefoose) in 1990 have been used extensively over the last decade in brochures, posters, signs, etc., throughout the species' range. A fresh and expanded selection of drawings is now needed.

4.2 Establish a network for distribution of information and education materials. While development of I&E materials is a major task, distribution of these materials to target audiences requires an even larger commitment of time and other resources. Atlantic Coast beaches are within a few hours' drive of many major metropolitan areas, resulting in a very large population of potential beachgoers. Some efforts have been aimed at use of mass media, such as radio and television announcements, but the majority of piping plover I&E distribution efforts have targeted specific user groups at beach parking lot entry stations and kiosks, visitor centers, and marinas. I&E materials have been distributed to beach-front homeowners and to applicants for off-road vehicle permits. Environmental education lesson plans contain many participatory activities and have been very popular among elementary and middle school groups. Major distributional efforts have been exerted by State and national parks, national wildlife refuges, and private conservation organizations.

5. Review progress towards recovery annually and revise recovery efforts as appropriate.

The piping plover's wide range, intensity of management, and the large number of people involved in its conservation dictate that new information reaches biologists in the field promptly. This ensures that human resources and money are devoted to the highest priority needs.

Communication, evaluation, and coordination must continue to play a major role in plover recovery efforts. The USFWS should continue to compile and distribute annual status updates, and other communication efforts focused on the U.S. Atlantic Coast breeding range must be maintained. If requested by Canadian agencies and organizations, efforts to share information and expertise with biologists in Atlantic Canada should be expanded. Coordination and communication among biologists within the plover's wintering range should also be increased.