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Application of 70mm Aerial Photography to Mechanized Timber Harvest Disturbance Assessment

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Introduction

As indicated by Zasada, 1971, a rapid change has been taking place in northern Minnesota timber harvest methods wherein the labor-intensive methods of the past are giving way to highly mechanized systems. The social, economic and biological effects of this change are of major importance and, as a consequence, are under intensive study by the University of Minnesota's College of Forestry at the Cloquet Forestry Center. The sub-project reported here was designed to determine whether the possible biological impact of various mechanical forest harvest methods could be assessed using aerial photography.

Site Description

A 1-1/2 acre 70 year-old jack pine (Pinus banksiana Lamb.) clearcut on the Cloquet Forestry Center was selected for study. The terrain is level and the soil is a well-drained Omega loamy sand with a 6 to 8 cm organic layer. Prior to cutting, stand basal area was 110 feet per acre and the predominantly hazel (Corylus americana Walt.) understory averaged 10,000 stems per acre.

The site was harvested in September, 1972, using a full tree system where unlimbed felled trees were forwarded to the landing for processing. Most logging slash and other miscellaneous debris were also removed from the site by a rubber-tired skidder. The driver was instructed to take no particular skidding route to the landing, but to distribute the disturbance over the entire cut area.

Several days after harvest, 70mm aerial photography was obtained at scales of 1:6,000, 1:2,000 and 1:1,000 with three film/filter combinations: (1) Aero infrared 2424/Wratten 12, (2) Ektachrome MS 2448/Wratten HF-3, and (3) Ektachrome infrared 8443/Wratten 15 + Color Compensating 20C.

Since the 1:6,000 scale photo detail was inadequate and the 1:1,000 coverage had excessive image motion, the 1:2,000 scale was selected for analysis. Subjective evaluation indicated that both the Aero infrared B&W and Ektachrome MS provided less information than the Ektachrome infrared and, as a consequence, the 1:2,000 scale color infrared photography was selected for study use.

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Preliminary viewing of the color infrared transparencies and several on-site inspections suggested the presence of seven site disturbance classes:

1. Rutted soil - All organic material was removed from the mineral soil surface and deep ruts remain from the skidder tires.

2. Bare soil - Similar to rutted soil, but with no tire tracks visible.

3. Turned duff - Organic layer turned over and intermixed with mineral soil; few herbaceous plants or shrubs visible.

4. Litter - Organic layer present, either in originally undisturbed condition or compressed, but not mixed with mineral soil; few herbaceous plants or shrubs visible.

5. Shrubs - Stripped of leaves and lying horizontally several inches to 1-1/2 feet above ground; organic layer may be in several conditions, but usually undisturbed or compressed; living leaves infrequent.

6. Herbaceous plants - Small, living herbaceous plants 1-3 inches tall are present; organic layer undisturbed; shrubs not present.

7. Slash - All tree crowns and loose branches removed during operation; only stumps, old logs, and miscellaneous debris remain.

Although this classification is more detailed, it corresponds with Zasada's and Alm's 1970 disturbance classification for a similarly harvested jack pine stand. The Zasada and Alm disturbance classification types indicate mineral soil exposure and vegetation disturbance.

Zasada and Alm, (1970) Disturbance Classification	Aerial Photo Disturbance Classification
Heavy	Rutted soil
Medium	Bare soil
Light	Turned duff Litter Shrubs
None	Herbaceous plants
Slash	Slash

Approximately one-third of the clearcut area was ground-checked for use as a training area. A transparent overlay was prepared which indicated examples of each type of site disturbance within the training area. The remainder of the clearcut area was used as the test area. A photo-transect system based on the technique described by Meyer, Cosgriffe and Linne, 1973, was used. A grid was super-imposed over the image of the test area and 140 randomly selected cells were marked on the interpretation test overlay. Each cell measured 2x2-feet on the ground and was indicated on the test overlay by an open-centered cross.

The 70mm training and test images, in sequence, were projected and enhanced by a blue sheet filter, to a scale of 1:450 onto a rear projection screen. Training and test overlays, respectively, were placed over their parent projected images and interpreted monoscopically. The interpreter, at his discretion, was allowed to use a 4X auxiliary magnification.

All of the five photo interpreters from the College of Forestry who participated had received at least one undergraduate course in aerial photo interpretation and most had on-the-job photo interpretation experience. The interpreters were briefed, familiarized with the disturbance classes and, with the aid of an interpretation key, studied the damage classes as they appeared on the training set. When confident of their interpretation capability and consistency, they proceeded to interpret the test site imagery. The test overlay was placed on the projected image and the interpreters tallied disturbance class calls for each cell on a special recording sheet. The ground truth was collected for all 140 cells after the photo interpretation.

Results

Photo interpretation results for the 140 test cells are summarized in Table 1. In general, the five interpreters were 52% correct in interpreting the several site disturbance classes with the 1:2,000 scale color infrared color photography. All interpreters correctly identified "Bare soil" (100%); they were fairly accurate in identifying "Herbaceous plants" (70%) and "Slash" (60%); but their accuracy dropped to 55% for "Shrubs", 54% for "Litter" and 42% for "Turned duff".

Table 1. Aerial photo interpretation/ground checked-matrix for mechanized timber harvest disturbance.

	Actual (ground-checked) Disturbance Class							3,4,5 Combined	Total Interpreter calls	Errors of Commission	
	1 Rutted soil	2 Bare soil	3 Turned duff	4 Litter	5 Shrubs	6 Herbac. plants	7 Slash			Number	Percent
Photo Interpretation Class 1	(0)		1	2	3			6	6	6	100
2		(5)	9	8	2			19	24	19	79
3			(75)	70	13		2	-	160	85	53
4			58	(186)	31	4		-	279	93	33
5			28	41	(74)	2	2	-	147	73	50
6			6	16	4	(14)	2	26	42	28	67
7			3	22	8		(9)	33	42	33	79
3,4,5 combined						6	4	(576)	586	10	2
Total Test Cells	0	5	180	345	135	20	15	660	700	337	48
Errors of Omission No.	-	0	105	159	61	6	6	84	337		
Errors of Omission %	-	0	58	46	45	30	40	13	48		
Correct Photo Interp. Cells	-	100%	42%	54%	55%	70%	60%	87%	52%		

The confusion between "Turned duff", "Litter" and "Shrubs", was probably due to the on-the-ground similarity of duff and litter and the tendency for both to be brightly colored on the image - similar to shrub coloration. While the test indicates that a high proficiency of distinguishing between "Shrubs", "Litter" and "Turned duff" is not feasible, acceptable results are obtained when these classes are combined as they were in the Zasada and Alm study. The correct classification of the combined class would then be 87% and the overall test proficiency of the interpreters would advance to 86%.

Individual interpreter scores were quite representative of respective training and experience. The best interpretation scores were attained by interpreters who either had visited the test training site on the ground or had considerable aerial photo interpretation experience; the poorest scores were those of interpreters with the least amount of working experience with aerial photographs. When the three "light" disturbance classes are combined, the interpreter scores are: 96%, 94%, 84%, 83% and 73%; if the classes are not combined, then the interpreter scores are 61%, 54%, 53%, 49% and 43%.

Conclusion

Based on the initial seven site disturbance classes believed to be interpretable on the color infrared transparencies, this study showed disappointing results. But based on the combination of classes which are more appropriate to the Zasada and Alm ground study, this study proved successful. With adequate training an individual interpreter could achieve a highly reliable score.

The following points need to be emphasized in future studies of this kind.

1. The site disturbance classes need to be well defined and not only reflect photographic capabilities, but also necessary management information needs.
2. Interpreters, besides training in aerial photo interpretation, also need familiarity with on-the-ground conditions.
3. The applicability of this technique needs to be determined for various soil and forest cover types harvested with different removal systems.
4. A lower cost aerial photographic system such as that explained by Meyer, et al. 1973, may prove more cost-effective and should be studied.

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