TIMBER SALE DESIGN FOR MOOSE MANAGEMENT IN NORTHEASTERN MINNESOTA

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Abstract: A technique was developed to compare moose (Alces alces) and whitetail deer (Odocoileus virginianus) productivity in response to different timber harvest regimes. The idea is to project moose and deer yields per project area based on integrated landscape models, timber types, stand age class, and animal use from clearcut edge and cover.

Based on projected moose and whitetail deer yields an economic evaluation was devised to compare the various harvesting regimes based on animals harvested while retaining a sustained yield. The economic analysis uses the recreation visitor day (RVD) process adopted by the USFS.

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The northwest portion of the Superior National Forest (SNF) is the focal point of a dilemma in habitat management. The problem is healthy moose (Alces alces) populations and the potential for whitetail deer (Odocoileus virginianus) populations of up to 20 per mi^2 (7.7 deer per km^2) on summer range. Moose populations on some areas near the Indian Sioux Burn (1971) are over 5 per mi^2 (1.9 moose per km^2) on summer range (Thunhorst 1985). The problem concerns the incompatibility of the two species because of Parelaphostrongylus tenuis (Karns 1977). A density of less than 10 whitetail deer per mi^2 (3.9 deer per km^2) is desirable in moose management areas to decrease the potential of P. tenuis infections in moose.

Methods: Timber Harvest Design

The Minnesota Department of Natural Resources (MnDNR) and the United States Forest Service (USFS) designated areas on the SNF to manage for moose, necessitated by the incompatibility of moose and whitetail deer and their different habitat requirements. In 1979, a cooperative venture was implemented between the MnDNR and USFS in an attempt to minimize the impact of P. tenuis on the moose population. The concept included designing clearcuts that would minimize the habitat requirements for whitetail deer and optimize the habitat for moose. The timber harvesting method adopted involves up to 200 acres (81 ha) of modified clearcuts, with residual individual trees and clumps of trees left standing for cover. The 200 acre clearcut is one of the few exceptions to the 40 acre (16.2 ha) maximum clearcut size regulated by the USFS. The standard 40 acre or less clearcuts are conducive to good moose habitat, but are also readily utilized by whitetail deer. With the higher productivity of deer over moose, the latter are increasingly exposed to potential P. tenuis infections.

Results: Timber Harvest Design

The residual tree species that are left uncut are usually balsam fir (Abies balsamea), paper birch (Betula papyrifera), red maple (Acer rubrum), and eastern white pine (Pinus strobus). These species are often found mixed with jack pine (Pinus banksiana), "upland" black spruce (Picea mariana), and quaking aspen (Populus tremuloides) stands. The sparsely stocked stands that remain following harvest serve as cover for moose, but not whitetail deer. Residual trees are usually not dense enough to greatly inhibit natural regeneration of clearcuts because they are distributed throughout the project areas. No mechanical or chemical release is used in the timber stand improvement aspect of the regeneration of stands to fully promote deciduous browse.

Clearcuts are designed to minimize the edge to harvest area ratio to further reduce the dense cover requirements for whitetail deer (Figure 1). The areas are as compact as the natural terrain and harvestable timber stands will allow. Individual scattered trees and 1 to 5 acres (.4 ha to 2 ha) of uncut patches of timber left in the clearcuts, lessens the negative impact of the reduced edge on the clearcut periphery for many of the indigenous species.

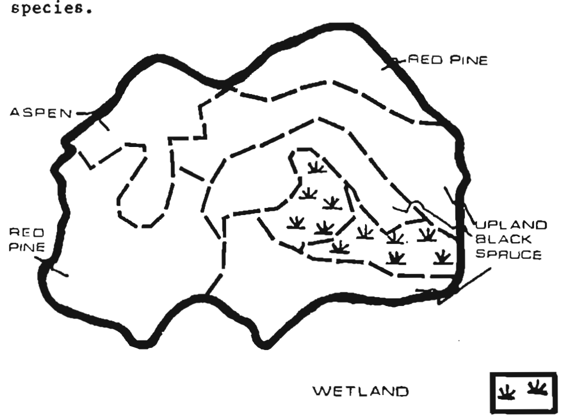

Figure 1. Example of Desired Configuration of a Harvest Unit to Reduce Clearcut Edge.

By leaving residual trees, not releasing regenerated stands, and by perpetuating hardwood species, moose habitat is enhanced by creating stands with high plant diversity. Miquelle and Jordan (1979) accentuated the importance of plant diversity in moose habitat enhancement. By expanding the aspen component and the shrub understory that accompanies aspen stands,

plant diversity is greatly improved in the majority of the project areas, which often exceed 90 percent conifer.

Shallow open water wetlands are important for moose habitat, because they produce aquatic plants which are a desired food source for much of late spring and summer (Karns 1984). Beavers (Castor canadensis) produce many of these valuable ponds and wetlands. By enhancing beaver habitat, moose habitat is also improved. When portions of the mixed conifer and aspen stands along streams are harvested, the aspen component is perpetuated and both beaver and moose habitat is improved.

Methods: Model for Analyzing Harvestable Moose and Whitetail Deer Yields

A model was developed as a tool to assess various timber harvest regimes. The moose and whitetail deer habitat yield indices developed by Siderits, Karns, Prettyman, and Ramquist (1981)[1] were used to assess the impacts of resource management on whitetail deer and moose.

The foundation for the whitetail deer and moose habitat model is the integrated land classification system used on the Forest (Prettyman 1980). The system is based on landforms, soils, and vegetation. There are two major breakdowns in the classification system, the landtype association (LTA) and the ecological landtype (ELT). A LTA is an area of land that has a distinct combination of physical and aquatic properties that distinguish it from adjacent areas. The LTA unit is useful for determining the best use of the land for social benefits and for the management of natural

[1]The habitat yield indices were not previously published, and are available through the planning records of the Superior National Forest.

resources. An ELT is an area of land within a LTA that has distinct physical and landscape properties that are the result of common land forming processes. These properties will respond in a predictable manner to land uses, and have a predictable potential to produce biomass.

The vegetation component of the LTA and ELT is subdivided by overstory, shrubs, and forbs according to densities, heights, structure, and types. By utilizing shrub species that are readily consumed by whitetail deer and those by moose, and forb species consumed by whitetail deer, habitat indices were developed for the two species by LTA (Siderits, etal 1981). A LTA that supports abundant forbs could potentially support higher densities of whitetail deer than a LTA that did not have a high forb component. Grasses, sedges, and aquatic forbs were not used in the model, nor was the affect of a higher winter severity index near Lake Superior. The fine tuning for the habitat indices came from potential whitetail deer and moose population densities for each LTA, which were derived from survey records and the expertise of wildlife researchers from the MnDNR (Karns 1980). Siderits, etal (1981) further subdivided the indices to the ELT level which can be readily utilized on a timber stand basis. Tables 1, 2, and 3 present harvestable whitetail deer and moose yields on a sustained yield basis for each ELT, stand age class, and general stand type. The stand types are represented as pine, spruce and fir, or hardwood stands.

Potter (1985) adapted the whitetail deer and moose yield indices to analyze various timber harvest regimes. The problem was to evaluate how different timber harvesting practices influence whitetail deer and moose production. The procedure incorporates animal useage of clearcuts based on edge or distance from cover.

Table 1. Deer & Moose/M Acres/ELT-Pine Stands

ELT	Species	Stand Age Class			
		0-10	11-20	21-40	41+
1 LLM	Deer	20	10	10	30
	Moose	9.5	4.5	0	3.0
2 LLW	Deer	--	--	--	--
	Moose	9.0	4.5	0	3.0
3 LCM	Deer	50	15	15	65
	Moose	14	7.0	0	7
4 LCW	Deer	--	--	--	--
	Moose	--	--	--	--
5 LPA	Deer	--	--	--	--
	Moose	--	--	--	--
6 LPN	Deer	--	--	--	--
	Moose	--	--	--	--
7 UDSD	Deer	15	10	10	10
	Moose	5.5	2.5	0	0
8 UDSI	Deer	35	30	30	35
	Moose	9.5	6.0	2.5	4.5
9 UDSX	Deer	15	5	5	10
	Moose	5.5	2.5	0	1.5
10 UDCD	Deer	50	75	75	90
	Moose	14	13	12.5	14
11 UDHD	Deer	20	20	20	10
	Moose	9	4.5	0	2.5
12 UDBD	Deer	15	10	10	15
	Moose	3.0	1.5	0	1.5
13 UDLDC	Deer	20	15	15	35
	Moose	9.0	6.0	2.5	4.5
14 UDLDM	Deer	50	50	50	75
	Moose	14	10.5	7	10.5
15 UDLDF	Deer	50	60	60	60
	Moose	14	12.5	10.5	14
16 USLD	Deer	20	10	10	20
	Moose	9.5	4.5	0	4.5
17 USLXV	Deer	15	20	20	25
	Moose	5.5	3.0	0	0
18 USLXE	Deer	5	0	0	25
	Moose	3.0	1.5	0	0

Table 2. Deer & Moose/M Acres/ELT-Spruce-Fir Stand

ELT	Species	Stand Age Class 0-10	11-20	21-40	41+
1 LLM	Deer	20	10	10	10
	Moose	9.5	4.5	0	0
2 LLW	Deer	35	20	20	45
	Moose	9.0	4.5	0	0
3 LCM	Deer	50	15	15	40
	Moose	14	7.0	0	4.5
4 LCW	Deer	35	20	20	35
	Moose	5	2.5	0	0
5 LPA	Deer	5	0	0	0
	Moose	1.5	.5	0	0
6 LPN	Deer	15	0	0	0
	Moose	4.5	2	0	0
7 UDSD	Deer	15	0	0	5
	Moose	5.5	2.5	0	0
8 UDSI	Deer	35	20	20	30
	Moose	9.5	4.5	0	2.5
9 UDSX	Deer	15	0	0	5
	Moose	5.5	2.5	0	0
10 UDCD	Deer	50	40	40	65
	Moose	14	9.0	3.0	7
11 UDHD	Deer	20	0	0	10
	Moose	9	4.5	0	0
12 UDBD	Deer	25	15	15	25
	Moose	4.0	2.0	0	1.5
13 UDLDC	Deer	20	10	10	10
	Moose	9.0	4.5	0	0
14 UDLDM	Deer	50	25	25	40
	Moose	14	9.0	3.5	3.5
15 UDLDF	Deer	50	40	40	50
	Moose	14	9.0	3.5	7
16 USLD	Deer	20	10	10	15
	Moose	9.5	4.5	0	2.5
17 USLXV	Deer	15	20	20	20
	Moose	5.5	3.0	0	0
18 USLXE	Deer	5	0	0	0
	Moose	--	--	--	--

Table 3. Deer & Moose/M Acres/ELT-Hardwood Stands

ELT	Species	Stand Age Class 0-10	11-20	21-40	41+
1 LLM	Deer	55	15	15	30
	Moose	9.5	6.0	3.0	3.0
2 LLW	Deer	35	20	20	40
	Moose	7.0	3.5	0	2.5
3 LCM	Deer	85	40	40	65
	Moose	14	9.0	3.5	7
4 LCW	Deer	45	20	20	15
	Moose	4.5	2.5	0	2.5
5 LPA	Deer	--	--	--	--
	Moose	--	--	--	--
6 LPN	Deer	20	5	5	0
	Moose	4.5	2	1	0
7 UDSD	Deer	15	5	5	5
	Moose	5.5	2.5	0	0
8 UDSI	Deer	35	30	30	35
	Moose	9.5	6.0	2.5	4.5
9 UDSX	Deer	20	5	5	10
	Moose	5.5	2.5	0	1.5
10 UDCD	Deer	65	75	75	90
	Moose	14	12.5	10.5	14
11 UDHD	Deer	45	20	20	15
	Moose	9	4.5	0	2.5
12 UDBD	Deer	15	10	10	15
	Moose	3.0	1.5	0	1.5
13 UDLDC	Deer	35	15	15	35
	Moose	9.5	6.0	2.5	4.5
14 UDLDM	Deer	65	50	50	75
	Moose	14	10.5	7	10.5
15 UDLDF	Deer	65	60	60	85
	Moose	14	12.5	10.5	14
16 USLD	Deer	35	30	30	20
	Moose	9.5	6.0	2.5	5.0
17 USLXV	Deer	10	15	15	20
	Moose	4.0	4.0	4.0	5.5
18 USLXE	Deer	10	5	5	35
	Moose	4.0	3.0	1.5	3.0.

Results: Model for Analyzing Harvestable Moose and Whitetail Deer Yields

The procedure for using the system to predict harvestable yields begins with the formulation of alternatives, followed by a detailed map of each. The alternative maps are subdivided by stand areas, ELT's, optimum use distance of each species from edge or cover, and maximum distance of each species from edge (Figure 2). The optimum use distance for moose from the clearcut edge or cover used in the model was 4 chains (80.4 m) (Hamilton, etal 1980), and 2 chains (40.2 m) for whitetail deer (Wetzel, etal 1975). Maximum use distance for moose from clearcut edge or cover was 16 chains (321.6 m) for moose (Hamilton, etal 1980) and 6 chains (120.6 m) for whitetail deer. The 6 chain distance is used by Area Wildlife Managers with the MnDNR as a maximum use distance of whitetail deer from edge.

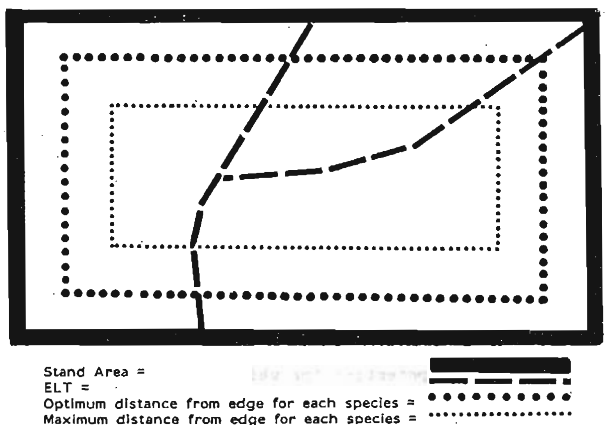

Figure 2. Subdivision of a Project Area for Analysis.

By utilizing a planimeter, the area of optimum use and the area of

maximum use can be determined for each ELT within each stand for whitetail deer and moose. These areas are multiplied by the appropriate yields for each projected stand type (pine, spruce or fir, or hardwood) and ELT, and desired stand age class. The yields from Tables 1, 2, and 3 are expressed in animals per 1000 acres, the yields need to be expressed in a per acre basis for calculations. The productivity of the project area, which in turn is reflected in the potential harvest rate, will vary from harvest through stand maturation. Initially following clearcutting, an edge effect will impact the carrying capacity of the area. This is taken into account by multiplying the yields per acre by the sustained yield factors in Table 4.

Table 4. Sustained Yield Factors for Moose and Whitetail Deer Based on Stand Age and Distance from Edge.

Use Distance from Edge	Stand Age 0 - 10
Whitetail Deer < 2 chains from edge	X 2
Whitetail Deer > 6 chains from edge	X 0
Moose > 16 chains from edge	X 0

The total harvest potential for whitetail deer and moose for each alternative is achieved by subtotaling the potential harvest yield by ELT for each stand type by age class. The stand subtotals are then totaled, giving potential animals that could be harvested for the whole project area by decade on a sustained yield basis.

The sustained yield factors in Table 4 were derived by using the different protective cover requirements of moose and whitetail deer. Within the optimum use distance from cover for deer a factor of two is used for the 0-10 stand age class. The factor was derived by assuming that optimum habitat conditions would exist for deer for 10 years following clearcutting within 2 chains (40.2 m) of edge. During the first decade, 20 percent of the whitetail deer population supported by the project area within 2 chains of edge could be harvested per year while retaining a sustained yield (SNF planning records). A 20 percent whitetail deer harvest over 10 years gives the factor of two. The sustained yield factors for whitetail deer and moose is zero for distances from edge greater than 6 and 16 chains (120.6 m and 321.6 m) respectively. These factors were derived by assuming that only negligible useage would occur by either specie beyond these maximum distances. After 10 years the edge effect would not be a factor in the utilization of the clearcut by either species.

Economic Evaluation

The Forest Service uses Recreation Visitor Days (RVD) or Wildlife and Fish User Days (WFUD) values to assess consumptive and nonconsumptive uses of various resource elements. Economic appraisals can be performed on the basis of these values. The monetary value for each managed acre for each moose (deer) harvested for a given alternative can be achieved by utilizing the following formula:

$ per acre per stand age class for moose (deer) =

Number of moose harvested per stand age class per project area X

Acres per project area X

$ for big game hunting per RVD X

The number of RVD's

By combining the costs and benefits of timber management, big and small game harvests, and other consumptive and nonconsumptive resources, a realistic picture of the impact of our management efforts can be obtained.

Discussion

The procedure presented is based on an integrated resource approach to moose management in an area of high potential P. tenuis infections. The large modified clearcuts (up to 200 acres or 81 ha) are designed to optimize moose habitat, based on known moose behavior patterns. The modified clearcuts provide habitat for whitetail deer but on a greatly reduced scale from use expected by the incorporation of small clearcuts with maximized edge. Surveys and research will ultimately show the extent that desired goals are being achieved.

A primary weakness of the model is the limited applicability. There are many areas that do not have soils inventory and vegetative mapping. In some instances when the soils and vegetative data are present, they are not in a form that can be readily used. The soils inventory can be utilized when landforms and vegetation are included in the soil mapping. The vegetative inventory can be utilized when all phases of the floral types are included in the survey including the tree, shrub, and forb layers. In addition to vegetation types, the size and densities of the flora are necessary.

The strengths of the model are not as obvious if the soil and vegetative inventories are not available. As a planning tool, the model can be used to show the feasibility of whitetail deer and moose management projects from a resource and economic perspective.

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