

alkaline rocks throughout the world that it behooves petrologists and geochemists to explain why. So far we have no particular answer to the problem, and we, therefore, cannot criticize Professor Gerasimovsky and his co-workers in this respect. They have given an admirable array of data with which later workers, by comparison with other massifs, may be able to provide some fundamental answers as to the origin of alkaline magmas enriched in elements like Ti, Nb, Ta, Be, Zr, and Hf.

Professor Brown has done a remarkable job in the translation of so complex a work. Throughout the two volumes the translation is clear, and the tables and graphs are well presented. The volumes are recommended to all those interested in alkaline rocks and their close associates, the carbonatites. For graduate students in geochemistry the data and ideas advanced on the partitioning of the elements during the magmatic events that produced the Lovozero massif will go a long way in explaining some of the facets of the geochemistry of some of the rarer elements in the earth's crust.

R. W. Boyle

THE MIGRATORY BARREN-GROUND CARIBOU OF CANADA. BY JOHN P. KELSALL. *Ottawa: Canadian Wildlife Service, 1968. 6 x 9 inches, 339 pages, 26 plates, 17 figures, 29 sketches, 24 maps. \$3.50.*

With the single exception of the North American Waterfowl Studies, no other wildlife project anywhere has matched in scope the study of the barren-ground caribou conducted in Canada through the twenty years since 1948. This has been a co-operative study involving the Provinces of Manitoba and Saskatchewan, along with the Canadian Wildlife Service, the Northwest Territories Administration and many local co-operators. About 20 biologists have spent thousands of hours on field studies always difficult and frequently hazardous. Courage, resourcefulness, imagination and ingenuity were constantly demanded of these men. The author of this monograph, John Kelsall, was personally in charge of the study for nine years, and was a fitting choice to prepare the published account of this important and ambitious research. His account does the research team justice, their accomplishments are impressive.

The book has been designed to be of use to a very wide audience. Its wealth of original data, much of it contained in the statistical tables included in ten appendices, makes the study invaluable to the research wildlife biologist and the student of animal popula-

tions. Its careful analysis of the data, presented in well-organized and thoroughly readable style, will be welcomed by student, field biologist and resource manager, as well as by those with more general interest in the Arctic and its creatures.

The region covered in this study is the continental mainland from the Mackenzie River to Hudson Bay, south into the forested areas of the central provinces used by the caribou as winter range. This is an area of some 700,000 square miles. In the early years of exploration it carried a population of caribou estimated by Kelsall at 2.4 million. Throughout the north it was the major animal influent and no other creature played so important a role in the survival of primitive man in this area, in facilitating the exploration of the Northwest Territories and in providing food for the trappers, prospectors, and others who pioneered the New North. Thus it was that the collapse of the caribou population through the 1950's was an event of major importance to Canada and national concern led to the study.

The text is in eight chapters, the first of which deals with the caribou as an organism. Here is the "natural history" of the creature in the conventional sense. The second chapter deals briefly with the tundra and taiga as habitat for caribou. Food habits, nutrient qualities of the vegetation, the seasonal use of the plants by caribou, and the vegetative yield of different types of plant communities that compose the summer and winter range are the subject matter of Chapter 3. Chapter 4 devotes 36 pages to migratory and other movements made by caribou herds. Detailed accounts are given of actual migratory movements of known herds, as well as massive shifts in population that were not migration. Other subjects treated are stimuli to movement, orientation, long crossings over ice, summer dispersal and winter concentration. The size of primitive and recent populations, sex and age ratios and the rate of increment to the herds are treated in Chapter 5 under the general heading of Population Dynamics. This section could have profited from a more analytical and synthetic approach with life tables leading to a population model. Such techniques could have thrown into sharp relief the relative importance of the several positive and negative forces that govern abundance and trends in size of the caribou population.

The breeding biology and growth are the subjects of Chapter 6. Here the details of the rut, the location and characteristics of calving grounds, calving behaviour, nursing, development and growth of the calf are

described. The first six chapters lead up to the answers to the problem that led to the study. In Chapter 7 there is a 75-page description and analysis of the factors limiting the caribou population. The final chapter is devoted to a discussion of the caribou as a renewable resource.

The discussion of limiting factors concerns itself primarily with natural mortality, human utilization, and crippling loss. The first is a cumulative category including predation, accidents and disease, that is regarded as amounting to 5 per cent per annum, excluding losses to calves of the year. Human utilization is known accurately for only 3 years, 1948-9, 1953-4 and 1954-5. In the first of these 100,000 animals were killed and used. The two latter years saw some 67,500 and 79,300 caribou taken by man. Crippling loss is regarded as averaging over 20 per cent of the known kill.

A large part of this treatment is a narrative account of the field results and an extended description of native hunting techniques. The importance of the natives emerges clearly from these accounts. Far more caribou were shot than were used.

One of the important results to emerge from the study is the discovery of the very heavy losses suffered by the new-born calves during the periods of severe weather that occur frequently at calving time. The difference in yearling increment to the herds in years of good weather during the calf drop and those of cold wet weather was about 50 per cent.

A fairly extensive treatment of wolves as predators is included, along with some details that are rather far from the main theme. In view of the greatly exaggerated figures of wolf numbers in the caribou range that were earlier published, it is interesting to note Kelsall's estimate of 8,000 individuals. The rather brief discussion of the intensive program of wolf control during the 9 years 1952-1961 gives important details of numbers taken, other creatures killed incidentally, and cost per wolf killed. The effectiveness of the control program in killing wolves was clearly reflected in the sharp rise in the proportion of young wolves in the catch. This started at 12 per cent in 1955 and by 1961 was 70 per cent. The inferences to be drawn regarding the mechanisms regulating the numbers of wolves are not pointed out. Unfortunately the influence of the control program on the survival of caribou was not determined.

Inasmuch as forest fires have been blamed for much of the decline in caribou populations, the discussion of this aspect is most

pertinent. The author concludes that at present levels of population the vast areas of burned land in the caribou range are not important in governing numbers of caribou. However, forest fires have greatly reduced the maximum number of caribou that could now be carried.

Under existing circumstances the caribou seems to be the only large meat animal likely to bring the vast northern areas of Canada into production. Kelsall shows that the primitive population of caribou could have sustained a harvest worth 12 million dollars, while even the meagre take of 15,600 shot in 1958 had a meat value of close to a million dollars. This was virtually indispensable to the survival of the natives who took them.

The primitive herds could probably no longer be supported on the greatly altered arctic rangelands. But Kelsall believes it possible to build and carry a continuing population of a million animals and to support an annual kill of 150,000, worth over 8 million dollars. This is for meat alone and neglects the recreational and minor secondary resource uses possible.

A succinct summary of the most important conclusions on the reasons for the decline and the essentials for effective restoration would have been welcome. However, one is led to the conclusion that the caribou is a species living under conditions such that it may for several successive years suffer calf losses so heavy that input leaves little shootable surplus. Under these circumstances human overkill has been the cause of the collapse of the population. At its present low level the balance of positive and negative factors is completely altered, and careful and sensitive management is urgent. Of first importance is control of the kill by men to a number below the yearling input.

I have but two criticisms of this book. It is largely narrative and would have made a more powerful presentation had a more incisive and analytical approach been used. It tends to be prolix and repetitive and would have been greatly improved by some rigorous editing. With these reservations, this is a most important contribution to the wildlife literature, one that will be widely used by students of many aspects of wildlife biology and wildlife management, as well as enjoyed by a host of others interested in this legendary and important species.

I found the book well produced, despite the large type face and niggardly margins which will make hard cover binding a problem. It is remarkably free of typographical errors. The photographic plates are excellent.

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