Effects of Human Activities on Alpine Tundra Ecosystems in Rocky Mountain National Park, Colorado

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ABSTRACT

The activities of summer visitors to the tundra of Trail Ridge in Rocky Mountain National Park results in the rapid destruction of vegetation in the areas seen by most visitors at close range—especially near parking areas. Ecosystems differ in their reaction to trampling; those with high soil-moisture are most easily damaged. Tall herb ecosystems are next, and then fellfield. Turf types are the most durable. Other activities affecting tundra are rock collecting, littering, crushing by car tyres, and flower picking.

INTRODUCTION

No civilized society has learned how to add Man to the landscape without robbing subsequent generations of resources and opportunities that are vital to their well-being.

The earth's landscape is a mosaic of complex systems in which many organisms and environmental factors interact. These interactions operate through a myriad of interrelated processes which, in their total effects, determine the characteristics of each system. Throughout the history of life on earth, a change in any one organism or environmental factor of a landscape system has resulted in other changes in the landscape. Although Man is a recent addition, he has made manifold and profound changes, most of which have caused problems for his descendants. Our task is to build systems in which Man will be able to achieve 'life, liberty, and the pursuit of happiness,' while keeping environmental quality, organic productivity, and system stability, at high levels. This paper describes some of the consequences of Man's entrance into an alpine tundra landscape. As this system evolved without Man for millions of years, it is not surprising that extreme changes occur when he is added.

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The study area is Trail Ridge (Fig. 1) in Rocky Mountain National Park, located in north-central Colorado. Some of the ecological features of this Ridge are described in a paper by Marr & Willard (1970). The Ridge is easily accessible by car on a paved two-lane highway that is kept open (*i.e.* free from snow) for three or four months during each summer.

METHODS

Studies were conducted throughout the tundra region of Trail Ridge, but intensive research was centred around the four major parking areas above tree-limit, where about 95 per cent of the visitors congregated.

Vegetation sampling methods followed Braun-Blanquet (1932). One of us (B.E.W.) developed the following scale of visitor effects:

Degree 0 — no known impact; total vegetation cover = 100 per cent of natural

Degree 1 — receiving visitor impact, but no alteration visible; total vegetation cover = 100 per cent of natural

Degree 2 — ecosystem obviously affected by visitor impact, but vegetation cover = 85–90 per cent of natural

Degree 3 — ecosystem definitely altered by visitor impact; plants show reduced vitality; attrition effects on normal growth great; normal growth persists in protected sites; soil exposed and eroding; total vegetation cover = 25–85 per cent of natural

Degree 4 — ecosystem radically altered by visitor impact; vegetation gone except in very protected sites; A horizon exposed over most of area, and eroding; vegetation cover = 5–25 per cent of natural

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Fig. 1. *A portion of the Trail Ridge tundra traversed by the road. Sorted-circle patterned ground behind lingering snow-patch in foreground. Several types of turf ecosystems and solifluction slopes are barely visible in left background. Long's Peak and steep slopes are seen in right background.*

Degree 5 — ecosystem virtually destroyed by visitor impact; plants existing only in very protected sites, if at all, and not growing normally; B and C horizons exposed by erosion; total vegetation cover 0–5 per cent of natural

This study was seeking information on the effects which visitors have in the course of doing whatever they normally do while in the tundra region. Consequently, our data consist of observations made without the knowledge of the visitors, and in the absence of any attempt to conduct experiments.

VISITOR ACTIVITIES AND THEIR EFFECTS

Unchanneled Walking

Over 100 observations showed that a few visitors strolling at random on natural tundra caused little immediate damage. During the peak of the growing-season (late June to early July), any evidence of such use was immediately erased by the resiliency of the tundra plants. At other periods of the growing-season, effects were detectable for only a few days. Use during freeze-up periods left no visible impression.

Repeated walking on one area by a small number of people over an extended period of time did not cause visible effects. For example, 10 to 20 trips were made by one or more people in each of 5 seasons to areas on the west slope of Sundance Mountain, and there was no visible impression on the ecosystems.

Concentrated Walking

Forest Canyon Overlook: Construction of a new parking area at Forest Canyon Overlook provided an opportunity to study effects of walking from the time of their commencement. Walking crushed and broke stems, leaves, and flower-stalks. In two weeks' time, we saw plants adjacent to the parking area becoming wilted and matted, and paths developed on the fell-field tundra. Repeated observations of this site for seven weeks, until the peak of the blooming-season, showed that the plants adjacent to the parking area did not bloom. Many plants were yellow and the convex surfaces of some cushion-plants had been eroded (Fig. 2). After 12 weeks of use, the several paths that had begun to appear during the first 2 weeks had become prominent, with the vegetation cover reduced to 87 per cent of the original. Aerial portions of nearly all the plants adjacent to the parking area were badly damaged or dead (Fig. 3). The eroded areas of cushion-plants had increased to between 1/5 and 3/4 of the original plant surface, and soil lichens were no longer present. There appears to be a correlation between compactness of cushion and the amount of damage caused by trampling. *Silene acaulis* L. (Moss Campion) has the most compact cushion and was the most damaged; *Arenaria obtusiloba* (Rydb.) Fern. and *Trifolium dasyphyllum* T. & G. cushions were more diffuse and less affected.

Two additional seasons of walking, concentrated in a small area (Fig. 4), reduced the vegetation cover to 33 per cent of the original, and damaged or destroyed the aerial parts of all plants. Damaged but still living plants existed mainly in the pockets beside rocks. Much of the area was covered with sand and fine gravel that was left behind as wind deflation removed fine particles after the vegetation cover had been broken.

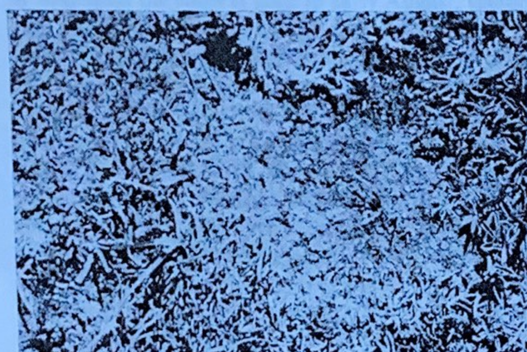

Fig. 2. Close-up of a cushion of Silene acaulis *L. after 7 weeks of trampling. The cushion is about 4 inches (10 cm) across at the widest point (note toothpick stuck in its edge in upper centre of photo).*

Fig. 3. Close-up of cushions of Silene acaulis *L. after 12 weeks of trampling. The cushion on the left is about 3 inches (7·6 cm) in diameter.*

Fig. 4. Tundra damaged by trampling for only one season.

Fall River Pass: A parking area was made along the cirque edge at Fall River Pass in 1920. The original ecosystem was fellfield similar to that at Forest Canyon Overlook. By 1958, visitor trampling, together with auto parking in the early years of use, had totally destroyed the vegetation and the A horizon of the soil over 95 per cent of the area. Patches of vegetation and soil a few inches wide hugged protective boulders (Fig. 5), while sterile sand and gravel covered the rest of the area. The remnant patches, with sharp vertical walls from 1 to 5 inches (2·5 to 12·6 cm) in height, showed how much erosion had taken place in the destruction of the original ecosystem.

Fig. 5. Remnants of the fellfield ecosystem at Fall River Pass as it appeared in 1958, after 38 summers of trampling. The islands of vegetation rise about 5 inches (12·6 cm) above the gravel surface and indicate that a similar thickness of plant cover and soil has been eroded away under visitor use.

In 1958, the small remnant patches of the original ecosystem still contained the more common species of this tundra type, but some 'character species' (*sensu* Braun-Blanquet), especially lichens, were lacking. Photographs taken in the early 1930s show that the ecosystem had by that time been modified to approximately its present state.

Field observations show that killing of plants creates bare areas which are subsequently enlarged by the erosion of wind, water, and needle ice. Eventually the fine soil particles are carried away, leaving a surface cover of gravel. Natural processes of frost-heaving and of disturbance by the Pocket Gopher (*Thomomys talpoides*) create bare areas a few square decimetres in extent, but great expanses of bare gravel do not occur in natural tundra.

Rock Cabins: This small parking space was used for 26 years by a few visitors. The only visible effect of their activity was on the vegetation of the fellfield within a few feet of the parking spaces.

Toll Pass: One of the largest snow accumulation areas adjacent to Trail Ridge Road above tree-limit occurs near Toll Pass. From the opening of the road in May until the snow is gone in early August, visitors stop to play in the snow. This activity increased in 1958 when a small parking area was constructed near by. Visitors walk across several snow-bed associations (Willard, 1963) in which the soil is kept almost saturated by snow-melt water. Our observations led to the following conclusions: (1) underground plant organs are damaged because the wet soil is easily compacted; (2) since the initiation of the season's growth follows the retreating edge of the melting drift, there is a shifting zone of young plants that are soft, succulent, and especially susceptible to trampling; (3) even mature plants of species that are generally resistant to trampling in other sites are susceptible to breakage in the snow-bed site because they are relatively large, succulent, and brittle; (4) plant recovery is poor because there is a short growing-season; and (5) as the natural vegetation cover is sparse, the reduction of plants is conspicuous.

A solifluction terrace north of the road in the Toll Pass area contains active sorted-net patterned ground —a tundra type that is infrequent under the present climate of the Front Range. Trampling by visitors altered the form and distribution of mineral material in the patterns. Whereas undisturbed sorted nets have convex centres of fine material, especially during the spring and fall seasons, and there are some gravel and a few boulders at the surface, trampled nets had a concave surface, an increase in clay, and a reduction in coarse particles in the centres.

Iceberg Lake: Ecosystems adjacent to the Iceberg Lake parking area show varying degrees of alteration, caused by 26 years of visitation, from a slight reduction to total destruction of the vegetation cover—depending on the concentration of use and the level of soil moisture. The snow-bed ecosystems north-west of the parking area have been almost completely destroyed. To the east, south, and west of the parking area there are ecosystems, mainly fellfield and *Carex rupestris* All. turf (Willard, 1963), with low soil-moisture and of less general interest to visitors. In these areas, the visitor effects are degree 2 (*see* above).

Little Rock Cut: This new parking area was constructed in 1958 adjacent to a *Deschampsia caespitosa* (L.) Beauv. ecosystem (Willard, 1963). Vegetation cover was reduced 10 to 30 per cent by trampling during the five summers of observation. The rate of modification was slower than at Toll Pass, probably because the *Deschampsia* ecosystem has lower soil-moisture, a longer growing-season, and plants that are more resilient. This system does have enough snow accumulation to cover the vegetation all winter, and the soil is saturated with water for an interval at the beginning of the growing-season, but it dries up earlier than in the patterned-ground sites.

South slope of Toll Memorial: A small parking area was constructed south of Toll Memorial in the summer of 1958 to accommodate visitors wishing to climb to the large, very late-lying snow-field just west of the Memorial. In 2 summers of activity, visitors had the following effects: (1) 22 paths developed within a distance of 150 feet (46 m); (2) a Kobresia meadow had reached impact degrees 3 and 4; (3) snow-bed ecosystems had reached impact degrees 4 and 5; (4) the remaining slope, covered with a mixture of fellfield and *Carex rupestris* turf, exhibited impact degrees 2 and 3.

Rock Cut: This parking area, one of the original three of the Ridge, has been used by visitors since 1932. The tundra slopes gently up from a long, narrow parking strip, making an inviting place for visitors to wander about looking at the scenery, flowers, and rocks. A large rock outcrop attracts people who wish to climb about and obtain a broader view.

As there were no set paths during the first 26 years of use, visitors wandered at will. A prominent, eroding trail leading to the rock outcrops developed near the south end of the slope. The remainder of the slope had been altered extensively by trampling to, in different places, all degrees of impact.

The original ecosystem over most of the Rock Cut slop was Kobresia meadow which generally contains 35 to 54 species, of which several are seed plants that are almost totally restricted to this type of ecosystem. About one-third of the species of each stand are lichens and mosses. Comparison of the stand on the Rock Cut slope with a natural undisturbed Kobresia (*Kobresia myosuroides* (Vill.) Fiori & Paol.) stand, such as occurs north-west of Toll Memorial, indicates the following effects of visitors: (1) fewer species and fewer individuals of each species were present, resulting in from 10 to 100 per cent reduction in vegetation cover; (2) plant growth, especially erect growth, was conspicuously less; (3) the number and size of inflorescences, and consequently the amounts of seed, were reduced; (4) nearly all lichens and mosses were eliminated; (5) although all character species of a Kobresia association were found somewhere on the slope, their frequency was much reduced; (6) pioneer species not found in the natural ecosystem grew in denuded microsites; (7) humus and fine mineral particles were eroding from the exposed soil, leaving bare gravel surfaces; (8) soil moisture, surface soil temperature, soil structure, and air temperature, were all altered; (9) plants, especially cushion and tussock forms, were damaged or deformed by erosion of their centres.

The four species with the greatest tolerance of trampling were: *Kobresia myosuroides, Oreoxis alpina* (Gray) C. & R., *Geum rossii* (R. Br.) Sér., and *Bistorta bistortoides* (Pursh) Small. It is interesting to note that these four species represent four different life-forms. Thus Kobresia is a tussock sedge with very tough and durable sheaths at the base of the culms, *Oreoxis* forms diffuse mats from large and tough rootstocks, *Geum* has extensive tough stolons, and *Bistorta* has fleshy corms (Daubenmire, 1941; Holch *et al.*, 1941).

Tundra Nature Trail: Beyond the area of heavy damage at Rock Cut a faint and narrow, informal footpath has developed to Toll Memorial—a bronze plaque mounted on a bedrock pedestal about ½ mile (0·8 km) north of the parking area. In 1960, this path was converted to a nature trail, the walking surface being widened and gravelled, with stone cairn markers placed at frequent intervals along its length. A self-guiding leaflet, prepared by one of us (B.E.W.), was provided in a covered stand at the beginning of the trail. Most visitors followed the gravel path closely, but some of them did walk on the tundra along the trail, as terrain on either side was level, and several persons could walk abreast. By 1962, the tundra along the trail had reached impact degrees 2 to 4.

Conclusions on Effects of Walking

These observations, made in a variety of ecosystems after different intensities of walking, lead to several general conclusions on the effects of walking on alpine tundra:

(1) Occasional trampling has no persistent visible effects.
(2) Trampling by fewer than 5 persons every few days over a period of many years has little or no persistent visible effect.
(3) Trampling by hundreds of people in one area can destroy a fellfield ecosystem in 2 weeks, a snow-bed ecosystem in from 1 to 3 weeks, and a turf ecosystem in 8 weeks.
(4) Soil-moisture greatly increases the susceptibility of ecosystems to damage from trampling. Those of high soil-moisture, such as snow-beds and marshes, are easily damaged by only a small amount of walking. In ecosystems with low soil-moisture, the growth-form of plants controls the degree of damage to some extent; *e.g.* the lush herb stands of gopher-disturbed areas are most quickly modified, fellfields with cushion forms are intermediate, and turfs dominated by grasses and sedges are the least affected.

Other Activities

Rock Removal: We observed that many visitors find the abundant lichen-covered rocks along the road so irresistible that they attempt to take home one, a few, or even a trunkfull—with the contention that 'there are so many, a few will not be missed.' This is invalid, of course, because the spot from which a rock is removed (Fig. 6) is automatically converted to visitor impact degree 4 or 5 by immediate exposure of the A or B soil horizon to various processes of erosion by wind, rain, and needle ice. As erosion undercuts the turf, this latter breaks off in pieces that blow away, which results in enlargement and deepening of the depression. Trampling intensifies these processes by moving loose materials and by breaking edges off the turf.

Fig. 6. A bare spot where a visitor has just removed a rock from the tundra. Metal rule is extended 9 inches (22·7 cm).

Rocks are also dislodged by visitors' walking, and this may actually cause more damage than rock removal, because in addition to creating bare depressions that are susceptible to the erosion processes, the dislodged rock destroys the plants on which it comes to rest.

Removal of flowers and plants: Flower-picking seems to be one of the most normal inclinations of uninformed visitors. They pick one flower to examine at close range and to show to others, a few to keep as a souvenir, or a bouquet for camp-site or cabin. Even those who know that this is both a prohibited and a destructive pursuit often cannot resist the desire to secure trophies or to see the beautiful things at close range. As most alpine flowers grow close to the ground, and few people wish to get down on their hands and knees, up come the flowers in the visitors' fingers before they stop to think of the consequences.

During the first season (1958) of the Forest Canyon Overlook parking area, there was a peak in the blooming of Rydbergia (*Hymenoxys grandiflora* (Pursh) Parker) plants in the adjacent tundra. Thousands of the large, yellow sunflower-like flowers speckled the landscape at the beginning of July, but in the following 3-day holiday almost all of the flowers were picked in the stand immediately west and south of the parking area—the stand most heavily visited. Early on the second morning, seven *Rydbergia* flowers were found lying on the parking area.

After many hours of observations during many different days, our notes yield the following information: (1) *Hymenoxys grandiflora, Geum rossii, Mertensia viridis* A.Nels., *Polemonium viscosum* Nutt., and *Sedum rosea* (L.) Scop., appear to be picked most commonly. (2) The flowers of Eritrichium (*Eritrichium aretioides* (Cham. in Cham. & Schlecht.) DC.) and Moss Campion (*Silene acaulis*) are occasionally picked, but as these are rosette or cushion plants, damage is limited to loss of seed because the main plant body remains intact. (3) Usually only a single flower-stalk is affected. (4) Picking occasionally involves uprooting part or all of a plant. In the case of plants which flower only once before dying, picking does not affect the future of the individual plant, but it does affect the species by reducing the potential seed-crop.

Occasionally, an avid gardener was seen digging up a plant or two, or a mass of turf to take home for his or her rock garden, leaving behind patches of bare soil exposed to erosion.

Littering: Littering, mostly with small pieces of paper and empty beverage cans, initiates processes that produce conspicuous bare areas. Paper disintegrates only after several seasons, due to the nature of the alpine environment. Some paper becomes compact, obstructs the passage of light and air, and results in the death of covered plants in from one to three seasons. Littering is objectionable ecologically as well as aesthetically.

Empty cans cause more rapid and extensive damage to vegetation than do pieces of paper. A can discarded on a cushion-plant may kill it in a single season, though erect vegetation may survive partial coverage for several seasons (Fig. 7). Cans disintegrate very slowly in the Rocky Mountain alpine climate. Some that were left by road construction workers in the very early 1930s are still intact and have identifiable labels. How long it would take for natural deterioration to take place in areas disturbed by such means is not known, but it far exceeds 30 years. Recovery of tundra is initiated only after the can is removed, and this procedure is employed only along the roadsides. Can damage resembles somewhat the effects of shredding of plants by small mammals, or the area of a collapsed gopher tunnel. However, the places denuded by cans are more restricted in extent and not as deep as those produced by natural processes.

Objects larger than cans and papers sometimes fall on the tundra. Shirts, sweaters, or scarves, are occasionally blown from visitors and not retrieved. Boxes, lumber, and even a roll of fibreglass insulation, have been found. These objects kill the vegetation in one season if they remain in place for three or more weeks during the growing period. However, damage is slight if they remain on the tundra only during the season of plant dormancy. Frost scars and gopher mounds are the only similar bare spots made by other means in natural tundra.

Fig. 7. The ecological effects of a discarded can on otherwise undisturbed tundra. Judging by its state of deterioration, the can has probably been lying for more than 10 years on the area of which the far corner is marked by the vertical pencil.

The magnitude of littering is impossible to determine accurately, but it is great enough to necessitate trash pickup by two men along the roadside every four days during the summer season. This collection results in a pickup truck-load of litter from each trip, and costs $1,400 for the four summer months.

Driving of cars on the tundra: In July 1961 we watched a visitor drive his car across fellfield tundra at Iceberg Pass. We examined the traversed area immediately and could not find any effect on the ecosystem: even the route of passage was invisible, because of the resiliency of the plants and the firmness of the soil. Another car was driven onto the lower slopes of Sundance Mountain in September 1958 while plants were dormant and brittle and before the soil froze. The resulting track was visible the following growing-season. Examples of effects of cars on wet ecosystems are fortunately lacking, but the compressibility of wet soil would obviously result in greater permanent damage than on dry soil.

DISCUSSION

Our experience in this programme illustrates one way by which ecologists can make their talents and knowledge more effective in Man's efforts to achieve a satisfactory environment. Different Park staff members have brought a variety of problems to one of us (B.E.W.) ever since the project began, and she has worked with them happily and fruitfully in using ecology to help find solutions. For example, after she had identified and carefully described three ecosystems with special botanical significance (Willard, 1963), she discovered that the Park's plans for developments, to accommodate the increase in visitors, included construction of a parking area near by. As this addition would obviously have endangered the survival of these rare systems which have special value to Man because of their uniqueness, the Park administration changed the plans so as to protect this valuable natural resource.

Trampling is the human activity which produces the most serious alteration of tundra. A few persons walking without design for several years, or even following a single route for a few seasons, produce only minor damage. However, where many visitors concentrate their walking on a small area, serious damage can occur in as short a time as ten days.

Some ecosystems were more easily damaged than others, by trampling, and the extent of the damage varied directly with the moisture conditions of the soil: in general, the wetter the soil, the greater was the damage. Plant form also influences the consequences of this activity; the sedges of wet sites were most easily damaged, cushion-plants of fellfields were more resistant, and the sedges of turf stands were the most resilient.

In connection with trampling, we observed that tourists tend to follow formal paths in a most admirable manner. The Park, in its continuing efforts to provide reasonable facilities for visitors while also preserving as much of the landscape as possible in its natural state, built new surfaced paths in some of our study areas while our research was in progress. It was evident that the most effective paths are those which go where the walker wants to go, follow the most direct possible route, and are wide enough to accommodate the maximum volume of traffic.

Visitors often pick up rocks and plants to take home, having overlooked or ignored the Park's prohibition of these activities. As is common with Man's behaviour everywhere, cans, paper, and other debris, are thrown out of car windows or dropped on the tundra by walkers. All these are, of course, now generally considered to be aesthetically destructive practices. Our observations indicate that they are also undesirable activities ecologically, sometimes causing damage that requires many decades to repair.

The landscape near parking areas loses its natural character under trampling in one to a few seasons of human activity. It is fortunate that these areas represent only a very minor part of the tundra landscape, but it is unfortunate that these damaged areas are the only tundra that most visitors see close at hand. The natural tundra is seen only as a car-window blur while tourists drive between parking areas. When they stop, that which is most accessible to them resembles the eroded turf of a poorly-maintained public playground.

As our research proceeded, papers were published or we found older literature on studies in other areas which reached conclusions similar to our own. There is not space here for comments on each of the pertinent papers, but anyone interested will want to study the following publications listed in the references section: Armstrong (1942), Bardel (1967), Brockman (1959, 1960, 1964), Coleman (1967), Edwards (1967), Hartesveldt (1963, 1965), Kraus (1967), Laing (1961), Lull (1959), Lutz (1945), Meinecke (1926, 1929, 1932, 1934), Michaud (1967), Rutter & Black (1953), Ryle (1967), Sharsmith (1959, 1961), Sumner (1936, 1941, 1947), Wagar (1964, 1965), and Westhoff (1967).

This research leads to the conclusion reached in many other ecological studies, namely that ecosystems are intricately organized, complex systems that are easily destroyed by the addition of 'foreign' components. The present components and characteristics of alpine tundra evolved in the absence of any organism resembling Man; it is not surprising, therefore, that careless addition of Man to tundra can have devastating consequences. Man's problems with alpine tundra are especially serious because of its position on or near the tops of mountains, so that changes in it can trigger processes and movements that will naturally tend to be downslope—with possibly catastrophic results. Fortunately, our studies indicate that it is possible to add Man to this beautiful and exciting landscape without destroying it, *if* we regulate his activities according to ecological principles.

One problem of National Parks is, of course, that they can serve their function only if they do add Man to the landscape. Darling & Eichorn (1967) emphasize the need to keep in mind the 'physiology' of the landscape—that is, its dynamic nature; they wonder if the landscape will adjust to tourism as it has done to fire, flood, etc.

We were impressed by the fact that most park visitors really do not wish to alter the landscape. Although, as Michaud (1967) states, humans tend to focus attention on activity rather than 'ecological stewardship', when visitors were helped to see and understand the need for changing their activities in order to preserve the ecosystems, they generally co-operated graciously and humbly—not wishing to be destructive but having previously been unaware of their great potential in this direction. A heavy responsibility for channeling activity and for education of the ecological facts of the national park landscapes lies with the National Park Service and with all recreationally-orientated groups.

The problems of visitor impact are summarized in the well-known and widely applied ecological principle that any natural area or ecosystem has a definite carrying-capacity of consumers (Leopold, 1933; Odum, 1959; Wagar, 1964), the extent of which varies with the type and size of the ecosystem and the type of use. Obviously, the paramount need is to maintain the size of the consumer (visitor) population well below the maximum carrying-capacity, in order that producers (the alpine plants) can maintain a dynamic equilibrium with the consumers. If destruction exceeds what the producers can support and tolerate, serious and lasting impairment of ecological processes results, culminating in disorganization and destruction of the ecosystem. Wagar (1964) emphasizes that carrying-capacity for human use varies with the natural values desired.

This ecological principle governing producer-consumer relationships in natural ecosystems has been discovered primarily through Man's violation of it. In ecology, as in physics, it is economically unsound, unwise, and ultimately dangerous, to disregard basic laws. We must determine the human carrying-capacity for all ecosystems, especially those in national parks, and use these data to maintain visitor populations at a level that will assure preservation for posterity at a high level of naturalness.

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Continued Excessive Harp Sealing for Skins

In 1940 the world population of Harp Seals (*Pagophilus groenlandicus*) was estimated to be approximately 10 millions. By 1963 this had dropped to an estimated 3 millions (cf. *Biol. Conserv.*, **2**, pp. 34–35, October 1969). The most rapid decline was reported from the White Sea, where numbers fell from 4.5 millions to fewer than a quarter-of-a-million during the twenty-three years' interval. Numbers there have, however, been increasing again since the Russians imposed a ban on seal slaughter.

The Jan Mayen herd has latterly been reduced to about one-tenth of its 1940 numbers, but killing continues. Likewise, in the Canadian Gulf of St Lawrence and on the international waters of the Canadian 'Front', off Labrador, sealing continues on a commercial scale. The combined herds in these last two regions have fallen from about 5 millions in 1940 to 3 millions in 1951 and an estimated 2 millions in 1969.

An unprecedented public outcry in Europe, unusual ice conditions, and the fact that only about a quarter-of-a-million females turned up to give birth in the 1969 season, caused the Canadian Minister of Fisheries and Forestry to halt the killing of new-born seals (called 'whitecoats') before the full quota had been killed.

Since 1958, when Dr Harry Lillie drew their attention to the cruelty involved in seal slaughter, the World Federation for the Protection of Animals has conducted a vigorous campaign to protect seals from unnecessary suffering. In 1965 the Canadian Government introduced regulations with respect both to licensing of seal killers and to the methods of killing (which usually involved smashing the skull with a wooden club). The regulations have been reviewed and tightened in succeeding years.

Following the sudden halt to the Canadian 1969 sealing season, the Minister of Fisheries and Forestry announced that he was considering making the Gulf of St Lawrence into a sanctuary for seals. It was, therefore, with disappointment that his announcement of new regulations was received on 15 October. These prohibit the killing of baby seals only until they are about three weeks old, when they cannot be approached and must be shot with rifles.

There was no change in conditions of the 1970 'hunt' on the Front, where Canadian sealing boats compete with those from Norway. WFPA requested the Seal Panel of the International Commission for the Northwest Atlantic Fisheries to introduce a catch quota and realistic open and close seasons for the 'Front', when that Commission met in Warsaw early in 1969. The matter is, however, still under consideration.

The Canadian Government estimates that the number of seals killed on the Front is three times the number which should be taken if the herd is to maintain even its present depleted size. This year a joint announcement by the Canadian and Norwegian Governments said that a quota on Seals killed on the Front will be introduced in 1971.

It is hoped that this report is not a 'public relations effort' similar to the October 1969 announcement by Canada. Observers at the Gulf hunt this year noted that the promised new regulations were not enforced. Rifles were not in general use and whitecoats were clubbed to death as usual.

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