# Reaction of Reindeer to Obstructions and Disturbances

## Experience in Scandinavia may aid in anticipating problems with caribou in Canada and Alaska.

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In Norway, Sweden, and Finland there are approximately 600,000 semidomesticated reindeer and 30,000 wild reindeer. Although reindeer are mostly confined to remote areas of Lapland and alpine plateaus away from population centers, the rapid industrialization of Scandinavia since the turn of the last century has brought mining, mechanized forestry, hydroelectric development, and increased human populations to the reindeer areas. These changes have caused new and increasing problems for the reindeer by eliminating traditional rangelands and creating obstructions to seasonal movements. More recently in all three countries, increased attention has been focused on the conflicts between reindeer and industrial developments, partly as a result of pressure by the Lapp reindeer owners and partly because of recognition of the problems by the governments. As a result, there is a growing body of knowledge about the behavior of reindeer in relation to man's influences on the environment, as well as experience in attacking the problems that have developed.

In North America, where we are entering an era of intense development of the North, we have little direct experience to enable us to predict the influences of oil development and other activities of man on the movements and welfare of caribou. Industry and conservation interests predict extremes in the influence of northern development on caribou, but this foresight seems to be based more upon the optimism or pessimism of the specific interests involved than on objective observations or data. This is exemplified in the viewpoints expressed in the satirical drawings in Fig. 1.

Reindeer in Scandinavia are not caribou in the American North, but the two are very similar in their behavior, both being members of the species *Rangifer tarandus*. Although the habitats in Scandinavia and North America differ and herding practices modify the behavior of reindeer, caribou and reindeer can be expected to show similar reactions under similar circumstances. Therefore, the Scandinavian experiences with reindeer, both semidomesticated and wild, should provide a basis for anticipating the problems to be encountered with caribou—and they may offer proven solutions to specific problems.

The material included here was drawn from personal observations during trips to Scandinavia in 1965, 1967, and 1970; from conversations with Lapp reindeer herders, government consultants, advisers to the reindeer herders, game biologists, and officials in government and industry; and from printed reports and publications.

### Highways and Railroads

Highways and, to a lesser extent, railroads have transected reindeer ranges and migration routes throughout much of Scandinavia. Apparently, they have not greatly interfered with the free movement of domesticated reindeer except under special circumstances. Highways are generally looked upon as desirable by the reindeer herders because they provide quick access to the reindeer, thereby allowing the herders to live in permanent settlements some distance from the herds. Although roads increase the mobility of the herders, they also create special problems during migrations. State laws generally prohibit driving reindeer on highways, although in periods of deep snow this is often the easiest procedure and is preferred by the reindeer. Also, herders are required to post flagmen or warning flares when moving reindeer across highways.

Similar problems are associated with railroads (Fig. 2). In some cases, fences have been constructed along stretches of railroad to funnel reindeer beneath bridges or to prevent them from crossing the tracks except at designated locations where the speed of the trains may be reduced.

In Norway, well-traveled highways and railroads have obstructed the movement of wild reindeer. In the Dovre-Fjell area south of Trondheim, the main highway and railroad between this city and Oslo transect an alpine plateau where a herd of reindeer formerly ranged on both sides of the road and railway. Reindeer used the region east of the transportation corridor primarily during the winter. After construction of the railroad, the reindeer continued to migrate between the two portions of their range for several years, but with the increasing frequency of trains, they appeared reluctant to cross the tracks (*1*). They were observed to mill close to the tracks for long periods before crossing and were repeatedly frightened away when trains passed. Snow fences, deep cuts through rock, and drifted snow acted as physical barriers to the reindeer along many stretches of the railroad. Finally, several years after the construction of the railroad during the early 1920's, the reindeer stopped using the eastern region.

In the western region, the population of reindeer, which had been reduced by excessive hunting, was given protection; it continued to increase, even though the railroad, with the adjacent highway, acted as a barrier to the animals' movement to the east. By the mid-1950's, serious deterioration was taking place in that range, and some animals again began to cross the railroad and highway to use the eastern region. In 1960 the population was estimated at a minimum of 15,000, and the need to reduce the number to a level consistent with the winter food supply was belatedly recognized (*2*). Through hunting and dispersal, the number of reindeer in the western region has been reduced to about 1000

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to 1500. A population of approximately 2000 to 3000 animals now uses the eastern region. A striking contrast exists today between the vegetation in the western portion of the range, which has not yet recovered from the overgrazing in the past, and that of the eastern region, with extensive stands of lightly used lichens.

There is evidence that the physical condition of both wild (*3*) and domesticated reindeer (*4*) determines their ability to adapt to changes in their environment and to adjust to disturbances. When the animals are in poor physical condition, seasonal migrations are easily disrupted and traditional ranges may be abandoned. On the other hand, ranges normally avoided may be used in such circumstances.

Although roads and highways provide the Lapps access to the reindeer, they also bring tourists, sportsmen, and others into the reindeer areas. This additional traffic increases disturbances of the reindeer and requires greater effort by the herders to keep the animals in the desired areas. During the first roundups in autumn, before the ground is covered with snow, close herding and corralling of the reindeer for slaughtering is extremely difficult, and the untimely approach of hunters or berry pickers can completely disrupt several days of work by the herders.

Hunting with dogs, which is very popular among sportsmen in Scandinavia, has been completely banned in large areas of Swedish Lapland where the Lapps have administrative jurisdiction over the land. In the large hunting grounds leased from the Lapps by the sportsman's organization of the city of Kiruna, the use of hunting dogs is now permitted, but only after they have been certified to be "reindeer proof." This requires a test, administered by the Lapps, to guarantee that the dogs are trained not to chase reindeer.

The usual amount of automobile traffic along highways does not appear to significantly disturb reindeer feeding or moving nearby; apparently they are somewhat habituated to it. Nevertheless, highway traffic kills a considerable number of reindeer, and, as with deaths caused by the railroad, the greatest losses occur in winter. This is because of a combination of factors, including reduced light and visibility for the motorist, slippery roads, the attraction of reindeer to roads as routes of travel, and the fact that most reindeer winter in forested areas that are transected by highways. The association of reindeer herders in Finland reported losses of reindeer through highway accidents of 1252 in 1967, 1262 in 1968, and 1474 in 1969 (*5*).

Reindeer owners in Sweden, Finland, and Norway may be compensated by the government or the motorists involved for reindeer killed on the highways. There is speculation that some owners deliberately allow a certain percentage of their animals to run free of the herd in order to collect the money provided when these animals are involved in highway collisions. The owners, however, protest that the payment received is inadequate compensation for the losses.

The trucking of thousands of reindeer from summer to winter ranges has created a new problem in Sweden in the last 4 years (*4*). Trucking has been undertaken by some reindeer herders when grazing conditions along the migration routes have been so poor that quick movement between the seasonal ranges is considered necessary. This method of moving reindeer in autumn has disrupted normal migratory behavior and has increased the number of animals that fail to follow the spring migration to the summer ranges in the mountains. Espmark (*4*) has suggested that disruption of the social structure of the reindeer, which occurs when the animals are gathered and moved by truck, and the failure of the younger animals to gain the orientation associated with the normal autumn migration are responsible for the loss of migratory behavior. The transported reindeer apparently find it difficult to reestablish normal group structure, and they remain in small groups with many dispersed individuals. Apparently a minimum number of animals in the group is essential for stimulating migratory behavior.

In Sweden, thousands of reindeer are killed by trains each year. During the 10-year period of 1945 to 1954, the mean annual loss was 650; the number for the following decade (1955 to 1964) was approximately 2200, with 3800 killed in 1964 alone (*6*). Reasons for the increased mortality in recent years are higher speed of trains, increased traffic, more severe snow and grazing conditions in winter, and the trend from close herding to loose herding. Peaks in the frequency of accidents are associated with the main migration periods, darkness, deep snows, and insect plagues in summer. The mean number killed in each accident is higher in winter than in summer because reindeer tend to be in more compact groups in the winter. Also, reindeer are reluctant to move from the snow-free railway into the deep snow on the sides.

Recent experiments sponsored by the Swedish railway administration (Statens Järnvägar) and conducted by Espmark (*6*) suggest that certain relatively simple techniques can be used to decrease the frequency of railway accidents. It was observed that dark objects on the snow attracted reindeer. When black or red powder was spread on the snow in strips perpendicular to the tracks, the reindeer tended to follow the strips rather than the railroad tracks. These strips were 4 to 5 meters long by 1 meter wide and were 50 meters apart. The strips were effective only until they were covered by new snow.

To prevent the reindeer from coming onto the railway, strips of jute fabric 1 meter wide and 10 meters long were placed in sequence parallel to the railway. Small plates painted with fluorescent colors were placed on the fabric. This technique was somewhat successful, but the reindeer, in time, adjusted to the arrangement and its effectiveness decreased.

In extreme northeastern Norway, adjacent to the Russian border, a unique problem has developed: reindeer enter railroad tunnels in summer to seek relief from insects. This behavior has been restricted to a limited area in which ore is transported a short distance from a mine to the sea. Because of the slow speed of the trains, the problem has been the obstruction of the ore trains rather than reindeer mortality.

### Hydroelectric Developments

Perhaps man's most detrimental influence on reindeer in recent years has been the extensive construction of hydroelectric projects. These projects have been most common in central and northern Sweden and Norway; they are less important in Finland and the extreme north of Norway. Valley bottoms, with their flood plains and alluvial soils, are normally the most pro-

ductive areas throughout Scandinavia, but they are also sites for hydroelectric impoundments. Valley bottoms within the reindeer region are often the best grazing areas on both the summer and winter ranges and provide shelter during calving.

Because reindeer move between their summer and winter ranges during spring and autumn, the ice on large impoundments usually makes travel unsafe, thus disrupting migration routes. The drawdown of water from the reservoirs throughout the winter frequently creates shelves of shore ice that slant down to the floating ice, and this produces a dangerous obstruction.

Efforts have been made in Norway and Sweden to mitigate the problems caused by obstructions to the movements of reindeer and the loss of rangelands and calving areas as a result of hydroelectric developments. Direct compensation to the Lapps is one of these efforts. Direct compensation can be in the form of cash settlements or annual payments to the herders to supplement the lowered productivity of the rangelands. Frequently, huts are constructed for the reindeer herders in those areas where increased

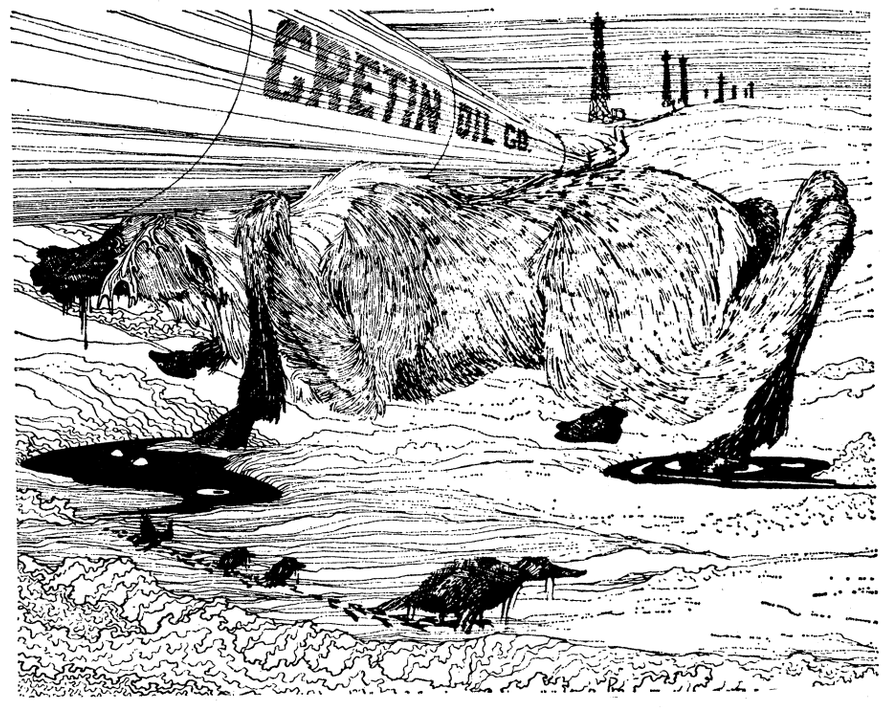
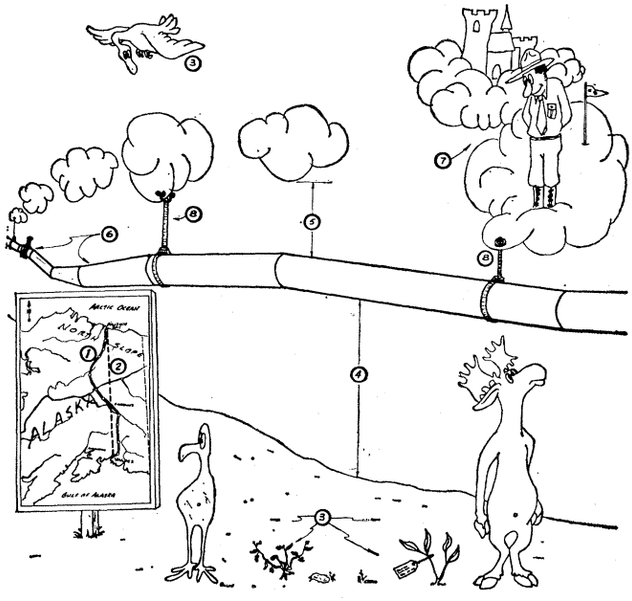



Fig. 1. The upper drawing, labeled "The pipeline caribou . . . known locally as the Hickel heifer," appeared in the November 1970 issue of *Audubon* in a satirical article, "Tomorrow's Critters" by E. C. Gilham. It provoked an outraged response from oil interests. The lower drawing, which ridicules the opposition of conservationists to the proposed Trans-Alaska pipeline, appeared in the December 1969 issue of *Arctic Oil Journal*, with the following descriptive caption:




Supportive Drawing for Proposal Submittal to T.A.P.S. [Trans-Alaska Pipeline System] (Typical Illustrative Sketch of Ecological Safeguard Routing of Pipe).

The following notes and specification guidelines shall serve as the basic requirements for this proposed method of routing and constructing the pipeline. Note that each item under these notes is referenced by number in the drawing.

1) Solid line indicates the approximately 800-mile surface route that the pipeline would follow under the old, objectionable plan, provided the right-of-way was granted.

2) Broken line indicates the direct "as the crow flies" route from Prudhoe Bay to Valdez hereby proposed, a route that is approximately 640 miles, or 20 percent, less than the surface route and that may save up to $200,000,000 in construction expenses.

3) Absolute protection of all flora and fauna (that is, the "delicate ecology"), which, after all, has only survived there a few million years when nothing else was hardy enough to.

4) All pipe, valves, fittings, etc. shall be at a minimum height above the surface to allow unobstructed migration of all wildlife, caribou, moose, etc.

5) Likewise, all pipe, etc. shall be at a maximum elevation above ground so as not to hinder birds, bees, etc.

6) All pipe fittings, etc. shall be appropriately painted as required to integrate the line into the natural beauty of the terrain over which it is to be suspended.

7) All clouds are to be numbered and the pipe so stationed and referenced thereto. Note that Cloud No. 9 will be the base station for "preservationists" monitoring the pipeline operations.

8) Pipe hanger construction and attachment to clouds supporting the pipe shall be so designed and constructed as to not adversely affect or puncture and capsize the clouds, particularly the ones inhabited by radicals or preservationists, or both. Please note that capsizing of clouds and so stated individuals or groups, or both, shall possibly jeopardize this method of routing and construction, and force placement of the pipeline on the ground above or below the surface, or both.

time and effort are required to change traditional migration routes. Several years may be needed to establish a new tradition of movement among the reindeer, and often this is impossible because special features of the terrain, to which the reindeer orient themselves, may determine their routes of movement. Sometimes fences are built to assist in establishing new patterns of movement, but the success of this technique has varied.

Storing water in reservoirs in early winter results in greatly lowered water levels in streams and rivers below the dams. This often causes shelves of ice along the stream banks with an ice-covered moat between, which may be completely impassable or a veritable death trap for reindeer. This situation creates controversy between the reindeer herders and the hydroelectric power officials. A few special bridges have been constructed in Norway to enable reindeer to cross over streams that have become impassable because of controlled water levels. The bridges must be 10 to 15 meters wide for herds numbering up to 2000, since reindeer tend to bunch up when crossing the bridges and may actually force each other over the edges if the bridges are too narrow. The actual width is dependent upon the size of the herd to be moved. Surfaces of the bridges are covered with soil. Location is critical to the success of the bridges, since reindeer are reluctant to use them unless they are built where reindeer traditionally cross the streams. Fences to lead the animals to the bridges have not compensated for poor choices of location.

Concern about the possible influence of electric power lines on the movement of reindeer is increasing, and limited research into this subject has recently been started in Norway. Herders claim that reindeer are disturbed by the newly constructed power lines, which are foreign objects in otherwise familiar surroundings. For this reason, reindeer are afraid to travel beneath the power lines, particularly during the first year or two after their construction. Clearing the vegetation within the power lines' right-of-way alters light, moisture, and wind conditions, and may reduce the growth of reindeer forage there and cause snow conditions different from those in the surrounding forested areas. This can be a deterent to the movement of reindeer. The "hum" of the power lines, which varies considerably with weather conditions, is also believed to disturb the reindeer and contribute to difficulties in herding.

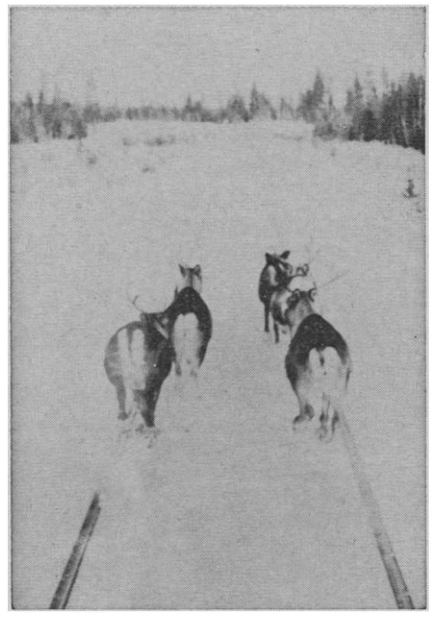


Fig. 2. Reindeer running before a speeding train in Sweden. These animals are attracted to the tracks, where travel is easier because the deep snows have been cleared away; as a result, thousands of reindeer are killed annually in Scandinavia by trains.

## Forestry

Large-scale forestry is extremely important to the national economies of Norway, Sweden, and Finland, and in the north of Scandinavia the winter grazing areas of reindeer coincide with the areas of intense forestry. As a result, several conflicts of interest have developed between reindeer herders and foresters. Pine (*Pinus sylvestris*) and spruce (*Picea abies*) seedlings are damaged by reindeer pawing through the snow in search of lichens, although the significance of this damage to the regrowth of the forests remains in question. Most of the felling of trees takes place in winter, and reindeer quickly learn to associate the sound of power saws with the availability of highly palatable arboreal lichens in the crowns of the felled trees. As a result, reindeer congregate in the cutting areas and are frequently killed or injured when the trees fall. The forest companies are required to compensate reindeer owners for such losses.

The reindeer herders complain that logging activities damage the lichens on the forest floor and that changes in the microclimate, caused by the removal of the forest cover, reduce the growth rate of lichens. There seems to be a sound basis for these complaints, but research into these problems has not as yet determined their significance. Because the wind causes snow within large clear-cuttings to drift and compact, it is generally more difficult for reindeer to feed in these areas than in the undisturbed forest.

Herbicides used in forestry were implicated in the death of several reindeer in Sweden in 1970. During a period when deep snows made lichens unavailable, the reindeer had fed on leaves from birch trees that had been killed by an herbicide. The herbicide used was a commercial preparation of two parts of 2,4-D to one part of 2,4,5-T, applied from the air in the amount of 2000 grams per hectare (*7*).

The incident stimulated the government to initiate a fairly intensive research program to determine the effects of herbicides on reindeer. Also, in the autumn of 1970, the Swedish government prohibited the application of herbicides from airplanes and limited the use of herbicides to those that have been officially tested and are considered safe.

In forest management, herbicides are used after clear-cutting to eliminate the broadleaf successional stage, thereby freeing the young coniferous trees from competition with broadleaf trees and shrubs. Broadleaved plants are eaten by reindeer in spring and summer, and in Sweden and Finland they are an important part of the diet of the "forest" reindeer, which inhabit forests all year. Hence, the effect of herbicides on the ecology of reindeer can be substantial. The possible long-term effect on soil fertility and forest ecology has not been investigated.

A recently introduced practice of management is the fertilizing of young forest stands. This is generally done only once in the life of the stand, usually during the first 5 years. After fertilization, the trees and other vascular plants of the forest floor respond with increased growth for one or more years. While the production of summer forage for reindeer may increase after fertilization, the growth of lichens is not stimulated by the fertilizers and may actually be inhibited by the engulfing growth of grasses, low shrubs, and other plants.

## Fences

Fences are being used with increasing frequency throughout Scandinavia to simplify reindeer herding. They are usually constructed of cattle wire and are approximately 2 meters high (Fig. 3). Fences have proved very useful and have created a minimum of problems when they are used in conjunction with traditional patterns of movement. The most frequent problem caused by fences is excessive trampling of lichens, since reindeer tend to move along fence lines rather than scatter out. Fences have been used for centuries as leads to direct reindeer into corrals, but they are successful only if they are built with a clear understanding of the relation between features of the terrain and reindeer movements and behavior. Several new and very large corrals with long lead fences have been built recently in northern Sweden to facilitate the handling of consolidated herds of reindeer. In many instances they have proven virtually unworkable because of the reluctance of the reindeer to be "forced" into dense herds in unfamiliar terrain.

Extensive fences built recently in Swedish Lapland to separate the grazing areas of adjacent herds of reindeer have created problems for moose, whose migratory routes are perpendicular to the fences. Adult moose can usually jump over the fences, but calves born that year are unable to. To overcome this problem, which is greatest during early winter, it has been necessary to patrol the fence lines with helicopters manned by volunteer sportsmen, who land and drive the moose calves through openings cut in the fences or, more recently, through pole gates provided for this purpose. When fences are constructed in open country, drifted snow in winter may make it possible for reindeer to cross them, thus defeating their purpose.

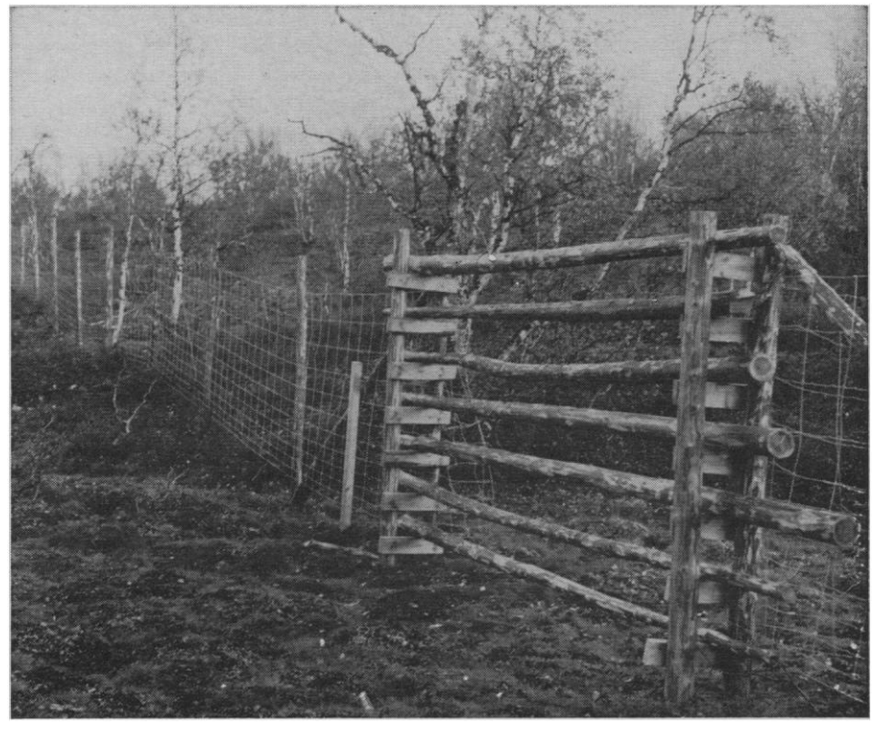


Fig. 3. A reindeer fence in Swedish Lapland which separates herds under different ownership. The pole gate is left open in winter, when reindeer are no longer in the area, to allow moose to pass through.

## Snowmobiles

During the past several decades, the practices of riding reindeer and using them to pull pulkas has decreased with the construction of roads and the availability of automobiles, as well as with the Lapps' acculturation and settlement into permanent villages. The development of efficient and relatively inexpensive snowmobiles, or motor toboggans, has, in the past decade, nearly completed the transition from animals to machines as the primary mode of transportation (Fig. 4).

Snowmobiles have greatly simplified reindeer herding by providing a degree of mobility totally unachievable in the past, but they are a mixed blessing to the herders. The initial purchase price and the cost of operation are high, in view of the limited cash income of the herders. Although the machines are invaluable during migrations and for loose herding, the reindeer are very disturbed by them; if approached too closely, they may panic and become unmanageable. Careless use of the snowmobiles during the calving period, when any disturbance can be detrimental to the pregnant females, can result in losses of females or calves. Herders and government officials are concerned that recreational use of snowmobiles

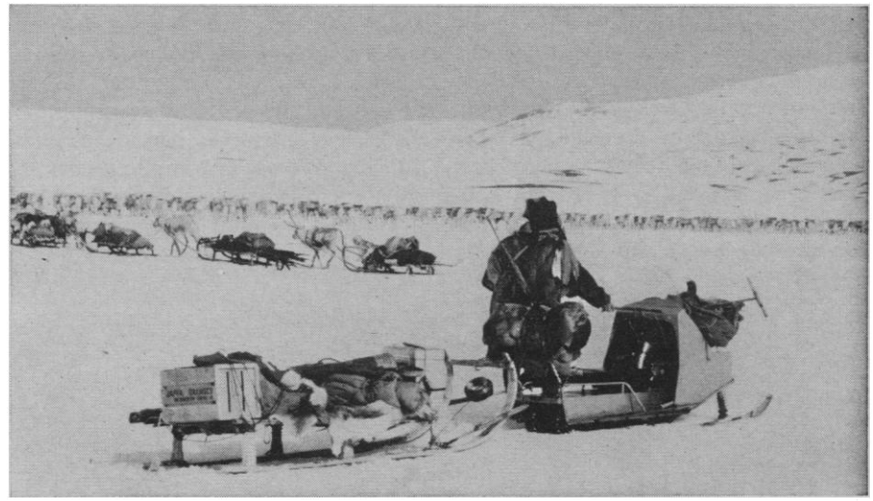


Fig. 4. The snowmobile is very popular among Lapp reindeer herders and has almost completely replaced reindeer for transportation. This picture was taken in Norwegian Finnmark a few years ago when reindeer were still commonly used to pull sleds.

will become widespread in Scandinavia, as it has in North America, and will increasingly disturb the reindeer. This has not come about yet, largely because the high taxes on snowmobiles make their cost prohibitive for recreation at the present income levels of most northern Scandinavians. The purchase price, including taxes, is usually twice that of a comparable machine in North America; however, the taxes are largely refundable if the machines are used in reindeer husbandry. In order to forestall the many problems that large-scale recreational use of snowmobiles would cause for the reindeer industry and the management of other resources, some countries have established regulations that greatly curtail their use. Legislation that would have a similar effect is being drafted at various levels of government in both Norway and Sweden.

## Air Pollution and Lichens

Lichens, the primary winter food of reindeer, derive virtually all of their nourishment, including water and minerals, directly from the atmosphere. Elements that man introduces into the atmosphere and that later fall out on the land are more readily incorporated into the living tissue of lichens than into vascular plants. This fact was demonstrated in Lapland several years ago, when high concentrations of radioisotopes in Lapps were traced back through the reindeer-lichen food chain and to the atmospheric testing of nuclear bombs (*8*). With the reduction of this source of atmospheric contamination, radioisotope concentrations in lichens, reindeer, and Lapps have gradually decreased. Now there is evidence that large amounts of atmospheric pollution from the British Isles and central Europe are carried by prevailing weather patterns to Scandinavia, where they fall out in rain and snow (*9*). This fallout, which is particularly high in sulfur dioxide, has already so altered the *p*H of certain streams in southern Norway that salmon eggs can no longer develop and the salmon runs have been eliminated (*10*).

Lichens are very sensitive to sulfur dioxide and suffer reduced growth or death in its presence. Throughout the world, large areas around industrial cities that have high concentrations of sulfur dioxide in the air have become lichen deserts (*11*). In Scandinavia, the effect on lichens of atmospheric fallout of industrial wastes is not known. Monitoring of atmospheric fallout and research into its possible effects have begun only recently. Baseline studies of the growth rates of lichens are being undertaken in Finland, Sweden, and Norway as part of the International Biological Program. However, there is no way of knowing if reductions in the growth rates of lichens have already occurred. Any significant reduction of lichens in the wintering areas of reindeer will obviously mean a corresponding reduction in the number of reindeer that can subsist on the range.

## Summary

In Scandinavia, highways and railroads have not generally created obstructions to the movement of domesticated reindeer, although thousands of animals are killed each year in accidents. Some disruption in the movements of wild reindeer in Norway has been associated with the construction of a railroad and highway through an alpine plateau south of Trondheim.

Hydroelectric projects have had the greatest detrimental effects on reindeer by flooding rangelands and obstructing migration routes. Special problems are created by the fluctuating water levels in reservoirs and rivers; efforts to mitigate the effects of these fluctuations have been only partially successful. Reindeer have strong traditions for migrating along specific routes, and realignment of these routes is extremely difficult.

Conflicts of interest exist between reindeer herders and foresters. During their winter feeding, the deer damage young trees. The cutting of forests usually results in a deterioration of the area as a rangeland for reindeer. Herbicides used in forestry have been implicated in the death of some reindeer in Sweden, and research is now under way to determine the effects of herbicides on reindeer.

The increased use of fences in reindeer husbandry in Scandinavia has emphasized the fact that reindeer behavior and characteristics of the terrain must be considered if fences are to be successful in directing or controlling the movements of reindeer. Herders now use snowmobiles instead of reindeer for transportation and herding, but the machines disturb the reindeer and must be used with discretion.

Recent evidence indicates that large amounts of industrial waste in the atmosphere are carried from the British Isles and central Europe to Scandinavia, where they fall out in rain and snow. This has raised concern about the influence of the wastes on lichens, the main winter food supply of reindeer. Studies are now under way in Finland, Sweden, and Norway, through the International Biological Program, to determine the growth rates of the several lichen species that are important to reindeer.

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