bi-monthly research notes

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ENTOMOLOGY

Detecting Windthrow, Potential Foci for Bark Beetle Infestation, by Simple Aerial Photographic Techniques. — During endemic years, certain bark beetles, notably the spruce beetle, *Dendroctonus rufipennis* (Kirby), breed principally in wind-thrown trees, which are important in the development of periodic destructive outbreaks in British Columbia forests (Dyer and Taylor, Can. For. Serv. Inf. Rep. BC-X-62, 1971). Large areas of mass-wind-thrown trees, uprooted by violent windstorms, are easily seen and salvaged; but scattered wind-thrown trees, a few per hectare, are probably just as important as sources for bark beetle buildup. A method of detecting above-normal numbers of such trees that could be used by forest managers without expensive equipment or without personnel with special skill would be useful.

One method of quickly examining large areas in detail is that of using aerial photographs. Current experience is only with large, clearly evident patches of mass-wind-thrown trees (Moore, pages 338-346 *in* Proc. Second Can. Symp. Remote Sensing, Guelph, 1974; Moore, Can. Surv. 28:126-127, 1974; Murtha, Can. For. Serv. Publ. 1292, 1972). However, by comparing sequential aerial photographs of suitable quality and scale, single wind-thrown trees or gaps created in the canopy resulting from downed trees should be apparent.

To test the concept of using simple aerial photographic techniques to assess scattered windfall, a study was done in a mature white spruce–alpine fir–lodgepole pine stand east of Hixon, B.C., where an extensive spruce beetle outbreak occurred in the early 1960's.

Vertical, stereoscopic, black-and-white aerial photographs were taken through the open hatch of a de Havilland Beaver fixed-wing aircraft in June 1973 before and after the felling of 13 codominant trees to simulate windfall. The camera used was a hand-held, electric-drive 70 mm Hasselblad 500 EL/M, with 80 mm planar lens and 70-exposure magazine. A photo strip ranging up to 2.4 km in length was taken at each of three sample locations.

To study scale, photographs were taken at three altitudes: low, 150 to 145 m above ground level (AGL) (scale 1:2,000 to 1:3,000); medium, 450 to 1 000 m AGL (1:6,000 to 1:12,000); and high, 1 700 m to 1 900 m AGL (1:22,000). For easier comparison between the two sets of photographs (before and after felling), enlargements of up to 20 × 20 cm (8 × 8 in.) were used.

The two sets of photographs were compared to detect the felled trees. Searching was confined to 1 ha rectangular areas representing sample plots and outlined on the photographs around each group of felled trees. Search time was recorded for each examination of each set of imagery. The 11 technicians who examined the photographs were experienced aerial observers but not skilled photographic interpreters of forest damage, and were not specifically familiar with observations of windthrow.

The imagery taken at the lowest altitude proved unsatisfactory because of excessive distortion, too little frame overlap owing to inability of the camera to cycle frame fast enough, and poor control of aircraft flight path. This poor control, preventing duplication of the first photographs, was, in part, due to restricted visibility of the ground from the aircraft. Photography at the highest level, about 2 800 m AGL, was easiest to duplicate but proved too small a scale for seeing windthrow. At medium flying heights, flight-path control also was the main in-flight problem. Comparisons were possible, however, where the lines converged or where there was enough edge overlap.

The 11 technicians took an average of 18 min to search for the 13 felled trees on three stereo pairs of medium-scale photographs. On the average, they located 13 trees each, of which 10 were correct; the remaining three trees were old windfalls, or gaps shown in the crown canopy in the second set of photographs and identified in error as representing missing trees (Table 1).

TABLE 1

Observations of 11 technicians

Search time (min) of each observer	No. of felled trees detected	No. of other trees recorded
6	11	2
13	10	4
17	11	4
18	10	1
20	11	0
20	8	6
20	11	3
21	6	3
21	10	8
23	9	4
25	9	1
Average 18	10	3.2

Observers found that the difficulty of searching for missing trees on the two sets of photographs was due to variations in several factors:

1. *Scale*—Comparisons were simplified if scale was nearly the same for each set of photographs; the photographs could then be viewed together stereoscopically. This rarely occurred directly, because flying height was never the same, but the scale could be partly adjusted by enlarging one or the other photograph.
2. *Resolution*—Enlargements were subject to resolution problems, particularly when low available light required a slow shutter speed, with resultant image motion.
3. *Angle of view*—Areas of interest on the imagery almost always were photographed from slightly different angles in successive instances. Comparisons between successive photographs were consequently difficult.

The method, while showing promise, needs improvement to become operational. Using a helicopter, rather than a fixed-wing aircraft, would reduce most of the problems. The less expensive fixed-wing aircraft requires more sophisticated control of location and scale than seems possible with a hand-held, small-camera system; most forest managers would probably employ a contractor specializing in this field. An alternative to aircraft, in suitable terrain, would be fixed, ground-based camera stations with a clear view of the stands. Color film, rather than black-and-white, might be worthwhile in spite of greater processing difficulties, additional expense, and narrower exposure latitude, as it would assist relatively unskilled interpreters in seeing greater detail. — J.W.E. Harris, A.F. Dawson, and R.G. Brown, Pacific Forest Research Centre, Victoria, B.C.

Sampling Overwintering Spruce Budworm Populations in Heavily Attacked Stands. — In cage experiments, spruce budworm females, *Choristoneura fumiferana* (Clem.), prefer to oviposit on nondefoliated shoots (Miller, page 75 *in* Mem. Entomol. Soc. Can., 1963). This led to the supposition that in heavily attacked stands more eggs might be laid on trees with the least defoliation (where defoliation refers to the loss of both current and old needles). Although this has never been checked, we have counted L2 larvae on trees in the same stand with differing degrees of defoliation.

The Maritimes Forest Insect and Disease Survey collected three midcrown branches from each of 20 trees in a balsam fir, *Abies balsamea* (L.) Mill., stand on Cape Breton Island. The collection area covered about 1.0 ha. The stand had been under heavy budworm attack and total defoliation ranged from 20 to more than 90% of the needles, and some trees were dead. Foliage samples were collected from 10 trees with 50% or