DEER IRRUPTIONS

Compiled by Aldo Leopold for the Natural Resources Committee, Wisconsin Academy of Sciences, Arts and Letters. (Aldo Leopold, Ernest F. Bean, Norman C. Fassett)

Foreword

It is my belief that the Wisconsin Academy, particularly through the members in the various educational institutions throughout the State, should provide scientific data that can be used as a basis for formulating public policy on the conservation and utilization of our local natural resources. With the approval of the Council, a standing committee on natural resources has been appointed to this end. The present paper is the first of a series of reports bearing on the State's conservation problems—A. W. Schorger, President.

From the fifteenth century until 1910, the deer problem of North America was a matter of too few, rather than of too many.

About 1910 the Kaibab deer herd in Arizona, long stabilized at a level of about 4000 head, began to pyramid its numbers. By 1918 the range showed overbrowsing (21, p. 237). Between 1918 and 1924, seven successive investigators warned of impending disaster, but nothing was done (16, pp. 11-13).

In 1924, at a probable level of 100,000 head, came the first of two catastrophic famines which reduced the herd 60 per cent in two winters. By 1939 the herd had dropped to a tenth of its peak size, and the range had lost much of its pre-irruption carrying capacity.

This was the first of a series of irruptions which have since threatened the future productivity of deer ranges from Oregon to North Carolina (22), California to Pennsylvania (8), Texas (23) to Michigan (1). Wisconsin is one of the more recent irruptive states.

This paper aims to present a background for the present Wisconsin problem.

Histories

Diagrammatic histories of four irruptive deer herds appear in Figures 1 and 2. Each of these herds is a self-contained population, either by reason of geographic extent or by reason of natural or artificial barriers.

(A) George Reserve. This enclosed range, owned and operated by the University of Michigan, was stocked with four does

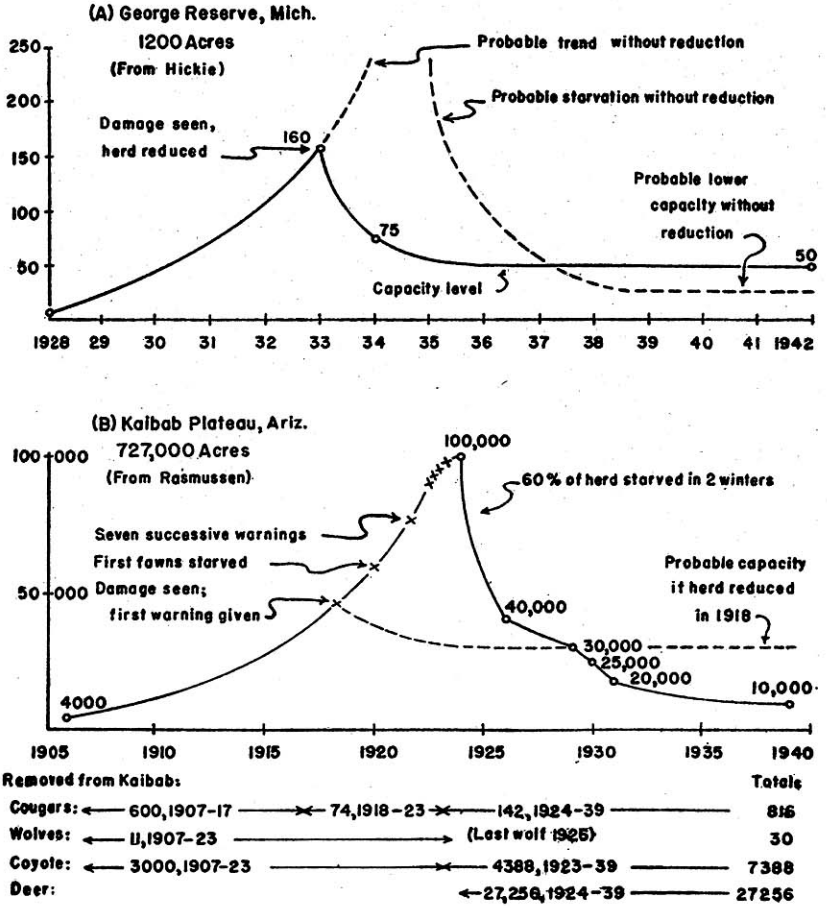

FIGURE 1. Effect of prompt vs. delayed removals on carrying capacity for deer. Herd A was promptly reduced, and now stands at a higher level than would prevail if starvation had been permitted. Herd B was allowed to starve, and now stands at a lower level than would prevail if prompt reduction had been made.

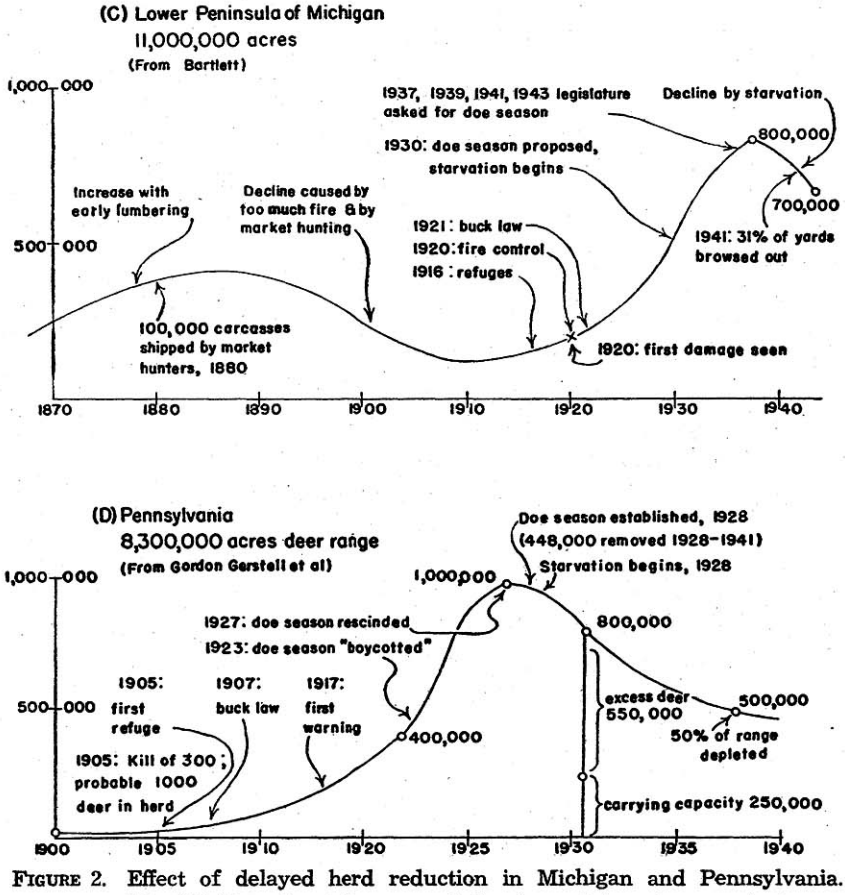

FIGURE 2. Effect of delayed herd reduction in Michigan and Pennsylvania. The Michigan herd has passed the fawn-dying stage, and starvation of adults is now started. The Pennsylvania herd was reduced, but not until eight years after the first warning. Probably as a result of this delay, both the herd and the range are on the downgrade.

and two bucks in 1928. In 1933 overbrowsing became visible. A census showed 160 deer present. This is the maximum possible increase from four does in six years. (12) There is no doubt, therefore, that this herd had actually started to irrupt.

The herd was immediately shot down to 75 head, and later to 50 head, and is now being held at the 50 level by annual removals. The evidence of overbrowsing has disappeared. The reduced herd is in equilibrium with its range. This is one of the

few known cases in which an incipient irruption was checked by prompt and decisive management measures.

(B) Kaibab Plateau. Unlike the George Reserve irruption, which was terminated by removing deer, the Kaibab irruption terminated itself by starvation. Some deer were in fact removed, but only after starvation had begun. The period of six years between the first warning (1918) and the final catastrophe (1924) was consumed in debate and litigation (16, p. 11).

The effect of prolonged overstocking on the winter food plants was very severe. In 1931, after four-fifths of the herd had starved and only 20,000 deer were left, one investigator says "the range had been so severely damaged that 20,000 was an excessive population. The herd continued to decrease slowly until an estimated 10,000 were present in 1939" (21, p. 237).

Another investigator estimates the loss in carrying capacity as high as 90 per cent in some areas (3, p. 369).

In short, the Kaibab, by reason of the irruption, lost a large part of its deer food without any gain in deer.

The dashed line in Graph B, Figure 1, indicates the probable trend of carrying capacity, had the herd been reduced in 1918, when range damage was first recognized. This hypothetical line corresponds to the actual history of the George Reserve herd, which was reduced after the first appearance of range damage.

(C) Michigan. Both the Upper and Lower Peninsulas have experienced two peaks in their deer herds, the first occurring soon after the first large-scale logging operations, and the second at the present time. The Upper Peninsula herd has lagged somewhat behind the lower in its time-schedule, due no doubt to the later loggings. The combined population in 1938 was estimated at 1,172,000 deer (1, p. 58).

Graph C, Figure 2, shows the history of the Lower Peninsula herd (1).

The size of the herd during the 1880-1890 peak is unknown, but no starvation and no range damage are on record, hence the peak cannot be regarded as of irruptive proportions. The increase in deer up to 1880 was probably caused by the opening up of the woods and the widespread reproduction of white cedar and other valuable browse plants (1, p. 10). The decline after 1880 was probably due to too much fire, and to commercial hunt-

ing and hunting for lumber camps. "More than 100,000 deer (were) shipped from northern Michigan stations during the fall of 1880 by market hunters" (1, p. 12).

The lower peninsula herd "hit bottom" about 1910. By 1925 the present peak was in the making (1, p. 14). Its inception coincides with the inauguration of a buck law (1921), an effective system of fire control (1920), a refuge system (1916-1932), better law enforcement, and wolf-control.

There is no reason to doubt that these changes, collectively, are the cause of the present irruptive behavior of the Michigan herd.

Range damage was first reported in 1920 (1, p. 47). The "cutting out" of many logging operations brought widespread starvation by 1930 (1, p. 48). In 1938 a survey of 300 winter yards showed "40 per cent in good condition, 27 per cent medium, and 33 per cent completely browsed out" (1, p. 49). The 1941 status was about the same.

The remedy, according to the Michigan Department, is to "take a limited number of antlerless deer in addition to the bucks" (1, p. 64). This was first proposed to the legislature in 1930, again in 1937, 1939, 1941, and 1943, but it remains a proposal.

Except for a few differences in dates and numbers, the upper peninsula herd presents a parallel history.

At the present writing the Michigan herd is shrinking by starvation, and with it shrink the good foods. It is an open question whether prompt reduction of the herd a decade ago would not have left Michigan with more food and just as many deer as she has today.

(D) Pennsylvania. The Pennsylvania deer herd dwindled steadily from Revolutionary times until about 1905, when it was nearing extermination. In that year the first refuge was established (20, p. 12). In 1907 a buck law was passed. By 1922, 30 refuges were in operation (20, p. 15), and the annual kill of deer had increased in fifteen years from 200 to 6115 (20, p. 12). The herd in 1922 stood at about 400,000, and was increasing rapidly.

Joseph Kalbfus predicted as early as 1917 that the deer herd would some day get out of hand. He recommended a doe season

every fifth year, but his advice went unheeded. In 1923 the Commission opened a limited local doe season, but sportsmen killed it by "boycott." Their slogan was "Don't be yellow and kill a doe" (11, p. 16).

Local doe seasons were tried out in 1925 and 1926 (27, p. 8). In 1927, by which time the herd stood at 1,000,000, a statewide doe season was proclaimed by the Commission, but the sportsmen "marched on Harrisburg" and forced a rescinding order (11, p. 16). In 1928 an antlerless deer season was finally put into effect. That this action was too long delayed is indicated by the wholesale starvation of fawns during the two ensuing winters (27, p. 29).

In 1931, the Pennsylvania herd was estimated at 800,000, and the carrying capacity of the range at 250,000 (4, p. 33). In other words, even after the Pennsylvania herd had been reduced 20 per cent, the range was still 220 per cent overstocked.

Between 1931 and 1941 five antlerless deer seasons disposed of 448,000 does and fawns (2, p. 7), but large-scale starvation, including adult deer, was still prevalent in 1938, when the herd had shrunk to 500,000 (8, p. 13). "Runting" by malnutrition was still widely prevalent (9). Equilibrium between the shrinking herd and its food plants was finally reached in 1940 (2, p. 6).

Deer damage to crops in Pennsylvania has been prevalent since 1915, and to forests and plantations since 1922 (4, p. 6). In 1938 "excess deer (had) in many sections resulted in the complete overthrow of natural forest regeneration, and made forest planting practically impossible" (9, p. 27). "Due to scarcity of food in the forests, wild deer were encroaching in hordes upon neighboring farms. Fencing one farm merely crowded the animals onto the neighbors' farms" (11, p. 17). A special survey made in 1938 showed that half the deer range was producing less than fifty pounds of food per acre, which was virtual depletion (10, p. 6).

The Pennsylvania herd now stands at about 500,000 or half the 1927 peak level. The reduction is the combined result of doe-removal, starvation, and range deterioration.

It is an open question whether the Pennsylvania history is not an example of "too little and too late." A splendid initial

success in management of deer has been partially cancelled out by delayed public acquiescence in herd-reduction.

Common Characters

These histories exhibit certain common characters of deer herds, of deer food plants, and of human attitudes toward deer, which seem worth recording as background for the Wisconsin problem.

They also exhibit a common sequence of stages which may help to interpret current events, to anticipate research needs, and to guide administrative policy.

Winter Food. Deer irruptions are a problem in winter food. The summer range usually exceeds the winter range in carrying capacity.

Except in agricultural regions where deer have access to corn, alfalfa, or winter grains, deer subsist in winter mainly on twigs, buds, and catkins of woody plants, i.e., "browse." The browse species differ in palatability. Many investigators have shown that palatable browse is nutritious browse, while unpalatable browse cannot sustain deer in winter (1, p. 39; 17, p. 20; 7, p. 21).

As a herd increases, the pressure on palatable browse plants weakens them and ultimately kills them. It also prevents their reproduction, or the emergence of their reproduction above snow-level. Artificial plantings to reestablish browse are eaten up before they have a chance to grow (2, p. 6).

The unpalatable species are thus given a competitive advantage over palatable ones, and replace them. Thus in overbrowsed Wisconsin winter deer yards white cedar, striped maple, red maple, red dogwood, and ground hemlock, all palatable, are being replaced by alder, aspen, and white birch, all unpalatable. This process of replacement of palatable by nonpalatable winter food is shown in Figure 3. Replacement has been verified repeatedly in artificially "browsed" experimental quadrats.

Trees above the reach of deer are browsed up to the level which a mature deer can reach standing upright on its hind legs (six to eight feet). The species of trees which show such a "deer-line" are a sensitive index to the degree of deer-pressure

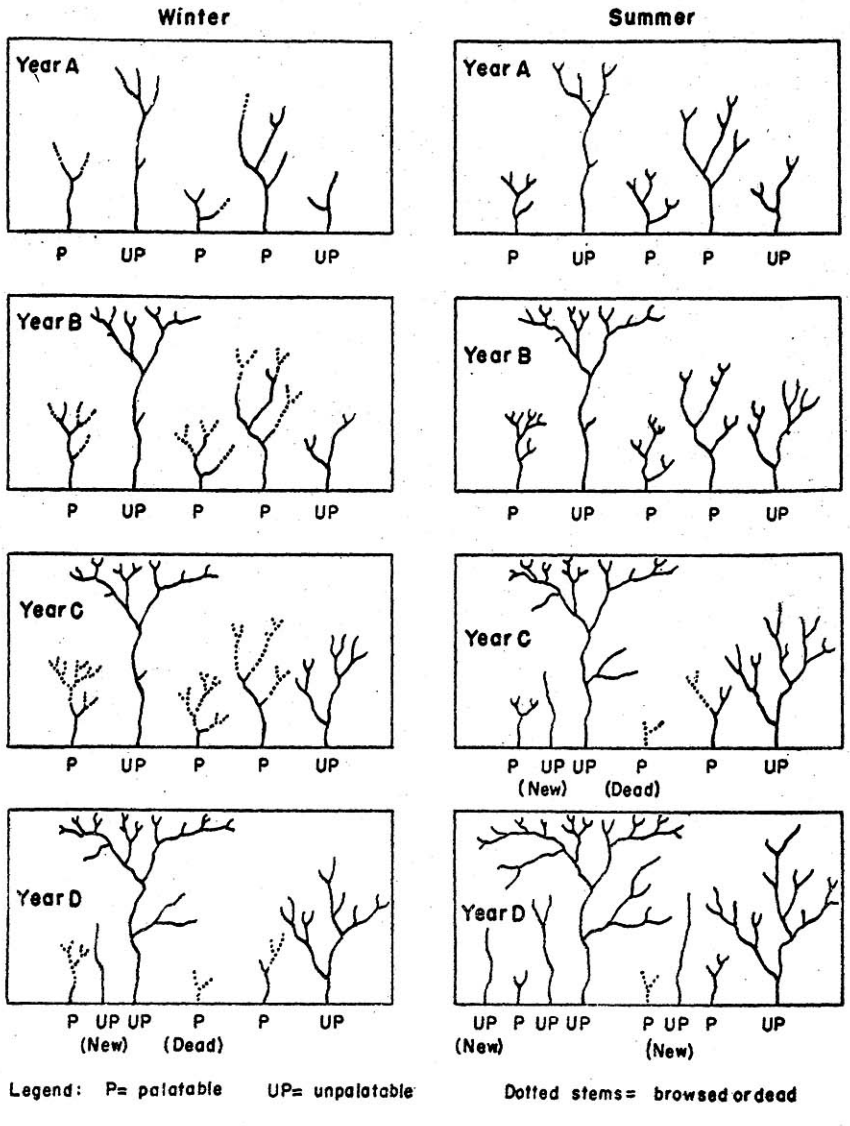

FIGURE 3. Effect of winter overbrowsing on composition of woody vegetation. The palatable species are gradually killed and replaced by unpalatable species. This process of replacement accounts for the low carrying capacity of overbrowsed ranges.

and its duration. A new deer-line on cedar and none on balsam shows an early stage of overbrowsing. A new deer-line on balsam plus an older one on white cedar shows an advanced stage. Fawns commonly starve at the stage when balsam or other poor foods first show a deer-line.

In other states these same principles hold, but for different plants. Thus on the Kaibab, deer pressure was first visible on cliffrose. As this good food became scarce, juniper and finally piñon pine were taken, and fawns began to die.

In Pennsylvania deer pressure was first visible on oaks, cherry, ash, maples, ground hemlock, and hemlock. As these became scarce, laurel, rhododendron, and pines were taken (4). Laurel is at the bottom of the preference list, but most of the fawns dying in 1928-29 had eaten it in quantity (27, p. 34). Many plants important to other game species were also depleted: thus greenbrier, on which ruffed grouse depend for cover, was nearly annihilated. Snowshoe hare and wild turkey likewise felt the pressure of excess deer. (Letter from Seth Gordon 6/15/43)

Winter Deer Behavior. Most animals, when crowded and hungry, disperse by their own social pressure. Deer herds, at least in winter, seem devoid of such pressure. State after state reports instances of deer stubbornly refusing to leave (or even to be driven from) (16, p. 18) a depleted winter range. Paraphrased in human terms, "deer would rather starve than move."

This trait results in *spotty* damage to the winter range. The Kaibab (21, p. 245), Pennsylvania (4, p. 21; 7, p. 19), New York (19, p. 12), and Michigan (1, p. 39) all report this spotty character, and it is now visible in Wisconsin. It confuses laymen, who see spots of undamaged winter browse and conclude that no crisis exists.

Perhaps wolves and cougars originally performed for deer the function of dispersal from congested spots which most species perform for themselves.

Limitations of Artificial Feeding. The first human reaction to deer starvation is always an impulse to feed the herd, rather than to reduce it. Winter feeding of game birds and songbirds carries no known penalties, why not feed the deer?

The main difference lies in the effect of artificial feeding on the supply of natural foods.

Game birds subsist in winter mainly on seeds (pheasant, quail) or buds (grouse). Both seeds and buds are produced in infinite quantity, and the consumption of seeds and buds does not affect next year's supply. Hence artificial food is a net addition to natural food.

Deer, on the other hand, subsist on palatable browse which is limited in quantity. Over-consumption progressively reduces next year's growth by attrition, non-reproduction, and replacement. Hence artificial deer food is not a net addition to natural food, and may become a net subtraction. For this reason, the most experienced states have come to doubt the wisdom of artificial feeding, except temporarily, or in emergency. For example, the Michigan Conservation Department says "winter feeding has not been successful, nor may it ever prove to be a feasible method of holding up declining deer populations" (1, p. 48). We doubt whether artificial feeding of deer is sound policy at any time, but we are certain that it is unsound to feed *before* the necessary herd-reduction has been made.

Experiments in semi-natural feeding by cutting trees or limbs have been conducted in Pennsylvania (18), Michigan (2, p. 6), and New York (5). This is less open to objection, and in hardwoods which sprout easily it may increase the natural food. It is expensive when done for deer alone, as are also all forms of artificial feeding (17, p. 34).

Predisposing Events

Predators. We have found no record of a deer irruption in North America antedating the removal of deer predators. Those parts of the continent which still retain the native predators have reported no irruptions. This circumstantial evidence supports the surmise that removal of predators predisposes a deer herd to irruptive behavior.

In weighing this question, one must distinguish between the substantial removal of predators and the extirpation of the last individual.

Thus Wisconsin still has a dozen timber wolves, but wolves ceased to be a substantial factor in our deer herds a decade ago.

Wisconsin lost its last cougar in 1884 (24, p. 32). Wisconsin deer started to irrupt after wolves had been substantially removed.

Pennsylvania lost its last cougar in 1886 (25, p. 7), but both cougars and wolves had become too scarce to affect deer at a much earlier date. Bobcats were cut down to the vanishing point during the decade 1915-1925. Pennsylvania deer began irrupting about 1915.

In most parts of the west, the substantial extirpation of deer predators took place within a decade after 1910, when the present system of paid hunters came into full-scale operation. Thus on the Kaibab, wolves were a factor in 1910 but gone by 1926. Cougars were abundant up to about 1915; they are still present but are now kept reduced to a very low level (21, p. 236). The Kaibab deer irrupted almost immediately after the extirpation of wolves and the substantial removal of cougars. (See bottom of graph B, Figure 1.)

In Chihuahua, where deer are abundant and organized predator control unknown, irruptions are likewise unknown (15). No irruptions are clearly recorded for Canada, nor has government predator control prevailed there.

In Germany, deer were abundant in the feudal forests despite the presence of predators, but range or forest damage is not recorded until just before the Thirty Years War, when predator control had begun. Damage did not become severe until the last century, after the elimination of predators and the inauguration of artificial feeding (14).

Coyotes do not seem to be effective predators in the sense of controlling irruptions, for the Kaibab herd irrupted in the presence of numerous coyotes (21), and coyotes occur on the present irruptive ranges of Wisconsin and Michigan, as well as those of Utah, Oregon, New Mexico, California, and other western states.

It appears, then, that cougars and wolves are the most effective deer predators. The evidence available supports the surmise that their removal does not cause irruptions, but paves the way for irruptive behavior, either at once or at some future time.

Cuttings. It is common knowledge that in humid regions, where the original forests were so dense as to shade out browse,

deer "followed the slashings," i.e., did not become abundant until after large areas had been converted to brush. Thus there were few or no deer around Lake Superior before the lumbering era (25, p. 119), and deer have spread north into Canada coincident with cuttings.

Here, too, a lag may occur. Thus Pennsylvania and southern New York were almost deerless for decades after slashings began. During this deerless lag exceedingly palatable plants, such as ground hemlock (*Taxus canadensis*) had a chance to accumulate. This stored reserve of very high-grade foods doubtless increased the violence of the later irruption.

In the open yellow pine forests and brushy foothills of the west, cuttings have no predisposing effect, for the original forests are open and can grow ample browse food.

Current Cuttings. Any winter cutting operation is likely to attract deer, which feed at night on the down tops felled by the loggers by day. The effect on deer depends on whether the cutting is continuous through the winter, and whether it makes available palatable trees capable of sustaining deer, or unpalatable ones on which deer starve despite full stomachs.

Cuttings are often interrupted by weather, or are discontinued in midwinter. In such event the whole dependent herd must starve suddenly unless natural browse is available. Such "trapped" herds seldom move.

A small cutting operation may "bait" a large deer herd, and keep it localized without actually feeding it enough tops to sustain life. In such event the dependent herd slowly starves.

Any cutting operating may safely feed a herd which is not too large for it, for the actual duration of continuous cuttings.

By and large, current cuttings have tended to postpone and exaggerate the penalties for excess deer. The present war demand for yellow birch and white cedar is feeding many deer which will be left foodless when the supply of these trees is exhausted, or when the demand for birch veneer and cedar posts falls off.

Buck Laws. Laws protecting antlerless deer predispose a herd to irruptive behavior to the extent that they are enforced, for the killing of males in a polygamous species has, within ordinary limits, no effect on reproductive rate.

By a strange irony, conservation departments in buck-law states, when they have failed to reduce their own does by legal means, have unwittingly delegated this important biological function to the law-violator, for the public begins to condone illegal doe-killing as excess numbers of does become visible. But for illegal doe-killing, many buck-law states would have irrupted earlier.

Buck laws are admirable for a herd which needs building up (20), but hardly for a herd in need of reduction. Irruptions have been confined to buck-law states, except in Minnesota where large refuges have shown irruptive effects. These large refuges have the same local effect as buck laws.

Other Factors

Fire. There is general agreement that a little fire improves deer range, but that wholesale burning destroys it (1, p. 10). When deer happen to irrupt a decade or two after the first effective fire control, damage to deer and range is exaggerated by the closure of tree crowns, for this shades out much browse at a time of maximum need for browse. The present deer crisis in Wisconsin is exaggerated by the present closure of tree crowns which grew up following the fire-control system established about 1930.

In parts of the west, there was widespread reproduction of forest trees following early overgrazing and later fire-control. These new forests have now closed their crowns, and thus shaded out much browse (13).

Irruption Sequence

These common characters of irruptive deer herds follow a sequence, the early stages of which are substantially alike for all herds, but the later stages of which differ according to whether remedial action is prompt and decisive, or dilatory and insufficient.

Stage 1: Setting the Stage. The combination of a buck law, a refuge system, good law enforcement, and predator removal

"sets the stage" for irruption. In humid regions, widespread logging and some (but not too much) fire is further conducive to irruptive population behavior.

Stage 2: Early Upgrade. A deer-line appears on palatable browse, but the deer are still normal in growth, and winter well.

Stage 3: Later Upgrade. A deer-line appears on unpalatable browse, such as balsam. Fawns begin to die every hard winter, but adult deer do not. The stomachs of these fawns contain unpalatable (non-nutritious) browse; their lungs are commonly pneumonic. At this stage conifer plantations begin to show deer-damage, and reproduction of palatable browse has ceased to survive.

If the herd is sufficiently reduced at this stage, a considerable part of the overbrowsed palatable plants may recover, and a corresponding fraction of the pre-irruption carrying capacity is salvaged (George Reserve).

If the herd is not reduced it proceeds to:

Stage 4: The Peak. The peak of an irruption which has been allowed to run its course is always sharp (Kaibab).

The peak of an irruption which has been treated is rounded to the extent the herd has been reduced (Pennsylvania).

Stage 5: Early Downgrade. The downgrade begins when either starvation or shooting removes does as well as the annual fawn crop. Death of fawns alone fails to check increase, because some fawns always get by on logging operations or other extra-favorable winter range. Downgrade by starvation always begins during a hard winter.

By this time palatable browse, weakened during stages 2-4, begins to die off.

The deer at this stage show light weight and small antlers. Even the summer range may show distress.

Stage 6: Late Downgrade. This occurs only in starved herds. It is marked by continued starvation, due to the fact that the browse shrinks faster than the deer.

Stage 7: Levelling off. This marks the new equilibrium between the starved-off herd and its depleted food supply. A

starved herd may stay level for decades, and that level is always lower than the pre-irruption carrying capacity. A herd which has been shot down levels off according to the promptness and decisiveness of the reduction. The sooner and greater the reduction, the higher the ultimate level.

This is why an irruption jeopardizes the future as well as the present welfare of a herd.

This Committee has not made a field study of the present Wisconsin irruption, but the Conservation Department has, and its findings are shortly to be published. The evidence gathered by the Department indicates that most northern Wisconsin counties, and some central Wisconsin counties, are now in Stage 3. If this is correct, there is imperative need for prompt and decisive herd-reduction in the irruptive counties.

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