Forest Protection and Wild Life in New Zealand

[An address delivered before the Philosophical Institute of Canterbury by F. E. Hutchinson, B.Sc.F., on 6th Aug., 1930.]

Introduction.

The subject of wild life is one that has been arousing more and more attention each year for the past decade, culminating in the recent "deer conference" held in Christchurch last May to consider ways and means of dealing with the menace that seems to be developing from one of the wild animals now established in New Zealand. Foresters in New Zealand have taken an active part in this movement, and indeed may claim most of the responsibility for originating, fostering, and guiding the recent agitation to have the deer declared a public nuisance. Such an attitude in a profession which had its beginnings in the keeping of the royal deer, and in whose duties even to the present day in almost every country game protection plays no inconsiderable part, is by no means understood beyond New Zealand, while even here at home, forestry is so new and so little understood that no clear conception exists in the public mind as to where the profession really stands in regard to wild life in the forests, and to what reasons have led it to adopt its present attitude toward the deer.

It is intended in this address to set out first, the interrelation of the forest and its animal inhabitants, second to make clear the standpoint of the forester in regard to all wild life in his forests, and third, to treat specifically of the chief forms of wild life now inhabiting our forests, and their relation to forest management in New Zealand.

The Interrelation of Forest and Animal Life.

In considering the interrelation of the forest and its animal life only the quadrupeds will be considered in this address. The importance of birds as controllers of insect life is generally recognised if not truly appreciated, while the part played by the insects, lower animals, microfauna, etc., in the reduction of plant material, and maintenance of the soil fertility can be readily grasped. The effect of the higher animals on the forest is expressed in two ways. There is first the mechanical effect of the animals' presence—trampling, breaking, rubbing, etc. This applies to all animals, and the effect is of course directly proportional to the size or weight of the beast, and the intensity of infestation or number of the animals per acre. This first effect is usually a minor one, limited to local areas such as winter "yards," bedding grounds, etc., and becomes important enough for consideration only in aggravated cases of infestation. The second effect is the eating of plant tissue, an effect naturally confined to the herbivorous animals.

Between the herbivorous animals and the plants composing the forest type a continual tension exists. The animals break down and devour the herbage. The plants attempt to replace the lost members by putting out new leaves, shoots, flowers, etc. Further browsing will meet with the same response until the loss of material proving greater than the recuperative power of the plants, death, deformation or disease will result. The intensity of infestation, or numbers and distribution of the animals is therefore of greatest importance. Where the effect of a few animals is not felt, being within the recuperative power of the forest, many animals will cause serious loss.

The form of damage done will differ with the animal present. Some, as deer, feed upon browse of all kinds; others, as squirrels, devour the seeds; others again, as rabbits, do great damage to the young seedlings of many species, but are powerless to destroy the trees throughout the rest of their development because the foliage and thin barked portion is after a few years beyond reach. In all cases, however, the consideration of damage done must be directed from the comparative basis. Most trees form seeds in great profusion, much more than enough if all survived, to

reproduce the forest. The excess of seed produced over that needed under given conditions represents in this case their power of recuperation, or margin of insurance against such calamities as animal infestation. If squirrels are few, their effect on the seed crop is unnoticed. An intense infestation, however, might mean the loss of the whole seed crop. Similarly, a few sheep might do some good to the forest in thinning out areas of saplings so dense that all could not hope to survive. Many sheep, on the other hand, would mean that not a single sapling could survive to reach the stage of immunity from harm. Extinction of the forest would then be only a matter of time.

In any given case the ultimate result of an infestation of epidemic intensity of a plant-eating animal is always the same, resulting in a regular series of changes in the composition of the forest, setting up what foresters call a downward gradation. This cycle obtains in principle regardless of the form of attack—that is, whether it is the mature foliage, bark, flowers, fruit, seed, young plants, etc., which form the food of the animal, but the cycle is most clear cut and continuous in the case of the grazing and browsing animals such as the deer. Such a case will therefore be used as an illustration. Given an infestation of deer of epidemic intensity, that is to say, one in which the numbers of the animals are increasing and are held only by the amount of available food, the changes take place as follows:—From the normal high forest of tall trees, shorter trees, undergrowth and ground vegetation which represents the highest type of plant occupation of the soil, the type grades downwards successively into low forest, thicket growth, scrubland, grassland of perennial grasses and herbs, annual grasses and herbs, annual herbs, bare earth. Time is the essence of all these changes. With all reproduction being grazed off as fast as it originates the lifetime of the high forest is the lifetime of the mature trees. Their downfall enables shrubs and thickets to form, the species being those characterized by rapid height growth, so that less time elapses before they are out of reach of the animals. They are more fitted than the larger slower growing trees to survive under such conditions. Not fast enough, however, if the animal infestation is maintained. They take too long to reach seed-bearing age, and do not produce enough seed successfully to run the gauntlet. Grassland types must follow since they seed early, seed copiously, and spread vegetatively. Continued over-grazing will as every grassland farmer now knows, still continue to lower the standard of the plant occupation, the perennials giving way to the annuals, which seed even earlier, and even more copiously, and which become established more quickly. And if the over-grazing still continues, the final result, obviously, is the bare soil. The latter stages of the cycle are becoming well known to the pastoralist, who uses his ratios of perennials to annuals as one of his first guides to over- or under-grazing, building down or building up his pasture, while feeding off alone holds much of the wetter parts of New Zealand in a grassland type. Cessation of close and continuous grazing would result in the re-establishment of a scrub or thicket type, as a precursor to a new occupation by high forest.

This cycle is the logical course which would be run in any forest subjected to continuous over-grazing for a long period of time. Actually in wild nature few areas have ever been known to run the full cycle for a number of reasons, of which may be mentioned, selectivity of food, and mobility of the animals, and the fact that epidemic infestations of herbivorous animals are usually controlled from above by their carnivorous and other enemies. In isolated cases, however, several stages of the cycle may be gone through successively. Thus in New Zealand we have turned loose herbivorous animals in a country free from all large carnivores, free from bovine diseases, free from a deleterious climate, so that the rate of increase must be something approaching the potential maximum, and an epidemic is most certainly in progress. Furthermore, we have confined these animals more or less closely by areas of settlement to rather small and circumscribed mountain districts of low carrying capacity, so that serious and increasing over-grazing is in progress, and the downward cycle has already begun over large areas of mountainous country in the South Island. Beech high forest is giving way to various scrub formations, while many scrub formations as well as alpine herbfields have run very rapidly through the last stages, due to severity of climate and poorness of soil, and

are already bare slopes and running slips. Hemmed in as they are on circumscribed areas in a small island country, the deer, already showing signs of malnutrition, are unable to migrate on a large scale to new lands, so that, lacking natural enemies in the future as in the past, the expected result would be the more or less total destruction of the vegetation in the mountain regions, followed by a great loss in numbers of the deer due to starvation, and then a more or less stable condition where a scanty covering of low herbage supported a population of deer whose numbers were limited by chronic starvation to such that deaths and births were balanced, and the result stationary. In other words, the epidemic would have been extinguished, and henceforth endemic conditions would obtain. It is not to be supposed, however, that such a continuance of the cycle to its ultimate end will be permitted in New Zealand. No such radical change in plant and animal occupation could take place without markedly interfering with the economic organisation of Man, who may be depended upon to take any steps necessary to safeguard his interests. These steps would be such as to introduce a new limiting factor tending to hold the numbers of deer stationary, or extinguish the epidemic, at some point short of starvation, which would arrest the downward cycle of plant occupation at the point considered to be the lowest stage permissible for the ends of Man.

The Attitude of the Forester toward Wild Life.

The attitude of the forester toward the wild life inhabitants of his forest is directed from this standpoint:—In what way and to what extent do they affect the object of management of the forest?

In olden times the sole object of management of the forests was to provide a harbour for the deer, boar, or other animals which provided the Royal chase. The sole duties of the early foresters were those connected with the prevention of poaching, and the driving of the game to suit the convenience of the noble lords of the realm. The royal forests were not forests such as we know the term to-day, well stocked with trees, but extensive tracts containing much open country, much scrub and thicket growth, and little valuable timber. The welfare of the forest, aside from the provision of covert, was not considered, so that the open glades and parks were to the ancient forester not the eyesore of unproductive land that they would be to the forester of to-day. At the same time, hunting, poaching, wolves, and hard winters took sufficient toll of the deer to keep their numbers about stationary, and at a level such that while the forest might not improve its ecological condition, it at least did not greatly deteriorate.

The modern forester, however, expects of his forest something of much greater and more general economic value to the community than merely harbouring animals to furnish sport for a leisured and wealthy caste. The objects of the modern forest may be stated thus:—The private owner demands of his forest, first and foremost, that it yield him a financial profit; and secondly, that it cater to his æsthetic tastes, and to his desire to enjoy the hunt. The State, as a forest owner, demands that the forests should first provide the community with all its needs of wood and other commodities, conserve to the utmost any beneficial effects as moderation of climate, prevent insofar as possible calamities such as erosion and floods; and then, if possible, provide recreational facilities for the inhabitants, and increase their happiness and augment the food supply through the enjoyment of the chase. It demands mandatorily, however, that, allowing for the fact that some of the community values mentioned are rather difficult to express tangibly in £ s. d., the forests shall be so managed as to return as great a financial profit as possible.

The difference between the old viewpoint and the modern one is the introduction of the economic aspect, what profiteth it? In the good old days, "the game was the thing." To-day, it is a question of dividends. And as the greatest community values of the forest are those wrapped up in the production of wood materials, while the provision of animal food is far more cheaply done by the farmer, and the revenue derived from hunting licenses is small, because such a small part of the community has the time, money, or inclination, the modern forester therefore has as his object of management the production of the greatest quantity of the highest quality of wood crops that his soil and climate are capable of producing, this aim to be achieved at the lowest

possible cost per acre. Where the aim is thus fixed upon the maximum production of wood tissue, grazing animals may cause loss to the forest's balance sheet, either by a lowering of the quantity or quality produced, or by introducing an added factor in the cost of production—that of controlling the pest. In such case, if the revenue derived from the sale of hunting licenses, or the community values achieved through the channels of sport do not equal or exceed the added cost of production, or the lowered revenues from the timber, then efficient forest management cannot countenance the presence of the animal. If. however, no financial loss is being caused the forest, then the animals might as well be there as not, and if any additional revenue can be derived through their presence, as by the sale of licenses, or through increased community use of the forest for sport, or health-giving recreation, then the animals might well be aided and encouraged, up to that point where their numbers become great enough to have a marked effect on the development of the forest. This is the basis which has obtained for many years in Germany, where, although the wood crops are the main object of forestry, the hunting fees form a steady and rather lucrative sideline. In all cases, however, the development of the forest crop is the prime consideration, and present gain from hunting fees by letting the animals multiply unduly is never allowed to come before the ultimate welfare of the plant community. In considering the welfare of the plant community, however, it is the financial portion of the silvical unit which is considered. The revenue is derived from the timber-producing trees, so that what may happen to the non-merchantable species is of little moment, unless those non-merchantable species are silvically indispensable to the development of the commercial species. Thus if pine seedlings are unpalatable to deer, and the deer feed upon herbaceous ground cover found in pine forests but not necessary for the development of pine stands, then deer could well be tolerated to the extent where shortage of herbaceous material forced them to eat the young pines. If, however, the herbaceous material was necessary to shelter or nurse the seedlings of the commercial species, then its destruction by deer could not be tolerated, as it would react upon the development of the important members of the type. In our rimu forests we have two distinct forms of vegetation, an upper tier of valuable conifers, together with under tiers of worthless herbaceous dicotyledons, palatable in the main to all classes of grazing animals. Whether the eating down of such growth as by deer is harmful, helpful, or of no significance cannot yet be stated, as we do not yet know the silvical relation of the rimu to its broadleafed associates.

The case of the commercial forest, managed solely for the production of dividends, has thus been stated. The forester's attitude toward the kind and number of animals present is governed by his forest balance sheet.

In the case of many forests in mountainous regions, however, there is an additional value, beyond that of merely supplying the markets with wood goods, to be considered. This is the protection value of the forest. That is to say, the value which the community derives simply from the maintained existence of the forest in a given spot, due to its efficacy as a controlling agent of run-off and erosion. This protection value, where the headwaters of large streams are considered, may be so great as to entirely overshadow any utilization value of the forest, and may be so important as to lead to special restrictions on utilization due to the danger of seriously lowering the protection value through opening the forest. This protection value of the forest is a definite and tangible value, albeit one difficult to derive, namely, the difference in value of the land affected with, and without the presence of the forest. That is, the value of all the land in the lower valley protected from flood, or subject to flood; irrigable or non-irrigable so far as water in the dry season is concerned; having water for power supply or domestic use at a regular and continuous flow, or at an erratic and intermittent flow; non-polluted or polluted, etc. Economic forest management would naturally strive to accomplish the greatest controlling effect with the smallest area of forest, or the lowest administrative costs possible. Where other returns such as direct revenue from sale of timber or of hunting privileges can be got without lowering the protective functions, so much the better, but frequently that is found not to be the case. The protective value is intimately wrapped up in the density and completeness of the forest cover, and where large areas of farmlands, etc., in the lower valleys are involved, the

protective value may be by far the greatest value of the forest, necessitating the complete subordination of all other forms of use. The protection value is much more easily affected by grazing animals than is the utilization value. It is not a question of a few valuable trees growing associated with others of no value. Every species is of value, and the greater the density of plant occupation, and the greater the range of height tiers, the more effectively the unit will conserve moisture. Tall trees are needed to make a deep band of air of high humidity, checking evaporation, and slow to respond to temperature changes, holding the snowfall. A dense under cover keeps out drying winds, and increases the non-conductivity of the area. A dense ground cover prevents evaporation close to the soil, while a deep layer of moss, humus, etc., has a large storage capacity. This surface sponge breaks up surface run-off, while the large root systems of the tall trees hold the top soil firm. No plant is unnecessary in such a combination, while any opening up of the stand by browsing of undergrowth, ground cover, surface mosses, etc., lowers the humidity and increases evaporation, while the packing of the soil destroys its absorbent qualities, leading to surface run-off, followed by gullying, slips and sheet-erosion.

It is this aspect of the effect of the wild animals that is causing the greatest concern to foresters in New Zealand at present. Our country is mountainous, our rainfall heavy, our geological formations frequently unstable. Originally our forest coverings were good. Through lack of vision, we allowed them to be destroyed largely by fire, speaking particularly of Canterbury. As a result, we have heavy chronic flood losses, despite a heavy burden of river protective rates. Now, at a time when we should be building up our remaining forests and steadily extending their area, we find that deer and kindred animals are destroying the remnants of bush still remaining, rendering it quite impossible to extend their area at any reasonable cost, and utterly devastating the alpine herb fields which function as a protective covering above the forest line. The values involved are not the utilization values of a few scanty areas of non-commercial timber located in inaccessible regions, but the values of all the lower lands subjected to flooding, the loss caused by the floods, the rates paid annually for river protective works that may palliate but do not cure, the interference with hydro electric or water supply schemes, and so on—factors which no one yet has attempted definitely to assess, as for the Waimakariri, for example, but which are quite definite and tangible in their action. With these factors of lowered values on one side, and the revenue to be derived from hunting licenses on the other, the forest balance sheet indicates very clearly whether the presence of the animals is or is not good forest management. Unless the numbers of animals can be kept at a very low figure, the loss is usually many times greater than the gain.

Recreational features of the forest are admittedly a community value, and might well be mentioned here. The value of animals in the forest from this standpoint might, in a public forest, be taken to offset a small loss in revenue due to damage to the timber, or cost of controlling their numbers. Such a value is difficult to assess. The difference in appeal between the native bush, free from animals, or peopled with exotic beasts, is probably slight to most New Zealanders, while health-giving exercise and sport may be secured in the forests without the taking of the lives of dumb brutes.

The viewpoint of the forester may then be summarized in the following way:—That animal life is considered in its relation to the aims of management, as expressed in their effect on the forest balance sheet. The forest is a producing unit, just as is a farm, and must give returns commensurate with its investment. These returns may be direct, through sale of produce, or indirect, through protection values, but are nevertheless tangible and definite. If animals in the forest seriously interfere with the attainment of these aims they must be controlled or removed. If they do not interfere with these aims they may be tolerated, while if they promise a source of revenue, as from hunting fees, sale of furs or skins, etc., and still cause no interference with the chief aim of the forest, then they are to be established, encouraged, and protected, up to the point where their numbers begin to affect the welfare of the plant community.

It should be clearly understood that a forest, whether owned by the State or by a

private individual, is an area managed productively to the good of man. It is not a national park, nor a national monument, nor an outdoor museum, nor a scenic reserve. The forester makes no attempt to maintain a status quo obtaining at any particular time. He attempts so to direct the dynamic forces of growth as to satisfy to the greatest possible extent at the lowest cost, the community needs from the forest lands. If animals help him in this, he will use them; if not, he will try to exclude them, or failing that, to control their numbers so that their harm is slight.

To give a concrete example, the forester is not concerned with the probable extermination by deer of a rare Celmisia, for instance. If the plant is rare, it is of no significance in forestry, for it cannot be a vital factor in holding the vegetative cover on the alpine slopes. But if the deer take to eating all the commonest plants and shrubs, as they are doing, the forester is at once concerned, since the more common a species the greater its controlling agency.

The Wild Animal Life of New Zealand and Its Relation to Forestry.

The wild animal life now present in New Zealand presents an unusual feature in that it is all of very recent origin, and was almost all deliberately made feral. The only quadrupeds in New Zealand at time of European settlement were a dog and a rat, both themselves imported by the Maoris only a few hundred years previously. Both are now extinct, or almost so, and our wild animal life is all of post-European origin. A few of our animals have gone wild by accident or undesigned circumstance, such as the wild goat, pig, cattle, and cat. Most, however, were deliberately set loose to live, by design, a feral life, thus temporarily reversing the evolutionary rule whereby when Man enters a new country he domesticates the useful species and eradicates the useless, so that wild animals tend to disappear. These wild animals were turned loose mainly upon the unoccupied Crown lands of the country to seek their own subsistence, it being thought, seemingly, that land unoccupied for agricultural or pastoral purposes was waste land, and might well support animal life, rather than lie absolutely idle. The unoccupied lands, however, are mainly the forest lands and the potential forest lands of the Dominion. Since 1921 New Zealand has begun a large scale development of forestry as a primary industry to work complementarily with agriculture in a fuller use of the surface of the soil. The forester has commenced his work very recently and comes into control of lands now containing various forms of animal life placed there without reference to the good of the forest, and under a system of control established by long custom, in which the forester, as such, has little voice. The control of the wild animal life of the Dominion has no place in this address, but is obviously a point of some magnitude in forest administration, as practically every wild animal now present in this country is already having some appreciable effect, direct or indirect, upon forest management.

The wild animals of importance to the forester may be divided into four groups, inasmuch as their effect is felt in four different ways.

1. The grazing and browsing animals—deer (all kinds), elk, moose, chamois, thar, goats, and cattle.
2. The herbivorous rodents—rabbits and hares, and the wild pig.
3. The carnivores—cats, rats, stoats, and weasels.
4. The fur-bearer—the opossum.

1. The grazing and browsing animals furnish the most pressing problem at the present time. This group includes a number of species that are hardy, vigorous, polyandrous, fecund, and by no means lacking in intelligence. They represent types which have been persistently hunted by man, and by carnivorous animals over many centuries, and yet which have maintained themselves in lands of scanty cover and a rigorous climate. Here, free from any enemies, and protected from indiscriminate shooting (in regard to all but the wild goat and cattle), they are multiplying fast. Owing to their size, activity, and catholic tastes in food, they are working marked havoc in nearly every mountain region of the South Island. The deer in the forests and lower slopes and the chamois and thar on the high alpine herbfields have already caused serious

damage to the plant cover of the mountain watersheds. Much of this damage is being done on areas admittedly of little present economic value, such as the region west of Nelson and north of the Buller.

Damage is also being done, however, on areas of much greater value, as the basin of the Waimakariri, a river whose control costs half the inhabitants of the province a heavy annual levy, and the Rakaia, part of whose watershed feeds the Lake Coleridge hydro-electric plant. Serious damage to cropland and pasture land is also occurring in South Canterbury and Otago, where the deer harbouring in the forest or scrub-covered hills, having thinned out the available food of greatest palatability, descend on the farmlands by night, returning to a safe refuge in the forests by day.

In consideration of the sport furnished, these animals have in the past largely been protected, and as man is their only enemy, they have multiplied enormously. It may be definitely assumed that the number shot each year is considerably less than the annual increase, while the proportion of the population of New Zealand that find recreation in the shooting of deer is extremely small, and seems to be steadily decreasing. In view of these facts, the legal protection on the deer has been largely removed, but that in itself is of little help. The situation now is that the protection forests, which least of all can stand animal presence without loss of value, are overrun with a pest whose numbers are steadily increasing. Degradation of the forest is occurring in many places, while any perpetuation of the forests or extension of their area is impossible while the numbers of the deer are as great as they are at present. What is wanted is first of all some scheme for effecting at reasonable cost a drastic reduction in numbers of the pest, followed by a means of keeping the numbers stable at a low level after that. The animals are so well established in inaccessible country that complete extermination seems impossible. A reduction to at least one-fifth of the present number seems essential if forestry is to be a paying industry on the low-valued lands of New Zealand or of the South Island particularly. Some means of accomplishing that reduction, and then seeing to it that thereafter destruction keeps pace with natural increase, is now being sought. The chief obstacle is the roughness of the country, which makes it difficult to clean and which renders all travel and transport costly, so that maintenance of shooting parties is high, while any value that the hides or meat might have is lost several times over in getting them to market.

Regarding methods of attack, poisoning has been frequently mentioned, its success in the case of rabbits being cited as a parallel. The cases are not parallel, however. There is first the necessity of getting the poison laid in the inaccessible back country, then the necessity of preventing sheep or cattle from reaching it, and finally the necessity of getting the deer to eat it, and to continue eating it until all are dead. This last point will prove difficult. With an animal as wary as the deer, a few deaths from any new food laid will very quickly teach the herds to leave it alone.

Inoculation with some virulent disease has been seriously suggested. With animals so close akin to cattle and sheep it is obviously unthinkable.

The systematic shooting of the beasts by groups of skilled full-time hunters operating continuously in the back country seems to be the only feasible scheme. Dogs could be used with great success over much of the eastern portion of the South Island, if the objections of the sheep farmers could be overcome. For the rougher forest-clad areas, even this aid to large scale operations would be impossible. Such a campaign would be a costly matter. It would mean keeping a small army of men equipped and supplied in out of the way camps for a couple of years, systematically beating the accessible portions of the South Island from end to end. No estimate of the cost has been prepared, but it would be surprisingly large—so large that the country would refuse to face it. It would seem that it would be cheaper to face it and have done with it now, however, than to continue the present system of partial protection in some areas, while at the same time the Government is paying culling expenses of Acclimatisation Societies in others, and in others again paying a bonus on tails. Sporadic shooting, whether by farmers or sportsmen, will never clean up the deer, but merely shift them temporarily from place to place.

If forestry is to become an important industry in N.Z., and if the protection values of our mountain forests are to be developed to improve the condition of the valuable river-flat lands endangered by floods, and to hold the mountain slopes against erosion, then some systematic and thorough-going campaign against the deer is essential.

That will not be done until the people of New Zealand are more thoroughly appreciative of the community values represented by these mountain forests, and of the menace to their utility represented by the grazing animals than is now the case.

2. The herbivorous rodents, hares and rabbits, and the wild pig are classed together in that they are of interest to the forester, not so much for the damage they do to the forest, but rather for the damage done the surrounding agricultural areas. Hares and rabbits are rarely found in the damp or cold native forests, but are a serious matter in all the forests of exotic species being formed so largely at the present time in the dry eastern portions of the country. They are a definite menace to all the young plantations, and poisoning, trapping and fencing are routine operations in every forestry project, prior to planting the area. The cost of establishment has thus been definitely raised, for though rabbit skins and carcasses are articles of definite value in New Zealand, the rabbiting on these areas must be carried to a point well below that represented by a profitable stocking. The rabbiters must be paid to operate on the area usually, rather than pay for the privilege of trapping, while erection and maintenance of fences is direct outlay without even a partial return. At the same time, once the initial years of the plantation are successfully passed, three to four years in Canterbury, then thereafter the stand is safe from further injury. The rabbits will continue to harbour in it, however, comparatively safe from hawks, owls, dogs, etc., while they will obtain their food from the adjacent croplands. Although no longer needed to protect the forest, rabbiting must continue to be a routine activity of the forester, simply for the protection of his neighbours. If he fails to clean up his rabbits he will stand convicted of harbouring a public nuisance, and measures may be taken to enforce control of the pest.

This burden does not rest heavily upon the forest anywhere in New Zealand, however, nor is it likely to do so. The animals are easily trapped or poisoned, and can be brought under fairly complete control without great difficulty, while the return from the skins goes a considerable distance toward lightening the financial load.

The wild pig is a serious problem only to parts of the North Island, particularly Taranaki, where its depredations at lambing time cause heavy losses to the farmers. The pig does no harm to the forest, may even do a little good in turning over the soil and eating grubs. It is a real menace to the pastoralists nevertheless. It takes shelter in fernland, second-growth, dense scrub and thickets, and small patches of bush left in land clearing, whence it sallies out at dawn to prey upon the fields. Consequently, it must be destroyed, and if the forester permits it to harbour in his forest, merely because it is doing him no harm, public opinion will speedily bring pressure to bear, to have the nuisance alleviated. The State Forest Service in New Zealand has recognized its responsibility in the organization of shooting parties in the Taranaki forests, and in the payment of snout bonuses. The wild pig is not an inhabitant of the true forest, however, hanging about the forest fringes and remnants, close to the open country. It is not adapted to rugged country, and is comparatively easily hunted. With the solution of our deteriorated lands problem, and a definite passing either into intensive agriculture or intensive forestry of lands now unoccupied or undeveloped, the extermination of the wild pig should be easily accomplished.

3. The carnivores are of indirect effect on the forest, taking form chiefly in their reaction upon the bird life of the forests. Birds are of value primarily as controllers of insect pests, and also in the pollinating of the flowers of some species, and in the distribution of seeds. Any factor which tends to diminish the bird life may therefore be detrimental to the forest. We have in New Zealand seen a great diminution of the native insectivorous birds, due to many reasons, of which the greatest probably is the introduction of small carnivores. The black rat, a stowaway which came unasked in the earliest ships to visit

New Zealand, is blamed as the chief offender against the bird life. The wild cat is no doubt also a deleterious agent. Where truly feral, this is also an undesigned inhabitant of the forest, though it may be safely assumed that more birds are killed each year in the Dominion by household pets and farmyard cats than by truly wild and entirely self-supporting felines. Various parts of the world have proscribed cats for this reason, but such action has not yet been seriously suggested in New Zealand. The truly wild bush cat is naturally of greatest importance to the forester, but its habits, plenitude, and actual effect upon the forest birds have not been investigated. It is not recognized in law, and to date no active measures have been taken against it.

Stoats and weasels were a reasoned and deliberate introduction, the intent being to cope with the rabbit pest through introduction of a natural enemy. They failed to bring the rabbits under control, but are now widely if rather sparsely established over the whole country, including open land, scrub, and even dense bush. Little is known as to their numbers in the forest proper, nor is exact knowledge to hand regarding their habits in detail, but all field observers agree that they are having a very serious effect on the ground birds, and also, many claim, on the arboreal birds as well. Because of their value as destroyers of rabbits, these animals are protected by law, but as their efficacy is doubtful, as rabbits can be better controlled by other means, and as they are undoubtedly an injurious agent so far as bird life is concerned, foresters, native bird protection interests and Acclimatization Societies are uniting in asking for the removal of the protection. This in itself will not accomplish their destruction, as they provide neither sport, skin nor meat, while they are rather difficult to trap or to shoot. Active measures of some sort may prove necessary, though of what nature has not yet been examined.

4. The opossum comes in a group by itself. This animal was imported and set loose in the forests on the premise that it could do no harm to any economic interest, and would furnish a valuable pelt, thus increasing the productivity of the forest lands. The second part of the premise has been amply borne out. The opossum skin industry is now a definite unit in our economic life, and our annual wealth has been appreciably augmented through this new activity. The first part of the premise, that the animal can do no harm to any economic interest, has not yet been settled. In fact, it has been stated by many interested observers that this animal is a definite menace to the wellbeing of our forests, firstly directly, by destruction of plant matter, and second, indirectly through attack on the birds.

Regarding the first point, they undoubtedly show unmistakable signs of activity in the undergrowth of the native forests, while considerable damage has been done locally in some cases to young exotic conifer plantations. It has yet to be proved that their activity in the native bush does any real harm from the forester's viewpoint—that is, lowers the productive value of the forest. The valuable components of the native forests are the podocarps and the beeches. Whether any of these are seriously attacked at any stage is at present not known, but observation to date has not recorded it. It is probable that the opossum relishes the berry-like seeds of most of the podocarps, but what effect it has upon the seed crop, or number of seedlings successfully established is at present quite unknown. The animal certainly damages the broadleafed trees of the understory, when numerous, but it is very possible that this has no detrimental effect on the development of the podocarps. The question cannot be answered until the silvical relationship of the podocarps to their broadleafed associates has been worked out.

On the second point, proponents of the opossum claim that he is entirely vegetarian, and defy others to establish the fact that he eats birds or any animal matter. It is even stated that his teeth are such that he cannot eat animal food. This second statement is obviously not true, since there are a number of well established cases of captive opossums eating various forms of animal food, while there is at least one seemingly authenticated case of a tame opossum robbing a fowl run and eating the eggs. It has been by no means established, however, that such action is general for wild opossums with unrestricted diet. A depraved individual taste, or an unbalanced diet in captivity may easily account for the facts recorded above, and they cannot

be accepted as proof that the opossum is really a menace to the bird life of the forests. Investigations have been made by a number of scientific workers with results indefinite so far, through lack of suitable means for carrying out the study. Should it turn out to be true, however, that the opossum is combining with the stoats, weasels and rats to deplete our avifauna, then the value of the skins would need to be weighed against the lowered value of the forest due to increased insect losses and poorer seed distribution, and a decision made as to which was of greater value to the forest, the animal or the birds.

Should control measures be necessary against this animal, it should not prove difficult or costly to put them into effect. Due to its natural curiosity, the animal is most easy to trap and also to poison, while the high unit value of the skins offers an incentive to the trapping even of sparsely populated areas. So long as the pelts are in good demand, any control measures should prove financially profitable, while even should the fur market collapse, and it become necessary to destroy the animals merely for forest protection, the problem may be considered comparatively simple and inexpensive.

Conclusion.

As a conclusion, the essence of this address may be presented in the following form: —The forester is attempting to increase the production of economic values in New Zealand by developing the latent productivity of lands not well suited to agriculture. The greatest community values of the forest lie first in the production of wood crops, and second in the protection value of the forest, such as control of waterflow and prevention of erosion, while the rather intangible but also important recreation and æsthetic values may be successfully combined with either or both of the first two values. Where the production of wood crops or maintenance of protection values is the aim of management, herbivorous animals in any quantity may seriously interfere with the attainment of these objects, and lacking natural control, some form of human control over the numbers of the beasts becomes essential. Here in New Zealand a number of herbivorous animals have been turned loose on the unoccupied lands and are now firmly established and increasing greatly. Since the time of liberation of these animals, the country has decided to use its unoccupied lands for forest production, having in mind both timber production and watershed protection on a large scale. The forester in attempting to organize this work is finding that serious damage is already in evidence and is increasing, as the number of animals steadily mounts. The protection values especially are being lowered, and some widespread and co-ordinated method of effecting a drastic reduction in the numbers of these animals is essential to the future development of forestry in this country. This is the greatest problem of forest protection now awaiting solution in this country. Besides this large problem presented by the grazing animals, the forester is interested in the other forest inhabitants principally in their relation to the birds, a relationship of which little is definitely known.