

A Task for Ecologists around Waterfalls in Labrador-Ungava

They have a last opportunity to study the effect of Churchill Falls on the surrounding ecosystem.

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Until recently, the inner parts of Labrador and the adjoining northern part of Quebec have been an uninhabited wilderness (1). The establishment of the iron mines in Schefferville (Knob Lake) in 1954 (Fig. 1), the founding of the cities of Wabush and Labrador City about 10 years later, and the building of the ore railways changed this situation. A highway between Esker and Twin Falls was built by the Twin-Falls Power Corporation about the middle of the 1960's. Thereafter the Churchill Falls Power Station

was established, and the city of Churchill Falls was founded. The Translabrador Highway to Goose Bay will soon penetrate the wilderness, and Labrador is facing the greatest change in its history (2). This change is no longer just Labrador's inner development; the activities of both the ore industry and the power station are international enterprises, whose economic interests concern Canada, the United States, and, in part, Europe. This international aspect is, perhaps, best represented by the transmission line that will extend from

Churchill Falls to New York after the greatest waterfall energy of all time (approximately as great as the energy produced by the Bratskoje More Project in Siberia) has been released (1).

So radical a change is relevant to conservation, the study of nature, and the world-wide problems connected with the changes of nature and their significance in the future of mankind. An area of dozens of thousands of square kilometers will disappear, uninvestigated, into history after the immense lake districts of Michikamau and Lobstick have been converted into the largest continuous reservoir in the subarctic region (3). The time is past when we could discuss the world's joint responsibility and cooperation in the conservation and study of nature. Even if it were possible to gather botanists, zoologists, pedologists, geographers, and game specialists from every corner of the world for the remaining summers during which investigation could still be made, their work would be bound to remain only symbolic because of the vastness of the area and the insufficiency of the time.

But it is still possible to carry out a more realistic and, from the point of view of ecological research, even more unique task, in which the relatively

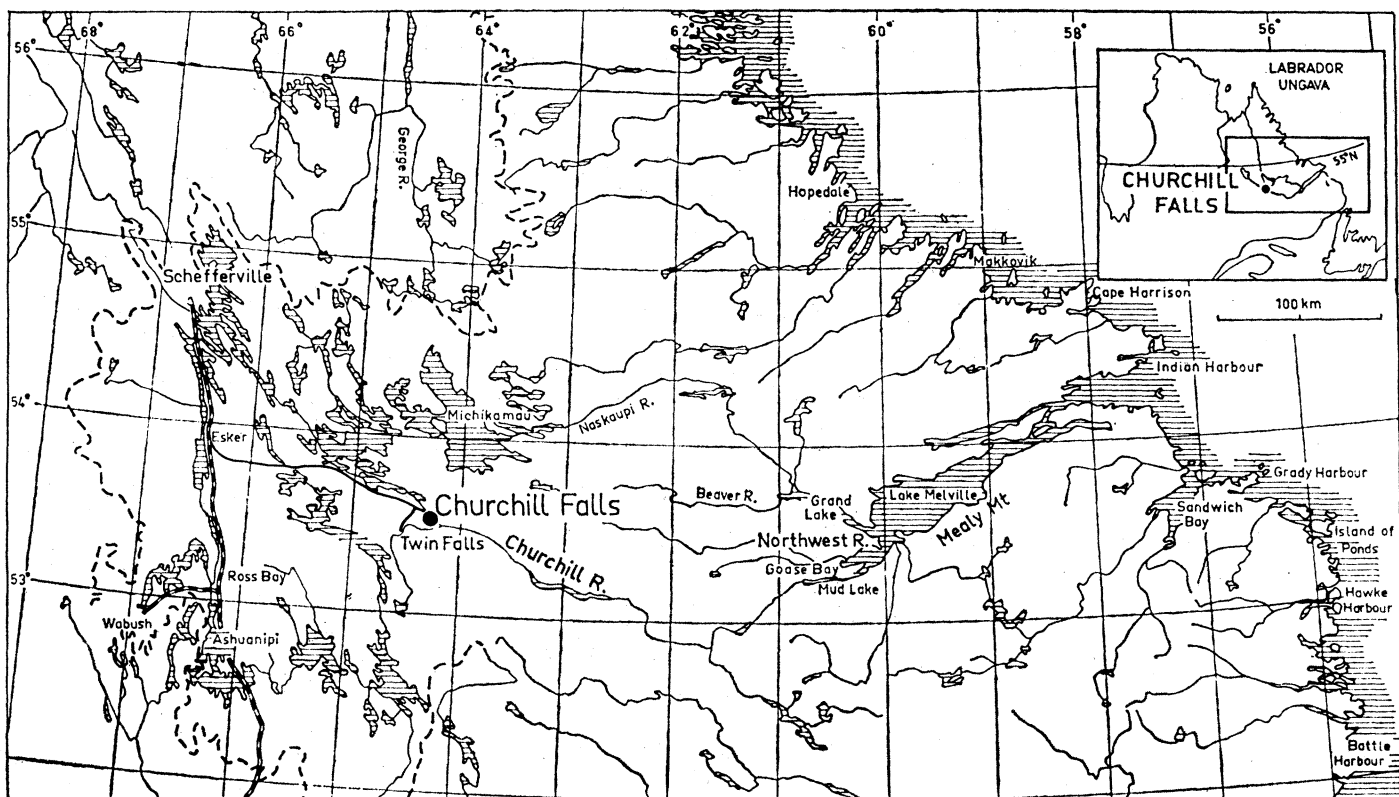


Fig. 1. Map of the Labrador-Ungava region.

small area makes possible intensive investigation. This task is to find the local significance of the waterfalls as an ecological factor in the forests surrounding the waterfall center of Twin Falls and Churchill Falls (see Fig. 2). With its great number of rapids and a large total area of spray zones, this waterfall center has no parallel in the subarctic region. The Twin Falls region was discovered as late as 1921! The falls had no name when Watkins (4) observed the winter "smokes" of the rapids in 1930. When Hustich and I first came to this area in 1963 to observe the spray zones, the water had already been partly led into new beds, and the zones were consequently drying up. Because of the hasty character of our expedition, we could not thoroughly analyze even the two falls already known, Scott Falls and Thomas Falls.

The Grand Falls of the Hamilton River—the name was solemnly changed to Churchill Falls in 1967—was still, in 1963, with its nearest surroundings, as virgin as in the days of Low, Bryant, Abbe, or Frissell (Fig. 3). An osprey had its nest on the top of a nearby spruce, and otters ran across the path in front of us. In late July 1968, when I had an opportunity to do some collecting in the area, the change was already to be seen: the falls itself was as it used to be, but the osprey did not nest any longer near the rapids, and the otters had disappeared. Instead, there was much evidence that photographers had been taking pictures of the rapids.

Churchill Falls is an ecologist's dream—an area in which the influence of an everlasting local rain on a relatively continental ecosystem of a subarctic wilderness can be investigated. Thus far no one has taken advantage of this opportunity. Botanists have visited this area more frequently than they have visited Twin Falls, but they have come mainly to observe details of the flora (3, 5, 6).

Churchill Falls is situated in the Ungava region where the high plateau of inner Labrador, with its many lakes, ends (at 53°36'N, 64°18'W), and where the system of the old Hamilton River drops into its preglacial canyon (7). The rapids are long, but the falls itself is here significant. As Frissell describes it (2), "During the last drop the huge mass of water is torn to

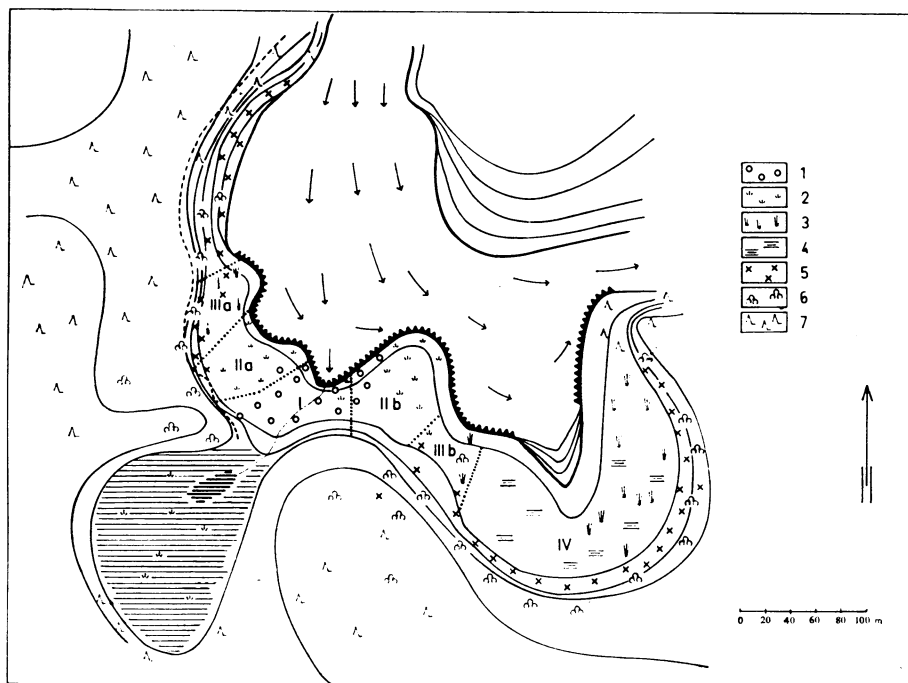


Fig. 2. A sketch map of Churchill Falls. Symbols are identified by number as follows: (1) Blocks in the spray zone (almost without vegetation); (2) sedges (*Carex stylosa*, and others); (3) tall herbs (*Streptopus*, *Solidago*, *Sanguisorba canadensis*, *Carex atratiformis*, *Calamagrostis canadensis*); (4) *Scirpus caespitosus* vegetation; (5) ferns (and bush) belt (*Dryopteris assimilis*, *Athyrium filix-femina*); (6) bush belt (*Alnus*, *Viburnum edule*, *Cornus stolonifera*, *Rubus idaeus*, *Amelanchier bartramiana*, *Ribes triste*, and ferns); (7) spruce forest.

shreds, and a great deal of it escapes in the form of vapour that can be seen 20 miles away. From the crest of the incline to the water level of the canyon Mr. Bryant measured a vertical distance of 312 feet, and Mr. Low

also estimated a minimum discharge of water of 50,000 cubic feet per second." This discharge was estimated later (1) to be 49,000 cubic feet per second.

The waterfall makes a spray zone on the opposite, or southern, side. This



Fig. 3. The falls in 1963.

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Fig. 4. View from area IIIc of Fig. 2, facing south, in the winter of 1969. [Steve Collins]

zone was mentioned by Abbe (5). The forest in the neighborhood of the falls shows a strong influence of the local humidity. The water will rush over the thousand-year-old falls for only a few more years, for the tunnel of the power station leading beneath the city of Churchill will soon be ready to receive the water. Therefore, the chance to make an overall investigation of this surrounding area is an ecological opportunity which should not be missed.

This task is one of the tasks associated with the planning of Labrador—those proposed by Hare (1), for example. As this task has a specific ecological character, I now suggest some things needing to be done—some research problems that I believe should be undertaken.

1) According to my estimation, the amount of “rain” in the central spray zone on the side opposite the falls is approximately 15,000 millimeters per year, whereas the precipitation in this part of Labrador is usually about 750 millimeters (5, 7). This very extensive humidity scale, as measured from the center of the zone to a distance of some hundred meters, provides the opportunity for an excellent gradient analysis of the flora and vegetation. It is likely that the growth of trees shows a similar influence of moisture from the rapids and the local precipitation.

2) The falls—in spite of the fact that they have continually moved upstream and changed their form (2)—have exerted their influence long enough to permit examination of certain climax vegetation. It would also

be possible to elucidate the ability of plants to spread to a small, isolated area with a specific climate of its own (to make a comparison of cryptogams and phanerogams).

3) It is possible that features of the local ecology can be seen in phenologic development. For instance, new answers to the problem of how the time of development of the fruiting bodies of fungi depends on the summer temperature and humidity might be found here.

4) As the “rain” of the falls goes on in winter, ice is formed (Fig. 4). Investigation of the consequences of this process belongs to “snowbed” ecology. We know nothing about the thickness of the ice calotte itself.

5) Since the spray water is river water, its nutrient minerals fertilize the soil on which it falls, as in the case of floods. A comparison between alluvial areas and the spray zone might clarify the nutrient influence itself, even though the secondary effects are different.

6) The factors under consideration have a direct influence not only on the flora and vegetation but also on the soil that is influenced by the falls.

7) It is especially important that we avail ourselves of the opportunity to study the change that will take place after the river has been dried up. This change should be observed over a long period, and for this purpose permanent marked experiment areas would have to be established.

The investigations of the influence of rapids on ecology that have been

made to date have been only incidental. The problem has received most attention from lichenologists in Fennoscandia, a “classic” place for research on plant ecology and flora (8). The rapids in Scandinavia are, however, situated near the coast, which is otherwise somewhat oceanic, whereas the rapids in the inner parts of Labrador are more clearly distinguished from their surroundings as an ecological factor. We also have some data about the influence of the rapids on the appearance of oceanic lichens in the Alps (9), but the local climate caused by an alpine topography already is somewhat oceanic. However, if we compare the influence of the rapids on the epiphytic lichen flora in Europe with my own findings in the surroundings of Churchill Falls, it is surprising to find how parallel this influence is. Thus *Lobaria pulmonaria*, *L. scrobiculata*, *Pseudocyphellaria crocata*, *Leptogium saturninum*, and species of *Collema* are the best indicators in both areas. I have not found these species outside the rapids areas in inner Labrador. The data for Canada have not yet been combined. It is likely that the requirements for “oceanity” of these species are shown to some extent by collected samples and by some published field investigations (10).

To my knowledge, the snowbed ecology around the waterfalls has received no special investigation. In the waterfall center of Labrador, such species as *Poa alpina*, *Carex bigelowii*, *Arabis alpina*, *Epilobium anagallidifolium*, *Anthelia juratzkana*, and *A. julacea* are found in association with this ecological feature.

The forest surrounding the falls represents a small part of Labrador’s most luxuriant forest, consisting of spruces with plenty of groves, the “fir-spruce-birch/rich herb type” forest (11), which changes, a bit farther away, into one most closely resembling the “spruce-feather moss type” forest described by Hustich (12). Still farther away we meet with a forest type called “open lichen woodland,” so typical of the inner parts of Labrador. Thus another problem to be investigated is whether or not we have here a correlation between the rapids and the forest type (instead of geological heterogeneity, for example).

The investigations mentioned would require a team of at least four people: (i) a person to investigate microclimate, who should set up a network for

temperature and rain measurements and investigate ice formation in winter; (ii) a pedologist, who should, preferably, be also a soil microbiologist; (iii) a plant ecologist; and (iv) an animal ecologist. The investigation should mainly concentrate on Churchill Falls, but, on the other hand, the present stage of the whole area of the Twin Falls center should be estimated from the point of view of ecology. It is evident that a number of ecologists from different parts of the world could get rid of their everyday duties to

gather into a working team, and the financing of the project seems to me a relatively reasonable thing in comparison with the worldwide economic wonder of Labrador.

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NEWS AND COMMENT

Conservation Law II: Scientists Play a Key Role in Court Suits

If the genius of a well functioning democratic system is to have reasonable compromises emerge from the clash of countervailing forces, one can say that the forces working for environmental quality have been undermanned and outgunned. At the moment, however, anti-pollution and other conservation issues have taken hold politically, and prospects for achieving gains for conservation have seldom been better. Conservationists are seeking to commit to the battle all the branches of government, the legislative, the executive, and—the judicial.

In view of the size and complexity of the environmental crisis, the best hope for coping with it surely lies in action by the legislative and executive branches. Citizens' suits and court rulings alone can never do more than a patchy, limited job of environmental protection. But environmental lawsuits, such as those which will be described here, are likely to play a significant role, especially by making the process of decision-making followed by government administrative and regulatory agencies more responsive to environmental concerns.

For instance, a suit now pending before a U.S. district court in Colorado is being closely watched by conservationists. If it succeeds, the U.S. Forest Service and other federal agencies will know that, in making plans to

dispose of resources under their control, they had better be prepared, through careful assessments of the alternative uses for those resources, to justify their decisions publicly—and perhaps in court. The Colorado case boils down to a charge by the Sierra Club, the Colorado Open Space Coordinating Council, and other parties that the Forest Service has, in deciding on a sale of old-growth timber near the Gore Range-Eagle Nest Primitive Area, neglected its statutory obligations by not properly assessing the wilderness and recreation values affected.

In the first of these articles on conservation law (*Science*, 19 January), two somewhat radical theories aimed at making the lawsuit a major weapon of conservationists were discussed. One of these was the theory that the Constitution's Ninth Amendment, which says that the enumeration of certain rights elsewhere in the Constitution does not deny other rights retained by the people, can be invoked against polluters and others who disturb the environment unnecessarily.

The other was the public trust doctrine, an ancient theory, given only limited application by courts in the past, holding that the sovereign (the government) has the responsibility of protecting all lands, public and private, from abuse. Wide acceptance by the courts of either of these

doctrines would be a breakthrough for conservation. But, in any event, conservationists are beginning to make effective use of the courts, although the usable precedents are still relatively few.

One such precedent may have been set last July when a federal appeals court, responding to the eleventh-hour petition of some Colorado scientists, prevented the destruction of the 34-million-year-old Florissant Fossil Beds by land developers. The court enjoined the development activity long enough for Congress to complete action on legislation establishing a fossil beds national monument. Estella B. Leopold, a paleobotanist at the University of Colorado (and daughter of the late Aldo Leopold, a noted conservationist), had testified that "the Florissant Fossil Beds are to geology, paleontology, and evolution what the Rosetta Stone was to Egyptology and what the Dead Sea Scrolls are to Christianity."

Citizens have often been denied "standing" to bring suit to block government actions or to have a nuisance abated unless they personally faced or were suffering loss or injury, to a degree not shared by the public generally. However, two Wisconsin conservation groups, with the help of the Environmental Defense Fund, the Long Island-based legal action group (see box), were able to petition—in an exhaustive state administrative hearing—for a ban on the use of DDT. And although the Wisconsin statute (enacted in 1943) allowing such proceedings is unusual, citizens in many states may now go to court and challenge government policies and activities which they deem to be harmful to the environment.

In a paper presented in September at the Conservation Foundation's conference on environmental law, Louis