MANAGEMENT IMPLICATION OF WOLF-MOOSE RESEARCH,

ISLE ROYALE NATIONAL PARK, MICHIGAN

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INTRODUCTION

This report summarizes wolf-moose research findings which have a bearing on management policies at Isle Royale National Park. It was prepared at the request of the National Park Service, and was initially outlined in a 12-month research proposal dated April, 1975. A first draft was circulated in June, 1976.

The research now spans 19 years, and was directed by Durward L. Allen, Purdue University (1958-75), and Rolf O. Peterson, Michigan Technological University (1975 to present). While the principal focus of the research has been the predator-prey relationship between wolves and moose, other aspects of Isle Royale ecology have been studied or at least informally observed; consequently this report deals with a broad spectrum of topics.

MANAGEMENT PHILOSOPHY

Isle Royale National Park represents a national resource of great scientific importance. The island's limited mammalian fauna currently experiences little or no human interference, an important factor when studying wolf-moose interaction.

While recognizing the importance of providing the public with wilderness recreation opportunities, in this report I have concentrated on what must be done to preserve for future generations certain natural features of Isle Royale, particularly the undisturbed character of the wolf and moose populations. Where short-term use conflicts with the goal of long-term preservation, I have recommended that the long-term goal receive priority consideration. This reflects a general attitude that compromising the undisturbed character of Isle Royale would often result in an irretrievable loss. While in individual cases adverse effects might seem insignificant, the cumulative loss over time could be serious and contrary to the goals of the Park.

Fifty years from now wolf populations may be limited to formally designated sancturaries, since de facto wilderness areas that now support wolves are rapidly disappearing. Isle Royale is already one of the few sites in the world where wolves and moose exist in the absence of human exploitation. It is the responsibility of the National Park Service to minimize human disturbance of these species, particularly when human activities might disrupt population dynamics or interactions between species.

WOLF AND MOOSE POPULATIONS (see also Peterson 1974)

Isle Royale supports an unusual high-density moose population. The high moose population is probably due to the fact that dispersal is prevented by Lake Superior, since similar habitat in Minnesota supports only about one-half as many moose (Peek 1971).

Research indicates that wolves are able to kill only a small proportion of the moose they confront, since most moose are able to adequately defend themselves. Calves experience the greatest predation pressure. Aside from an unknown amount of non-predatory loss soon after birth resulting from fetal malnutrition, birth defects, etc., most mortality of calves results from wolf predation. Calves are also preyed upon heavily in winter, depending on their abundance and snow conditions; some cohorts experience almost complete loss before the calves are one year old. However, those moose that survive their first year have a life expectancy of 7-8 years. Almost all adults are eventually killed by wolves, and most adult mortality is concentrated in a relatively short period in winter.

Bull moose have a slightly shorter life expectancy than females, probably because of a higher incidence of arthritis (mostly pelvic) and malnutrition among males. Both of these conditions may be indirectly caused by activity and high stress levels during the October mating season. A. B. Bubenik, wildlife biologist and ethologist from the Ontario Ministry of Natural Resources, hypothesizes that the high density of moose on Isle Royale, coupled with an age structure containing many "teens" (about 1-5 years old), results in an unusual amount of competition and social stress, especially among older bulls. It is interesting that arthritis first becomes evident at about six years of age, just after bulls attain "prime" social rank and grow the largest antlers. After this age males begin to die at a slightly faster rate than females.

Moose-vegetation relationships on Isle Royale are atypical because of the high moose population. Favorite species of browse are currently heavily utilized; historical records and data from other researchers indicate that this has been the case ever since the 1920s. Moose browsing has a pronounced effect on the composition and density of the forest, as shown by the research of R. Janke. However, the substantial biotic effects of moose on Isle Royale vegetation reflect an entirely natural chain of events beginning with colonization of the island by moose in the early 1900s and subsequent population growth.

Moose population levels are ultimately determined by food supply, although the immediate controlling influence is wolf predation. Briefly, wolf predation seems to adjust the moose population to its food supply. Predation is not intense enough to eliminate winter malnutrition among moose, but usually prevents actual starvation.

The wolf population is regulated ultimately by its food supply (prey population density), although it is likely that behavior patterns and social stress act as intermediary factors that provide more direct control. Pup mortality may be quite high, especially if the summer food supply is low. Actually, we know very little about direct causes of wolf mortality on Isle Royale, among both pups and adults.

In contrast to the seemingly stable wolf-moose relationship observed through the 1960s, recent years of study have demonstrated how dynamic this predator-prey relationship can be. Calf production and survival dropped to low levels, predation losses among 1- to 5-year-old moose suddenly increased, the wolf kill rate rose as wolves began to surplus-kill, and finally, the wolf population doubled in the short span of only a few years. The moose:wolf ratio dropped from about 80:1 in 1969 to about 20:1 in 1976, and the current predation pressure is the highest ever observed on Isle Royale.

While these changes were not predictable, we are at least able to explain them in retrospect. An important subtle change in moose habitat occurred during the 1950s and early 1960s. As aspen and birch in the 1936 and 1948 burns grew out of reach, moose tended to shift away from the burns to mature stands of spruce and fir. Essentially, moose were forced to subsist on a less-abundant food supply in predominantly coniferous stands. Pellet counts during this period by Krefting (1974) suggest increased defecation rates as moose fed on poorer quality food (my interpretation). There is also evidence that the moose population grew (for inexplicable reasons) suddenly in the mid-1960s (Jordan and Wolfe, unpubl. data), so that by the late 1960s Isle Royale contained a high moose population supported by a relatively sparse food supply.

During at least three of the next four winters (1969, 1971, and 1972), Isle Royale received abundant snowfall, which limited moose movements to conifer stands, which were already heavily browsed, and made calves especially vulnerable. Winter malnutrition increased, and calves born after these severe winters were physically retarded. These generations of calves showed poor survival, and those that survived to adulthood grew at a slower rate and may have suffered other side effects from fetal malnutrition. Wolves began to prey heavily on these young adults in the early 1970s, when over half of the adults killed by wolves were between the ages of one and five years .

Wolves showed two types of response to high moose vulnerability: an immediate, functional response indicated by higher kill rates, surplus killing and incomplete carcass utilization (evident from 1971 to 1973); and a long-term numerical response resulting in the establishment of a second, and then a third large wolf pack. As the wolf population increased, wolves again cleaned up their kills, they no longer killed more than they could eat, and winter food supply (on a per wolf basis) declined to more normal levels. It should be pointed out that the numerical response would not have occurred if wolves had not been able to rely on an alternate prey species, beaver, in the open-water season. Beaver numbers doubled between 1962 and 1973 (P. Shelton, unpubl. data), and beaver now constitute half of the summer wolf diet.

Isle Royale now supports a very high wolf population and a moose population which still shows evidence of winter nutritional distress (indicated by heavy utilization of browse, fat-depleted bone marrow in some individuals, and low calf production). Food supply may still be slowly contracting because of forest succession, and heavy browsing early in the 1970s may have contributed to deterioration of browse in wintering areas. Winter severity (especially snow conditions) now has an extremely important effect on the dynamics of the moose population; we would expect abundant calf crops only after mild winters--otherwise calf production will be low and yearling recruitment (calves surviving to one year of age) very low. This idea is supported by data

indicating that calves born in 1973, after a mild winter when there was no evidence of malnutrition, were physically the largest calves born between 1970 and 1976. The 1973 calves showed high over-winter survival, and relatively high yearling recruitment.

Losses to predation have probably exceeded recruitment by at least 5% during 3 of the last 4 years. A conservative estimate of decrease in the moose population since the 1974 census would be 10-20%; thus the 1976 winter moose population is estimated (roughly) at 800-900 animals.

The Future. We expect that, barring developments such as a major fire, moose will continue to decline, at least as long as the wolf population remains high (30 wolves or more). The greatest reduction in moose food supply probably occurred when the 1936 and 1948 burns became unavailable to moose. I would expect that additional shrinkage in moose food supply from forest succession will be insignificant. The major reason for continued decline in the moose population will probably be non-compensatory predation loss. It is quite possible that the moose population will be temporarily reduced to a point below that which would have been reached without wolves. In such a case we would expect to see an increase in calf production resulting from a higher overall nutritional plane among the surviving moose.

A more subtle reason why the moose population may continue to decline is the age structure of the population. Since 1969 calf production and survival have been quite low, resulting in relatively few moose younger than eight years of age. As older moose continue to age and finally die, they may not be replaced by younger moose in equivalent numbers. There is evidence (from fall composition counts) that a large proportion of the young adult moose in the population were born in 1973-- other cohorts have shown low survival.

Following a significant moose population decrease, we would expect the wolf population to decline from food stress and probably intraspecific strife as packs trespass on each other's territories in search of food. Since 1974 wolves have again relied on old moose in winter, probably because of a top-heavy age structure in the moose population and because young adults do not appear to be vulnerable, as they were in the early 1970s. It is reasonable to expect the wolf population to decline to or below the long-term average of about 24, although it is not possible to predict a time span for these changes.

One possible way for the wolf population to remain high would be if winter nutritional stress in moose becomes chronic, resulting in heavy predation on young adult moose that are born physically subnormal. In essence, wolves could then simply "recycle" moose at a younger age, resulting in a similar rate of biomass turnover (moose to wolf) and a shorter average life expectancy for moose. Such a relationship would be rather unstable, since wolves would be dependent on annual cohorts of vulnerable young moose.

SPECIFIC MANAGEMENT TOPICS

Those areas of park management for which wolf-moose research is most relevant are discussed individually in this section. Generally these are areas of potential problems which the National Park Service can prevent from actually occurring. It is both easier and wiser to take preventative action against potential problems rather than to attempt remedial action after problems have developed and, in some cases, irreversible damage already done.

Research Techniques

Winter Wolf Study. Isle Royale wolf research has been conducted primarily from light aircraft in winter. Visual tracking in snow is the sole method used to locate wolves. Direct observations are often possible when circling over wolves at an altitude of several hundred feet. Whenever possible, wolves are backtracked to determine previous movements and locations of kills. Needless to say, this type of research is heavily dependent on the skill and experience of pilot and observer; pilot Donald E. Murray has provided the necessary expertise for a succession of students that have worked on the project. In planning for the continuation of this work I believe it is essential that the aerial field work be conducted by individuals with extensive prior experience. Changeovers in observers are reasonable only if the pilot provides continuity, and vice versa. For this reason I agreed to take a leave of absence from Michigan Technological University and the Isle Royale work (except for at least three weeks during winter study) from 1977 through 1979 only when Murray indicated a willingness to continue. Thereafter I will be able to maintain continuity during the inevitable pilot changeover.

Approximately 5-10% of our flying time in winter is spent observing wolves. In order to disrupt wolves' activities as little as possible, observations are normally made with binoculars at an altitude of several hundred feet. Photographs are occasionally taken at low altitudes over open ice, but only when wolves show no signs of uneasiness. Most Isle Royale wolves are oblivious to aircraft. However, when the research aircraft approaches, the East Pack usually arises and engages in a group greeting; this pack was disturbed by unknown aircraft prior to the 1973 and 1976 winter studies, and this experience has probably made them extra-sensitive to all planes.

Ground observations of wolves (usually the West Pack) are possible at Windigo during the winter study at carcasses of moose that have been shot for necropsy purposes. The reasons for necropsies and subsequently feeding the wolves in this manner are the following:

(1) This enables us to gather data (parasites, blood samples, body weight, measurements, condition) on intact moose picked at random from the population.

(2) Our presence at Windigo excludes wolves from the area to a certain extent. Winter necropsies of one-two moose tend to compensate for lack of predation because of our presence.

(3) Wolves and scavengers will ultimately consume carcasses of necropsied moose; we normally try to move these carcasses onto the ice of Washington Harbor across from Windigo in order to maximize opportunities to observe wolves.

(4) Wolves living at the SW end of Isle Royale are difficult to observe and identify from the air because of the heavily wooded terrain and small area of open ice. At Windigo we have occasionally seen wolves that we were never able to record from aircraft.

(5) While we essentially provide wolves with a "free meal", this amoung of food has never significantly altered food levels for wolves during the course of the winter study.

Summer wolf study. Summer wolf research prior to 1973 was limited to occasional scat collecting to determine food habits. Since 1973 we have been able to follow the major movements of the East Pack from whelping den through a succession of rendezvous sites. In 1975 we were also able to do this for the West Pack. This has provided better data on food habits, plus numbers of pups present, and areas of traditional use. This is possible only because wolves are highly traditional in their choice of dens and rendezvous sites. Once such locations are determined for a pack, we can usually find them by checking all known areas. I believe we are now aware of most major activity areas for the East Pack; we are progressing in that direction for the West Pack; we still know very little about summer activities of the Middle Pack and other small packs.

We generally monitor presence or absence of wolves at homesites (dens and rendezvous sites) by camping overnight about one-quarter mile away and listening for spontaneous howling. If several hours pass with no howling heard, we generally howl ourselves and attempt to stimulate a howling response. Dens and rendezvous sites are not visited until wolves have abandoned the site.

It should be emphasized that summer studies of wolves at homesites are possible only if wolves are undisturbed at these sites. If wolves are forced to re-locate frequently because of human disturbance the traditional pattern of movements is disrupted, and their movements will become unpredictable.

Moose research. Much of our moose research involves mortality patterns--primarily locating, examining, and collecting bones and other remains of dead moose. Tallies of live moose are also made during summer field work and during an aerial survey in October to provide data on sex ratio, calf production and survival, and yearling recruitment. Moose necropsy procedures were discussed in a previous section.

Blood samples and one tooth have been collected from immobilized moose during winter study at Windigo. This is done on a small scale as the opportunity arises. Currently moose are ear-tagged with a small, black ear tag which is not visible except at a range of a few feet (one moose was fitted with a yellow ear tag in 1973 and 1975 at Windigo).

Mid-winter aerial censuses of moose are flown whenever conditions permit high accuracy when counting moose on small, randomly distributed plots. The most recent such census was in 1974.

Behavioral observations of moose are made at moose licks to determine frequency of use by individuals, seasonal variation in use, and intraspecific behavior. These observations, coupled with analysis of lick samples, should indicate the ecological significance of moose licks.

Visitor Effects on Wolves in Summer

It is fairly well-established that wolves normally avoid humans whenever possible (see Mech 1970). In most cases wolves are excluded from concentrations of human activity.

Wolf scats were counted on Isle Royale trails in 1973 and 1975, before and after the visitor season, to determine the effect of human activity on wolf use of these trails. The 1973 data indicated a 90%+ reduction in wolf use after visitor use began; the 1975 data indicated a 37% reduction. The data for 1975 are detailed in Appendix A. The differences in the two years' data might be caused by: (1) sampling methods-- more care was taken in 1975 to avoid bias due to trampling of scats by hikers; (2) increase in wolf population and consequent pressure to utilize all areas of the island; or (3) increased tolerance of wolves to humans. I am inclined to believe that the first two factors are both responsible for the different results in 1973 and 1975.

Data on wolf den and rendezvous site locations also indicate pronounced avoidance of humans. With one exception, all 16 wolf homesites of which I am aware are more than 0.5 miles away from a park trail; more than half of them are more than 1.0 mile away from trails. If we assume that wolves will not normally establish a den or rendezvous site closer than 0.5 miles from a park trail, then the existing trail system (160 miles) would exclude wolf homesites from 75% (160 sq. mi.) of Isle Royale (slightly less because some trails border water). While wolf sightings are sometimes made on trails and occasionally near campsites and other concentrations of humans, this does not refute the claim that Isle Royale wolves avoid humans whenever possible; such sightings are relatively uncommon, and we would expect more chance observations as long as wolf density remains high.

Trail and campsite development has eliminated a wolf rendezvous site at the SW end of Feldtman Lake. In 1964 researchers documented summer wolf activity in this area; they found the carcass of a malnourished pup and saw 2 adults nearby on the shore of Feldtman Lake (Jordan et al. 1967). The trail from Feldtman Tower to Grace Creek plus a spur trail to Rainbow Cove was established in the mid-1960s; this trail passed by the SW end of Feldtman Lake. After hikers began camping at this site, a campsite was officially established in approximately 1973. Although this area supports an unusually high summer population of moose along with several beaver colonies, wolves have not used the site since the trail was established.

It has been amply demonstrated that human presence (and/human howling imitations) cause wolves to move their pups more frequently between homesites (Mech 1970; Carbyn 1974; Joslin 1967). Wolves may move pups away from dens after just one instance of disturbance by humans (Carbyn 1974). Such movements

expose pups to new dangers such as being left alone, disruption of feeding, inclement weather, and foreign surroundings. For this reason it is desireable to provide security for wolves at summer homesites, which should include preventing humans from knowingly visiting such areas and ensuring that there are adequate remote areas available for wolves to raise their young where the liklihood of disturbance is low. While it is probably impractical to reduce human concentrations where they already exist, I would strongly recommend no additional expansion of human activities (see Trail Development and Visitor Numbers and Distribution) without documentation that such an expansion would not further reduce the amount of area available for wolf homesites or travel.

I am aware of only two areas where wolves have not shown fear and marked avoidance of humans: remote Arctic areas where wolves have not been exposed to humans to any great extent (Clarke 1971) and in working camps along the Alaska pipeline, where wolves have taken handouts from workers (Alaska, several issues from 1975 and 1976). In the latter case it is possible that food scarcity prompted wolves to disregard their fear of humans. This type of wolf-human interaction on Isle Royale would be undesireable both from aesthetic and public safety standpoints. There are presently no indications of an imminent decline in summer food supply, as there are for winter food supply, but the peak wolf population is probably operating with a small food margin in summer. The National Park Service should be alert to the possibility of individual wolves becoming accustomed to people and frequenting campgrounds for food.

Since wildlife is often more sensitive to environmental disruption than humans, various wildlife species have served as indicators of environmental quality. An important management goal for Isle Royale is to preserve the wilderness character of areas designated as such. Since Isle Royale wolves are sensitive to human disturbance, wolves can serve as a wilderness indicator species. By preserving a wolf population in a relatively undisturbed condition, the National Park Service would be safeguarding not only an important component of this ecosystem, but also wilderness qualities perceived by visitors and cherished by many people who will never even visit Isle Royale.

Visitor Numbers and Distribution

Visitor impact varies tremendously with the type of activity involved. Backpackers, while requiring little more than primitive campgrounds, probably have the greatest ecological impact because of their widespread use of trails and campgrounds. Lodge guests typically have little impact on the island itself, but do require costly facilities, power, and waste disposal. Private boaters also cause little island impact but do require considerable dock space and sometime have an adverse impact on other visitors' experiences. Visitors that come and go in a single day on commercial transportation cause the least environmental impact (but probably benefit least from their experience).

According to NPS calculations, the present transportation services operating at a near-capacity rate could carry about 20,000 visitors/year to Isle Royale. It is obvious that over-crowding of facilities occurs (e.g. in campgrounds) with as few as 17,000 visitors/year (the maximum annual

visitation recorded to date). If visitor facilities and campgrounds are overcrowded, the problem can be approached in two ways: limit visitation to levels which can be accomodated without environmental degradation, or expand facilities to accomodate increased visitation. In the latter case provisions to limit visitation must ultimately be made in order to prevent repetition of the same problem. I believe that it would be preferable to adopt limits on visitor volume now, before significant ecological losses have occurred.

In developed areas of Isle Royale, facilities could be upgraded and perhaps expanded without adverse environmental consequences, provided waste disposal is adequate and increased use of adjacent designated wilderness areas does not result. In backcountry areas, I would recommend that, if additional campsites are required, existing campgrounds be enlarged rather than establish additional campgrounds. From the standpoint of minimizing disturbance to wolves, it is more important to minimize the number of areas where people are allowed to camp rather than to limit the size of each area or campground. In other words, it is preferable to have people concentrated in a few, large campgrounds than dispersed among a large number of small campground; in the former case a large proportion of the island is free of people at night, when most wolf activity occurs, and it would also minimize the liklihood that people would discover and disturb wolves at homesites after hearing them howl at night.

Since there is evidence that human activity already reduces wolf activity over a substantial part of Isle Royale, I would recommend no additional development of new sites as campgrounds. If more campsites are definitely required, existing campgrounds should be enlarged. From the standpoint of the wilderness user large campgrounds are undesireable, so ultimately a permit system might be required to limit the number of visitors in a particular area and simultaneously prevent overuse of the smaller, backcountry campgrounds.

Use of undesignated sites for campsites should be limited. Such activity can rapidly lead to shoreline deterioration, litter accumulation, and fire risk beyond the direct control of park managers. Some wilderness areas allow camping only in sites already designated and developed for this purpose by competent resource managers (in 1976 the U.S. Forest Service prohibited camping except in developed sites in the BWCA). Camping in undesignated sites is a luxury which is reasonable only when few people are involved.

It should be realized that the Endangered Species Act of 1973 prohibits federal actions which might further jeopardize the habitat of threatened or endangered species. It is my opinion that park management should address itself to this question even if such legislation did not exist. It is important that the National Park Service recognize that, using present wolf research techniques, it is almost impossible to determine the impact of proposed trails and campsites on wolf activity. Only in cases when a proposed expansion of human activity would obviously involve a known denning area or region of traditional use are we able to demonstrate a negative impact. We are aware of only a small portion of the wolf homesites that exist on the island, and there is no assurance that we will ever gain that type of knowledge for the entire island. Using present research techniques, there is virtually no way that we could say with any degree of confidence that a proposed development would <u>not</u> affect wolves to an important extent. Such knowledge could be obtained only through intensive radio-tracking of the various wolf packs during the visitor season, and NPS has previously determined that this would be highly undesireable. Even using telemetry, we could still not predict the future importance of a specific area to wolves and their prey, since this would depend on unpredictable factors such as distribution

of future fires and vegetation patterns. Since there is already solid evidence that wolf homesites are excluded from almost three-quarters of Isle Royale (p. 7), additional expansion of human use of the island should be avoided if possible.

Trail Development

In view of the data presented above, I recommend no further trail development without documentation that proposed additions would not interfere with wolf movements, predation intensity, or choice of homesites. A trail from Chippewa Harbor to Siskiwit Bay has occasionally been mentioned as a possibility; in this case there is fairly good evidence that such a trail would: (1) reduce or eliminate summer wolf predation on the narrow isthmus between Siskiwit Lake and Lake Superior, a region of high calf abundance, and near Hay Bay, a summer concentration area for moose, and (2) disrupt wolf activity along traditional travel routes (Malone Bay isthmus, Little Siskiwit River and nearby shoreline areas).

Fire Management

I concur with the Fire Management Plan developed by NPS staff and circulated for comments in 1976. My comments are contained in a letter shown in Appendix B.

Winter Use

Since 1959 an annual winter study of wolves and moose has been conducted on a cooperative basis between the NPS and Purdue University (in 1976 with Michigan Technological University). The winter study typically lasts seven weeks from late January to mid-March. This is the most important period of research, since the wolf and moose populations are censused, wolf travel and kills are recorded, and wolf behavior and population composition are studied. From the standpoint of wolf-moose interaction, it is an extremely important time of year, for most adult moose are killed during a rather brief period in winter. Winter conditions not only determine to a great extent how many calves will survive to adulthood, but also the condition of calves born the following spring.

Research use. Wolf research personnel and NPS staff normally number only 3-4 people in winter and require a minimal amount of facilities: one building for housing, plus power supply, and vehicle for getting water and transporting supplies. It is in the interest of both the park staff and researchers to limit the number of people present to those absolutely essential to the work; additional people require more space, food, water, use of vehicles, etc., which often detracts directly from the research effort.

Visitor use. NPS has wisely discouraged winter visitation on Isle Royale, both for safety reasons and to minimize disturbance to wolves and the research effort. To my knowledge only two groups of snowshoers have been allowed on Isle Royale in winter, in 1969 and 1975.

The 1975 group consisted of four people who snowshoed from Windigo to Lake Desor on the Minong Ridge and then back to Windigo on the Greenstone Ridge over a three-day period. They had hoped to travel as far as Hatchet Lake before turning back, but were not able to do so in spite of excellent snow conditions and unusually fine weather. When they returned to Windigo they were almost out of white gas for their stoves, and they had no reserve supply. This group was highly

experienced in winter camping yet encountered difficulties that might have been serious in the event of injuries, bad weather, etc. During their three-day hike: they traveled within 400 yards of the West Pack, which was trying to bring down a wounded moose near the Minong Ridge-- we chose not to circle above the wolf-moose encounter as we would normally do because this might have alerted the party to the wolves' presence (they were anxious to observe and photograph wolves); at least twice we had to circle over a decoy area so as not to give away the location of wolves near this group; the Middle Pack was frightened off Lake Desor as the hikers first emerged on this lake-- the pack was approaching their territorial boundary, and this was the only day in the entire 1975 winter study when we were able to observe this pack while they were active. Observations were terminated after the pack ran off the lake.

The above chronicle is provided in order to point out how disruptive winter visitation can be, even when only a small group takes a relatively short trip. Winter movements of wolves and spatial distribution of predation can be easily disrupted by winter visitors, since the lakes and shorelines used by wolves wouls also be preferred routes for hikers. Wolves could adjust to this type of disturbance by hunting more at night, in heavy cover, and avoiding open ice, but in any case it would alter normal travel and behavior patterns, and further reduce the opportunity for researchers to observe wolves, an endeavor in which much time and money is invested. I don't believe that providing a very small segment of the public with an opportunity to visit Isle Royale in the winter is worth sacrificing the undisturbed character of wolf-moose interaction and reducing the effectiveness of wolf research. Protection of the island at this critical season would be best accomplished by official closure of the park from November through April.

Aircraft. Occasionally Isle Royale wolves have been seriously harrassed by aircraft. In recent years most incidents have probably been caused by people interested in observing or photographing wolves. In 1971 Don Murray and I followed such an aircraft, detailing its activities (accounts provided in Appendix C). In 1973 and 1976 the East Pack was extremely wary of the research aircraft when the winter study began, even to the point of leaving a fresh kill upon simply hearing our aircraft. The East Pack is most susceptible to aircraft harrassment, and has never fully adjusted to the research aircraft. Since there is slow turnover in pack leadership, disturbance can have a long-lasting effect on a pack's behavior.

Aircraft engaged in buzzing wolves or photographing them at low altitudes would be violating (1) NPS regulations against harrassing wildlife, (2) FAA regulations against harrassing wildlife and possibly low-level flying, (3) the Endangered Species Act of 1973 prohibiting disturbance of eastern timber wolves, and (4) federal laws against hunting or otherwise disturbing wildlife from aircraft (50CFR19.11, as amended by PL92-159).

It would be helpful if the various flight service offices of the FAA which border Lake Superior were aware that the Park Service is interested in protecting the island's wildlife from aircraft harrassment, and that there are a number of laws which specifically prohibit this type of activity.

It would also be helpful if starting and ending dates for the annual winter study were not widely publicized; people are less likely to violate regulations if they might be observed in the process, and I think many people believe that personnel are present all winter.

The most important deterrent to aircraft harrassment of Isle Royale's wildlife would be a well-publicized airspace restriction over the island. Such a restriction would appear on all navigational charts and maps, and would be strictly enforced by the FAA.

Wildlife Diseases

Island populations of wildlife tend to be more unstable and subject to rapid change than mainland populations, primarily because fewer species are present to buffer predator-caused fluctuations and because animal density is often higher than in mainland ecosystems.

Diseases can also cause rapid declines in some species, and there are a number of diseases which could affect Isle Royale's wildlife. Management goals should be directed at excluding introduced parasites and diseases from Isle Royale, and this is discussed in a letter to the Superintendent reproduced in Appendix D. This letter summarizes reasons for excluding pets from Isle Royale National Park.

Rabies. An endemic, viral disease, rabies is usually fatal in canid species such as foxes and wolves. The most important outbreak of rabies in the northern part of the continent began spontaneously near the Arctic Ocean coast in Canada in the early 1940s. The epizootic spread southeastward, reaching southern Ontario in the 1950s. This was an especially virulent strain, respon - sible for deaths among foxes, wolves, and domestic ungulates such as cattle and sheep. It was also probably responsible for a wolf attack on a railroad worker in Ontario in the 1940s, the only documented wolf attack on a human in North America. While the disease is still a serious problem in southern Ontario, it apparently never reached northwestern Ontario and the region surrounding Isle Royale. Strains of rabies present in Minnesota do not seem to affect foxes and wolves in that state. For this reason, plus the fact that the disease is spread from mammal to mammal, there is relatively little liklihood of a rabies outbreak on Isle Royale, especially if pets are excluded.

Tularemia. This disease is quite serious among rodent species, and could affect both snowshoe hare and beaver on Isle Royale. Shelton (1966) suggested that the serious decline of Isle Royale beaver in the early 1950s could have been caused by tularemia. The disease can be spread by blood-sucking insects and can also be transmitted through water to other animals and humans. The disease produces very high fevers in humans and can be fatal, although medical treatment can be effective if started early enough. The disease produces numerous tiny, white spots on the liver among rodents.

Park staff should be alert to the possibility of tularemia in any snowshoe hare or beaver that is found dead and intact on Isle Royale. Such animals should not be handled or cut open; they should be placed in a plastic bag, frozen, and autopsied by Michigan DNR pathologists.

We would not expect tularemia to become a problem unless it is present in areas surrounding Isle Royale. I am not aware of recent cases in either Minnesota or Ontario.

Heartworm. A parasite (Dirofilaria) which lodges in the heart of domestic and wild canids. Endemic in the southeastern U.S., it has moved northward as far as Michigan following the northward spread of its vector, a certain species of mosquito. It can cause serious disabilities and death in canids. This parasite may eventually reach Isle Royale via northern Minnesota or upper Michigan; its impact on the island's foxes and wolves is unpredictable. The cause of the spread of the mosquito and the parasite into

the northern U.S was apparently habitat change caused by man, but to date there is no effective method of halting the spread of the parasite.

Reintroduction of Mammals

Mammals which have become extinct on Isle Royale in this century are the coyote, lynx, and woodland caribou. Marten may have been present early in the century, but all evidence of their presence that I have found depends on the reports of a single trapper, Charles Preulx. Possible causes of these extinctions are discussed below. Since the original presence of the marten is somewhat doubtful, there are, from the evidence that I have seen, no likely candidates for reintroduction at this time.

Coyote. Common in the first half of the 1900s, coyotes seem to have disappeared within 7-8 years after the arrival of wolves. I suspect that the principal cause of their disappearance was direct killing by wolves, since the decline was very rapid.

Caribou. Disappeared from Isle Royale in the 1920s, about the same time that moose increased to very high levels. I believe the principal cause of caribou disappearance on Isle Royale may have been competition for food with moose. Studies by Bergerud (1971 and elsewhere) indicate that caribou can subsist, indeed thrive, on woody browse in winter, and that their classical winter food, lichen, is not very nutritious. Since the original caribou population on Isle Royale was apparently small, and since moose browsing may have severly reduced the amount of winter browse available to caribou, moose may have been responsible for their disappearance.

Lynx. Lynx also disappeared from Isle Royale in the 1920s, and there is reason to suspect that the high moose population was at least partially responsible. Research by R. Janke (pers. comm.) on the outer islands of Rock Harbor indicates that moose and snowshoe hare densities are inversely proportional. Moose browsing may have removed a significant proportion of the winter food available to hares, leading to lower populations. Lynx were probably almost solely dependent on snowshoe hares for food, and perhaps disappeared because of a food reduction. Trapping by humans certainly occurred early in the 1900s, and may have accelerated their decline. Lynx have been periodically observed on Isle Royale in the 1960s and 1970s, but for some reason they have not taken hold. Lack of a sufficient source of food may be an important reason for lack of recolonization.

Marten. If marten were present at one time on Isle Royale, they may have been eliminated by man. Marten are easily trapped, and trapping is believed partially responsible (along with ill-defined "habitat changes") for the virtual elimination of marten in the Lake States. Marten that have been reintroduced in Wisconsin seem to subsist on snowshoe hares, voles, and red squirrels. Since Isle Royale has an abundant, relatively unexploited squirrel population, there is reason to believe an adequate food supply exists. However, until it can be established beyond a reasonable doubt that marten were part of the original fauna of Isle Royale and were eliminated by man, they would not be a candidate for reintroduction.

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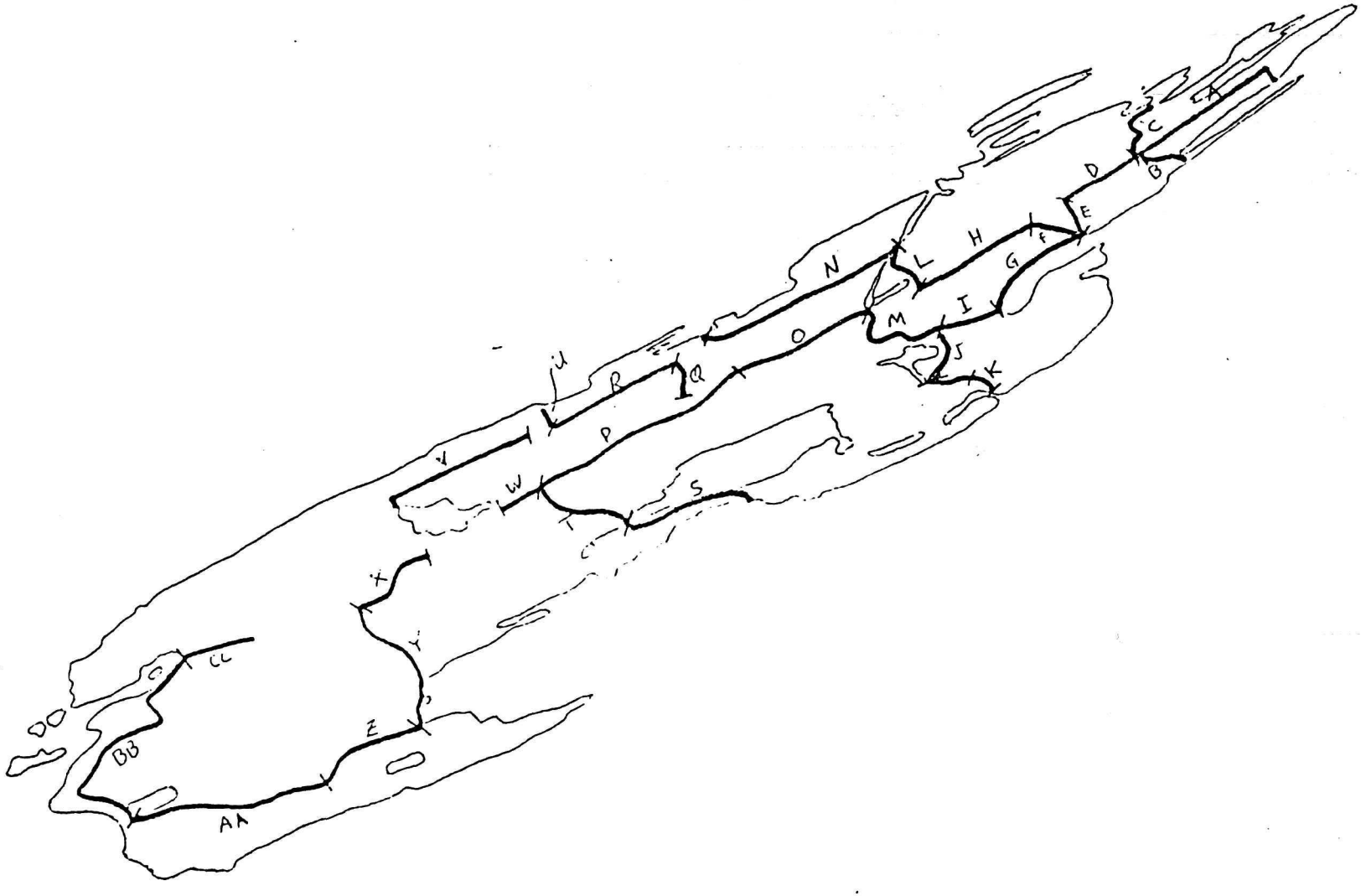
APPENDICES

APPENDIX A.1. Isle Royale hiking trails where wolf scat incidence was recorded, 1975. Letters correspond to those in Appendix A.3.



APPENDIX A.2.

Notes on Wolf Scat Tallies, Isle Royale National Park

1. Scats were tallied each time a trail segment was hiked.

2. Dates of scat accumulation on trails before visitation were assumed to be:

   Oct. 15 (leaf fall) to Dec. 20, or 66 days,

   April 15 to the last tally in the month of May

3. The best index to scat accumulation in relation to time and distance was assumed to be:

   (no. scats/miles/no. days) X 10^{-2}

   Multiplication by 10^{-2} eliminated large decimal figures.

4. Not all trails covered in the spring were covered after visitation began. Only those trails covered in both periods (before and after visitation) were used in the comparison.

Scats Recorded on Isle Royale

Hiking Trails, 1975

TRAIL SEGMENT		BEFORE VISITATION		AFTER VISITATION	
Trail	Length(mi)	Scats/ days	(Scats/mi/ days)X10^{-2}	Scats/ days	(Scats/mi/ days)X10^{-2}
A	(4.5)	(25/87)	(6.4)	--	--
B	(2.2)	(22/95)	(10.5)	--	--
C	1.3	25/95	20.2	16/81	15.2
D	2.7	27/95	10.5	18/50	13.3
E	1.7	15/111	11.1	10/68	8.7
F	1.8	10/110	6.1	12/94	7.1
G	(2.0)	(18/82)	(11.0)	--	--
H	3.6	10/104	2.7	6/87	1.9
I	2.2	57/92	28.2	17/101	7.7
J	2.7	57/91	23.2	12/80	5.6
K	(0.6)	(6/96)	(10.4)	--	--
L	1.8	7/104	3.7	4/87	2.6
M	3.4	12/107	3.6	6/86	2.1
N	6.6	57/105	8.2	23/86	4.1
O	5.0	34/107	6.4	31/86	7.2
P	5.8	22/90	4.2	6/94	1.1
Q	(1.4)	(9/105)	(6.1)	--	--
R	3.8	56/106	13.9	45/73	16.2
S	3.6	41/90	12.7	20/74	7.5
T	(3.6)	(42/99)	(11.8)	--	--
U	0.5	3/106	5.7	3/72	8.3
V	(4.9)	(20/98)	(4.2)	--	--
W	(1.8)	(3/115)	(1.4)	--	--
X	(2.9)	(11/97)	(3.9)	--	--
Y	4.5	34/99	7.6	11/62	3.9
Z	(3.6)	(53/97)	(15.2)	--	--
AA	(6.1)	(32/97)	(5.4)	--	--
BB	(8.6)	(79/97)	(9.5)	--	--
CC	2.5	13/98	5.3	3/100	1.2
TOTALS (without those in parentheses)	53.5	480/1710	0.52	243/1381	0.33

From: Rolf O. Peterson
Department of Forestry and Conservation
Purdue University
Lafayette, Indiana 47907

Re: Statement on observations of an aircraft over Isle Royale on Feb. 7, 1971.

Purdue University and the National Park Service have conducted a winter wildlife study on Isle Royale annually since 1959. In this work, an Ierence Champion aircraft piloted by Donald E. Murray is used to make observations of wolves and moose. The following, taken from field notes, is a description of our experiences with another airplane while flying over Isle Royale on Feb. 7, 1971.

Don Murray and I took off from Windigo Ranger Station at 9:55 a.m. After flying around the southwest end of the island and over the Siskiwit Swamp region, we found a pack of nine wolves traveling across the ridge of Houghton Peninsula towards Siskiwit Bay. At 10:30 a.m., as we were circling the wolves, a Piper Cherokee aircraft passed beneath us and followed Houghton Peninsula out to Houghton Point, where it circled briefly. The plane was white with bronze trim, and its numbers were N7212T.

We followed the plane as it flew across Siskiwit Bay and along the Greenstone Ridge to Moskey Basin. When we reached Moskey, the Cherokee was quite low and circling two wolves that had been traveling south across Moskey Basin west of Baker Point. As the Cherokee continued to circle them the wolves separated and both ran south, bounding through the new snow as fast as possible and panting heavily. They continued this pace even after the Cherokee had departed, the plane heading up the length of Rock Harbor. I'm quite certain the pilot and passenger if the Cherokee were aware of our presence at least from this time on, if not before.

We continued following the Cherokee, which flew out to Blake's Point and then turned around and came back down the Greenstone Ridge, flying around the southwest end of the island and returning to Houghton Peninsula along the south shore.

When the Cherokee arrived at Houghton Peninsula, we were already flying over the pack of nine animals. They were lying in a group on the ice of Siskiwit Bay, not far from shore. The Cherokee then proceeded to buzz the wolves many times, causing them to get up and scatter. Four wolves headed eventually toward the shore of Houghton Peninsula. Two other animals, followed by the Cherokee, ran far out onto the ice of Siskiwit Bay.

During this time I took seven 35mm. color transparencies of the Cherokee. Two of these slides are close-ups of the plane, showing its numbers, four slides show the plane over the wolves on Siskiwit Bay, and one slide shows the plane about 50 feet off the ice near the shore of Houghton Peninsula.

The Cherokee departed at approximately noon, flying northwest over Washington Harbor on its way to the mainland. We landed at Windigo at 12:15 p.m. after a flight of 2 hours, 20 minutes. We had followed and observed the Cherokee for 1 hour, 30 minutes.

Rolf O. Peterson