

3. EXAMPLES OF POSSIBLE CUMULATIVE ENVIRONMENTAL IMPACTS

Repeated visits by ship-based tourists, coupled with other human activities, could have cumulative effects on the landscape, flora, fauna, historical artifacts, and science programs and support activities in the areas visited, and on nearby marine areas. As noted in the next section of this report, the nature and severity of the possible cumulative effects may differ from site to site depending on the characteristics of the sites and variables such as the frequency of visits. The following are examples of possible cumulative impacts identified by the workshop participants.

Landscape. The topography, geology, and other physical characteristics of the sites visited by tourists and others may be changed in a number of ways over time as a consequence of those visits. Repeated grounding of boats and off-loading and loading of passengers at access sites may disturb sand and gravel, and increase the rate of beach erosion. Visitors walking from landing beaches to points of interest at the sites may compact soil and wear footpaths, which in turn may cause increased wind and water erosion, alter the topography of the area, and affect where snow, ice, and rain water accumulate, and when and how snow and ice melt and run-off occur. If not well educated before going ashore, and supervised while on shore, visitors may discard and over time sites may accumulate litter such as food remnants, candy wrappers, cigarette butts, film boxes and containers, soda cans, sandwich wrappers, gloves, and other items of clothing. Litter can both affect the aesthetics of sites and, as noted below, harm wildlife in a variety of ways. Visitors also may unintentionally introduce non-indigenous flora and fauna, including microorganisms, which can affect soil formation and, as noted below, displace or harm indigenous flora and fauna. Further, particulates and chemicals in exhausts from ship engines and small boat motors can be transported to and accumulate on land, on snow and ice, and in melt pools.

Terrestrial Flora. Repeated visits of sites with assemblages of grasses, mosses, and lichens can have a variety of effects on the distribution, abundance, and productivity of the vegetation. For example, walking on mosses and lichens can crush and uproot them, and over time wear pathways and compact soil, which in turn can affect the retention and flow of water and cause soil erosion beyond the areas directly affected. Such damage may also affect the soil substrate and competitive ability of some species and lead to changes in species composition and increased vulnerability to invasion by non-native species. Damage and destruction of floral assemblages and related ecological processes (e.g., soil formation) also may be caused or enhanced by deposition of combustion products from ship and small-boat engines, and

The nature and severity of the possible cumulative impacts of ship-based tourism will depend in part on the characteristics of the sites visited.

by accidental introduction of non-indigenous species, including pathogenic microorganisms.

Terrestrial Fauna. As noted earlier, one of the principal reasons that tourists visit the Peninsula area is to see the various species of penguins, flying birds, and seals that are present on land there during the spring and summer reproductive seasons. If not done carefully and with adequate supervision, people visiting sites to see these species first-hand can accidentally trample cryptic eggs and nests, and disturb animals in ways that 1) cause them to abandon nesting and pupping sites; 2) interfere with incubation of eggs, formation of mother-pup bonds, and tending of young; 3) increase the vulnerability of bird eggs and chicks to skua predation and of penguins and young seals to leopard seal predation; and 4) cause stress that makes animals more susceptible to diseases and parasites. Over time, such mortality and disturbance can cause shifts in colony locations or boundaries, declines in the number and sizes of breeding colonies, and maladaptive changes in behavior that can escalate declines in productivity and abundance (e.g., increased intra-species aggression, and less time spent attending and feeding young).

As noted below, the nature and severity of impacts may vary depending upon when during the breeding cycle disturbance occurs.

Historic Sites and Monuments. Many tourists have read about the history of human activities in Antarctica and are interested in visiting old whaling and sealing stations, such as those on Deception Island, and the locations or remains of historic structures, such as those at Port Lockroy. The buildings and artifacts at such sites have been subject to decades of weathering and any disturbance can expedite further degradation. Also, while the visitor guidelines set forth in ATCM Recommendation XVIII-1 make specific reference to not defacing or vandalizing buildings, or taking parts or contents of buildings or other artifacts as souvenirs, many visitors understandably would like some memento of their trip and may see no harm in picking up rocks, bones, and other artifacts that may be present in and around the sites that are visited. Over time, such seemingly harmless activities can denude and destroy the historic value of such sites if passengers are not well educated before going ashore and not properly supervised on shore.

The Marine Environment. Operation of tour ships and related small-boat operations may have a number of cumulative effects on the marine environment and its component parts. Repeated anchoring of ships while passengers are transported to sites on shore can disturb bottom substrate and damage, destroy, or cause changes in the species composition of benthic communities. Fuel and oil leaks, and illegal dumping of sewage and waste likewise can have cumulative effects on benthic communities near terrestrial sites that are visited repeatedly. It also is possible that, in some areas, noise from ship and small-boat oper-

ations, and repeated attempts to approach whales, seals, and penguins for viewing could interfere with biologically important activities such as feeding and, over time, cause animals to abandon or avoid areas traditionally used for such purposes.

Science and Science Support Operations. Many tourists are interested in visiting and seeing first-hand the kinds of science being done at research stations operated by different countries in the Peninsula area. Such visits can interfere with the daily routine of station personnel and, if they occur frequently, may interfere with station operations if passengers are not well educated before going ashore and supervised while on shore. In some cases, repeated visits may interfere with or compromise on-going research. For example, visitors simply turning lights on or off in areas where experiments are being done to determine the effects of light on plankton, krill or other organisms can affect the study results.

Most national program managers have established restrictions on station visits, and procedures for structuring those visits to avoid or minimize possible impacts on station operations and personnel. Such actions are the responsibility of the individual program managers and were not considered by the workshop.

4. SITE VARIABLES AFFECTING POSSIBLE CUMULATIVE EFFECTS

The nature and severity of the possible cumulative impacts of ship-based tourism will depend in part on the characteristics of the sites visited. The following are ten site characteristics identified by the workshop participants.

1. Biological Diversity at the Site. As noted earlier, many tourists visit Antarctica to see wildlife. Thus, sites with large numbers of multiple species of penguins, flying birds, and seals are more likely to be visited than sites with smaller numbers of fewer species. As noted below, the frequency of visits and numbers of visitors are two of the principal factors determining the likelihood of cumulative impacts.

2. Location Relative to the Distributional Ranges of the Species Present. Sites with the greatest diversity of flora and fauna are likely to be in areas where the ranges of multiple species overlap. Species' distributions generally are determined by geographically variable environmental factors, such as the presence of ice-free areas at critical times in their breeding cycle and the absence of competing species. Thus, species at the margins of their distributional ranges may be more subject to stress and vulnerable to disturbance-related effects than species near the centers of their distributional ranges.