The reasoning behind this hypothesis follows. Large herbivores tend to match their consumption rate to the level of preferred forage resources available (Senft et al. 1987). This relationship appears to be more closely tied to the nutrients in the forage than actual biomass (Senft et al. 1985). Therefore, areas with high-quality forage receive a disproportionately high rate of biomass removal. Subsequent forage growth is high quality. This can lead to a spiralling effect of animals spending more and more time grazing certain areas of the pasture. A similar type of behavior could lead to "patch grazing" observed by Ruyle et al. (1988). They reported that cattle maintained small areas (patches) of heavily grazed Lehmann lovegrass

The idea of manipulating cattle distribution in a systematic manner based on animal memory of locations and diet selection rules has not been exploited. If an area is burned or fertilized, animals may consider it so much better than other areas that they would be willing to travel up steep slopes or long distances from water in order to graze it. But, animals may not change patterns of use in the areas they pass through to reach the burned or fertilized areas. Changing the similarity among patches will probably not overcome the effects of water, salt, steep slopes, comfort, or physical-barrier limits. Integration of these techniques with the proven techniques of water and trail development and salt placement may improve cattle distribution.

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A Post-Chernobyl Grazing Economy—North Wales in the Second Year and Beyond

Sian Mooney and William A. Kerr

Editor's Note: Readers may wish to refer to the article "Nuclear Accidents and Rangelands: The Effect of Chernobyl on the Grazing Economy of North Wales," by William A. Kerr and Sian Mooney *Rangelands* 10(1):6-9, 1988. We all need to be aware of the potential effects of nuclear contamination. There is much to be learned from these two articles.

As the grass flushed in 1987, signaling the commencement of a new grazing cycle, areas of North Wales in the United Kingdom began their second year of coping with radioactive material received in the wake of the Chernobyl accident. Government policy progressed from crisis management to a state of ongoing disaster administration. The short-term disruptions to farmers' grass management systems have largely been eliminated. Serious questions now arise regarding the long-term policies required to deal with contaminated areas. This is particularly important given that preliminary data suggest the level of radioactivity may not be declining as fast as originally projected.

In the summer and fall that followed the disaster at Chernobyl in April 1986, sales and movement of ewes and lambs were banned affecting a total of 2.5 million sheep of 5,000 operations. Later, in areas where radiation levels persisted, these activities were undertaken within a set of stringent regulations which were bureaucratic, time-consuming, and poorly designed to facilitate good management of the grazing resource. As a result, some overgrazing occurred and was particularly evident on geographically discontinuous farms.

In its attempts to deal with the crisis, the government was initially hampered by two problems. First, there were no data available concerning the effects of radiation on

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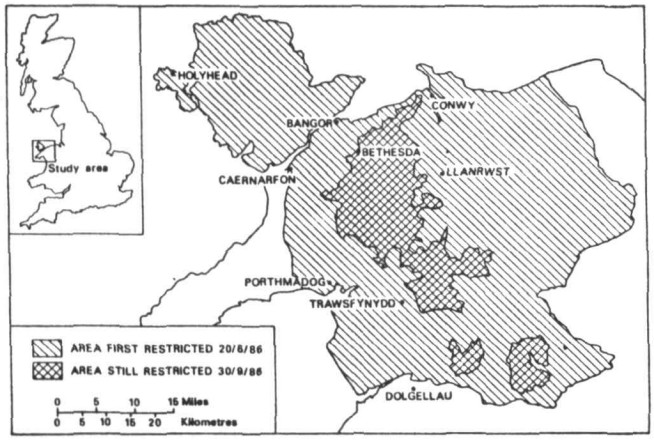
Author's Note: This *note* is an update of a report on the effect of Chernobyl radiation on North Wales, United Kingdom, published in *Rangelands*, Vol. 10, No. 1, 1988.

the hill and upland pastures. The government plans reflected reactions to ongoing events and little cohesive policy could develop. The second problem was a shortage of trained manpower and equipment, particularly for the testing of sheep. It must be said that for all their deficiencies, the government policies were successful in achieving their primary aim, which was to keep contaminated lambs out of the market.

At the beginning of 1987, there were still 300 farms with 100,000 ewes under restriction. Winter precipitation had reduced the levels of radiocaesium and it was hoped that the new spring growth of herbage would further dissipate the radiocaesium. It was expected that there would be a slight increase in radiation levels found in breeding ewes when they were moved onto the contaminated upland pastures. Farmers had been assured that even the worst cases of contamination reported in breeding animals were not high enough to cause birth defects in lambs or infertility problems in the breeding ewes (Welsh Office, February 24, 1987).



On the basis of these expectations, a series of policy measures were announced by the government for the administration of those areas which still exhibited high levels of radiation. Trained staff and sufficient equipment were available to test all sheep being sold or moved to new locations. As a result, more sheep could move through market channels and the disruption to farm incomes was substantially reduced. Experience gained from the preceding year indicated a high correlation between levels of radiation in ewes and their lambs (Welsh Office, April 8, 1987). This allowed the monitoring of ewes only (providing lambs were not offered for sale as single units), reducing the stress and trauma associated with the handling of young lambs. The procedures under which farmers could transfer ownership or move animals within restricted areas were streamlined. Flocks could, with a minimum of planning, be moved to take advantage of changing grazing conditions.

Lambs with levels of radiation in excess of those considered to be safe by government were marked for visual identification and moved through normal marketing channels for further fattening on uncontaminated pastures but were not permitted to be slaughtered. These "marked" lambs were discounted in the market. The original compensation was based on price differences relative to a market average. The new scheme calculates the discount on the basis of individual lots and, hence, quality premiums will be realized. The compensation scheme now formally recognizes that the extra time and effort associated with the process of monitoring represents a cost to farmers. In the first year, disruptions in farm cash flow delayed feed purchases, and some pastures were overgrazed to compensate. The policies developed to deal with contamination in the second season have removed most of the aspects of the original emergency policy which inhibited sound management of the grassland resource.

The above initiatives represent improvements to policies which were designed for crisis management. It soon became apparent that longer-term policy measures were needed. On-site sampling and laboratory simulations undertaken by Bristol University toward the end of 1987 indicated that the level of radioactive caesium in vegetation eaten by lambs was not declining as rapidly as had been initially hoped (Harvey 1987). Preliminary results suggested that some radiocaesium would be recycled in vegetation found in restricted areas during spring and early summer. In the House of Commons the Minister of Agriculture, Michael Jopling, stated:

> It had been hoped that radio-caesium levels in spring grass would show substantial falls as caesium became locked into the soil. Unfortunately, these low mineral soils are not binding caesium as efficiently as lowland soils and the first two cuts have shown evidence of some continuing recycling of radio-caesium.

This is particularly worrisome because caesium-134 has a physical half life of 30 years.

On May 15, 1987, a new programme of monitoring was announced to provide data which would determine which areas should undergo intensive testing for the purpose of de-restriction (Welsh Office, May 15, 1987). In restricted areas one flock in ten was sampled. Twenty-five lambs and five ewes from each flock were tested on a weekly basis, starting when lambs were approximately twelve weeks old.

It was found that radiation levels were rising and testing was extended to cover sheep outside of the restricted area. On July 9, 1987, the first of a number of orders was made reintroducing restrictions on movement and slaughter of sheep (Welsh Office, July 9, 1987). During July, 17 farms had restrictions reintroduced, with an additional 24 farms restricted in August, and 50 more in September. With the addition of these areas, there were approximately 416 holdings and 296,000 sheep within the restricted areas of North Wales (Welsh Office, September 17, 1987). In the first three months of 1987, 13% of the sheep tested in North Wales exceeded the government-established limit of 1,000 becquerel/kg. (a becquerel is one radioactive disintegration per second). However, as can be seen from Table 1, approximately 34% of those tested failed in June, 36% in July, and 32% in August, a signifi-

Table 1. Live monitoring programme in North Wales restricted areas.

Months	Number tested	Number under 1,000 Bq/kg*	Number between 1-2,000 Bq/kg	Number between 2-4,000 Bq/kg	Number above 4,000 Bq/kg
June	3697	2439	1063	195	0
July	3764	2415	1082	261	6
August	260	176	64	20	0

*1,000 Bq/kg is the level below which meat is considered to be safe for consumption.
Source: Welsh Office News, September 4, 1987.

cant increase on the previously recorded levels.

Up to the present time, the British government has implemented several short-term plans, altering and improving them as the need arises. It is evident that a long-term plan needs to be developed to deal with the possibility of continued contamination.

The government has funded limited research work to collect data which might facilitate the introduction of a long-term plan. Compared to the amount spent on compensation very little money has been allocated to research. The research and development budget for 1987/88 is only 0300,000 (1⁰ = 1.67US$) compared with more than 05.2 million paid to farmers in compensation (Harvey and Wilson 1988).

A major piece of government-funded research conducted by Bristol University in early 1987 showed that the radiation contamination would continue for a longer period of time than originally predicted. Other independent research studies suggested that additional research was required to complement and expand upon work carried out at Bristol.

Farming groups, understandably concerned about the future of their members, launched their own enquiries into the situation. They wished an answer to the following question: if the existing levels persist, are farmers in the restricted areas going to be faced, year after year, with disrupted markets, movement restrictions and the burden of extra time and effort which is required to monitor lambs? There is a fear that land values in contaminated areas may decline as a result of persistent radiation contamination in the soil. Genuine concern has been expressed by the farming community that this is already occurring. The government does not agree with this view and maintains that if farmers are fully compensated for lost income there will be no loss in the value of the farm. This view only considers the value of the farm in terms of earning potential when many other factors are capable of affecting its perceived value. Examples are: the ability to use the land for the farming occupations for which it is suited, the perceived effects upon the health of his family and the consumer's perception of the product these farms produce. A further concern is that, as the pastures are blighted, there will be little incentive to manage them well. Welsh branches of the Country Landowners Association formed a study group which recommends a full scientific enquiry by the government (Chernobyl-Scientific Inquiry, 1988). Their report suggested ways in which farmers could assist with reducing contamination such as the controlled burning of contaminated vegetation to encourage the removal of radioactive caesium by surface erosion.

Most government suggestions centre around diversification of enterprises in upland areas or upon methods to hasten reduction of radiocaesium. The Ministry of Agriculture, Fisheries and Food (MAFF) began experiments to reduce caesium levels using a top dressing of bentonite and clinoptilite (both clay materials). Bentonite was also given directly to sheep in the form of a drench. Levels of contamination were reduced, but where bentonite was administered directly it had an adverse effect on the animals. It was eventually decided by the ministry that usage of bentonite could disrupt the delicate mountain and moorland ecosystems (Harvey and Wilson 1988). Separate, non-government funded research by a team from the Rowett Research Institute, Aberdeen University, and the Macaulay Institute showed that in laboratory tests, clinopyilolite and a ferrocyanide complex were the most effective absorbers of caesium. Further studies on this approach are required.

MAFF accepts that in the long run the best hope of reducing caesium contamination is "by progressive, slow immobilization in the lower levels of the soil profile." A second option is to encourage farmers to diversify. Unfortunately, alternative uses for the unimproved hill and upland meadows are not immediately apparent. Cattle are of a sufficient size so concentration levels for radioactive materials do not reach the government danger level but most of the contaminated areas are too rough for cattle grazing. A further spin-off effect as a result of contamination of upland pastures is the potential effect on the economy of the lowland pastures. Unless compensation continues at a realistic level, "whole communities will be destroyed in the hill areas that are reservoirs of stock for the lowlands" ("Cash Flow Help for the Lowlands," 1988).

In recent months, criticism has been leveled at the government regarding the manner in which the long-term problem has been handled. For example, "It would have been much better to have brought the farming industry into the research process at the outset and to have drawn on its knowledge and resources" (Chernobyl-Scientific Inquiry 1988). "I am very sore about the attitude of officials at the height of the crisis and shocked by their total lack of knowledge of farming systems" (Harvey and Wilson 1988). In particular, criticisms centre on the lack of consultation with local farmers when making policy decisions and the poor knowledge of the grazing system by the policy makers. The government actions have caused many members of the farming community to lose faith in MAFF's ability to adequately control and contain/improve the present situation.

Without a means to effectively reduce contamination or to diversify, farmers may have to be bought out and the

lands left unused or possibly reforested. Of course, this would mean hardship not only for those individuals directly involved but would alter the economy of the area significantly.

Without a firm grasp of potential future events, it is difficult to initiate policy discussions. As yet, neither the research required nor the necessary policy discussions have been undertaken. All those concerned with rangeland management should observe the ongoing process carefully for the insights it may provide in the event there are similar accidents in the future. As yet there are more questions than answers.

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Once Upon a Time...

James R. Brunner

In the mythical kingdom we'll call Sheldon, there once was a king that favored antelope. Genuine prong-horns really were the delight of his eye. So the king issued a decree that hence-forth the kingdom was to raise an abundance of antelope.

He conferred with his Chief Soothsayer and asked him how to go about it.

"Well," said the Chief Soothsayer, "the first thing we ought to do is get rid of those durn cows. Everybody knows that."

"Look into it," spake the king. "See how to do it."

So the Chief Soothsayer wandered about and thought for awhile and came back and told the king what he'd figured out.

"Over on the east side, in the Province of Dufferina, we have about a hundred head of antelope. There are only a couple of stockmen over there. If you wave your magic wand and smite the cows, surely food and water in abundance will grace the land."

"But our big antelope herd is over on the west, in the Province of Susanville," objected the king. "How many antelope do we have over there?"

"Oh, near five hundred head of the beauties," smiled the Chief Soothsayer. "But there are a bunch of ranchers over there and they say they'll go to war if you smite their cows."

"Hmmm," mused the king. "Well, let's do the Dufferina first then. Once the antelope herd gets up to two hundred head, we'll have a good reason to smite the cows over west. By the way, why should we rid the land of cows?"

"Competition," asserted the Chief Soothsayer soothingly. "Everybody knows the durn cows are eating all the spring forbs so the antelope can't get enough. That's why the herd hasn't increased the last few years. So once we rid the land of cows, the mama antelopes can get lots of forbs and give lots of milk and the babies will grow up swift and strong."

"Hot dog!" said the king. "Sounds perfect. Stand back, here we go!"

The king reared back and waved his magic wand smote every cow in the Province of Dufferina. SHAZAM!!

The following year the king summoned the Chief Soothsayer and inquired about the antelope.

"Oh, the west side bunch is doing very well," spake the Chief Soothsayer.

"And how are the east-side bunch doing?"

"Not so good," admitted the Chief Soothsayer ruefully. "Must be the durned drought. We raised very few fawns."

Two more years passed. The king summoned the Chief Soothsayer again.

"Hey," said the king. "Is this report right? We only got thirty mature antelope left in the whole Province of Dufferina?"

"Yep."

"How come?"

"Damfino," shrugged the Chief Soothsayer. "Must be the durned drought."

The king thought for a day, then put forth a proclamation asking all the Wise Men to assemble unto him and tell him howcome his east-side antelope herd had gone plumb to hell. And forty-'leven Wise Men gathered from far kingdoms like Yale and Minnesota, including the Kingdom of Washington. They conferred for three days and then reported to the king.