Introduction and Background

NAMP Objectives

The Vermont objectives of the project are to:

1. Determine the rate of change in sugar maple tree-condition ratings from 1988 through 2 !

#ith sugarbushes+ such as logging or gra0ing+ #ere accepted. 14ode 12

%on-sugarbushes - & hard#ood stand #ith sugar maple+ 1 cm d.b.h. and larger comprising more than half of the upper canop6. The stand could not have evidence of disturbance in the previous , 6ears before establishment+

d. /oil series--Docal soils scientists or recentl6 publishiMà 0b

changed since <uropean settlement+ and8 2+ changed from one forest t6pe to another

c. Cra0ing assessed in ; classes:
1 - no signs of gra0ing
2 - old damage+ but no recent signs of gra0ing
" - current+ light8 no tree damage apparent
; - current+ heav68 soil compaction obvious+ tree damage present and ver6 little reproduction present.

d. Tapping is rated in four classes:
1 - currentl6 active
2 - at least once in last , 6ears+ but not in current 6ear
" - old+ none in the last , 6ears
; - none ever

e. Tapping method 1obtained from lando#ner2 is coded as:
1 - buc3et
b2c3et

this #as discontinued in 2 ". The procedure #as as follo#s. : egeneration #as collected on each of the , plots #ithin the plot-cluster. *t #as counted on a circular milacre plot 1".) foot radius2 located at !.! m 12 feet2 from the plot center+ in the <ast direction 19 degrees2 *f < #as unavailable+ a second choice #as made going cloc3#ise 1/+ . + %2. The milacre plot #as permanentl6 mar3ed at the center #ith a K inch pvc pipe.

: egeneration #as counted on the milacre plot in " categories: /ugar maple+ - ther hard#oods+ and 4onifers. - ther hard#oods included all commercial tree species. <ach categor6 contained 2 divisions: /eedlings I 1 m in height+ and /eedlings L /aplings G 1 m in height+ but I 1 cm dbh. 5urther+ the /eedling I 1 m #as divided into 2 classes: I " cm in height+ and from " cm to 1 m in height.

&ll seedlings>saplings #ith greater than 2 leaves 1cot6ledons2 #ere counted for each categor6 and recorded in the appropriate bo$. *f stump sprouts or coppices generated multiple shoots+ each shoot #as considered a separate seedling. - nl6 those seedlings #hose stem #as #ithin the milacre plot #ere counted. & ma$imum of , #& seedlings are recorded.
The data sheet included:

RECORD NUMBER IN EACH CATEGORY

CLASS 1: <=30 cm
CLASS 2: BETWEEN 30 cm & 1 m

"ecanium %cale Population %urve*

Starting in 2005, visual estimates are made of scale populations on understory and lower branches of sugar maple using the abundance rating system listed below. Ten branches per subplot are examined and rated, using the branch portion with the most scales. Ratings are made to estimate the surface area covered with scales on 12 inches of growth, wherever the scale is heaviest. The minimum and maximum rating are recorded for each the 5 subplots. When scales are not present or visible, other evidence of scales is recorded: honeydew, sooty mold, crawlers on leaves. If not sugar maple is within touch or sight, that is recorded as “6”.

Lecanium scale abundance rating system

0 = None
1 = Trace : spotty single scales
2 = Light : less than 30% of twig surface area with scales
" = Moderate : 30-60% of twig surface area with scales
; = Heavy : more than 60% of twig surface area with scales
, = Other evidence of scale presence: honey dew, sooty mold, crawlers
! = No understory sugar maple to rate

#&EE MEA%) &EMEN#%

The follo#ing section describes methods used to inventor6 individual tree condition. &ll the data #ere recorded at the time of plot establishment 15ig. ;2. Thereafter+ the primar6 emphasis is to record cro#n condition+ #ith periodic accounting of ingro#th and D? = changes. <vidence of ne# bole or trun3 damage and tree cro#n position changes are recorded annuall6.

#ree %election and Identi'ication

&ll the trees 1 cm 1; in2 and larger #ere mar3ed #ith aluminum tags and nails at d.b.h.8 identified to species+ or as close as possible8 and inventoried for condition and damage. ajor emphasis #as su•

• ! C ; Ž þ #° 0 ð‘€ #• R” R” R” kW X o ¿ ˜ þ #° 0 ð‘€ #

um0 !3 @u)@u)K@ò+ .. # !3 @u)@ 1; 2 scalß+ • #ßÐ sc 1; 2]+ .. /90 scal o± "?90 sc)Ò±

recorded to the nearest 1 cm.

(ro, n Position 1&ll species - changes onl62

4ro#n position ratings #ere recorded for all the species in 1988+ and changes are recorded annuall6. 4ro#n position rating of each tree #as done b6 t#o observers. The lo#er rating #as given #hen the t#o raters failed to reach an agreement. . hen cro#n positions had changed during the previous , 6ears because of a disturbance the rating #as given according to the best estimate of #hat the cro#n position #as at the time of disturbance 1tree and cro#n si0e #ere #eighed more heavil6 than the light factor2. 4hanges observed after the original plot establishment are entered as corrections of the previous entr6. The follo#ing codes and definitions #ere used 1B/D& 198;2:

1 -dominant 1trees #ith cro#n e$tending above the general canop6 and receiving full light from above and partl6 from the sides8 larger than the average trees in the stand8 cro#ns #ell developed+ but some#hat cro#ded on the sides2

2 -codominant 1trees #ith cro#ns forming the general level of the canop6 and receiving full light from above+ but relativel6 little from the sides8 usuall6 #ith medium si0e cro#n+ more or less cro#ded on the sides2

" -intermediate 1trees shorter than in the preceding classes+ but #ith cro#ns just belo# or e$tending into the canop6 of dominant and codominant trees8 receiving little direct light from above and none from the sides8 usuall6 #ith small cro#ns considerabl6 cro#ded from the sides2

; -suppressed 1trees #ith cro#ns entirel6 belo# the main canop6 and receiving no direct light from above or sides2

+igor &ating 1&ll species2

Ceneral cro#n vigor #as recorded for all species in 1988+ and changes are recorded annuall6. The vigor rating is done in broad classes similar to those used in other forest decline projects. &lthough these #ere not initiall6 considered critical measurements+ in 199;+ the definitions #ere clarified+ and vigor became part of the training and certification. The acceptable error is plus-or-minus one vigor class.

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The codes are used as follo#s:

8 tree appears to be in reasonabl6 good health8 no major branch mortalit68 cro#n is reasonabl6 normal #ithin the stand situation8 less than 1 percent branch or t#ig mortalit6+ defoliation or discoloration present.

8 branch mortalit6+ t#ig diebac3+ or foliage discoloration present in 1 to 2, percent of the cro#n8 bro3en branches or cro#n area missing based on presence of old snags is less than 2! percent.

8 branch mortalit6+ t#ig diebac3+ or foliage discoloration in 2! to , percent of the cro#n8 bro3en branches+ or cro#n area missing based on presence of old snags is , percent or less.

8 branch mortalit6+ t#ig diebac3+ or foliage discoloration present in more than , percent of the cro#n+ but foliage is still present to indicate the tree is alive8 bro3en branches+ or cro#n area missing based on presence of old snags is more than , percent8 branch brea3age and cro#n missing is recorded in the ,-percent classes in the notes.

8 tree is dead+ either standing or do#n8 phloem under bar3 has bro#n strea3s8 fe# epicormic shoots ma6 be present on the bole8 no further entries needed.

+ 8 tree removed8 tree has been sa#ed or girdled b6 humans.

#apping &ecord 1/ugar maple onl62

5rom 1988 through 2 ;+ taphole closure #as recorded. The number of tapholes #as recorded annuall6 for all the sugar maples. -ne entr6 #as made for the total number of open tapholes. & taphole is considered open #hen the point end of a pencil pushed into the hole hits cambium. . hen not certain the hole #as not counted. Bnusual observations+ such as predominance of multiple taps on one side of a tree+ are recorded in the notes. This measure #as discontinued in 2 , because man6 sugarbushes had begun using smaller diameter taps+ and it #as difficult to determine taphole closure.

/tarting in 2 ,+ the ne# tapping data consisted of: tapped or not tapped8 and the si0e of the tap being used on each of the , plots 1)>1!M 1standard2+ 19>!;M 1health spout2+ or smaller 1micro22.

Bole -ualit* 1&ll hard#oods2

%o individual N?ole Aualit6M #ill be ta3en in 2). *nstead+ a N?ole Damage 4odeM #ill be entered for sugar maples 1see separate section belo#2. /evere bole damage that might affect tree vigor #as recorded for all species in 1988. &nnuall6+ _____ thought to have occurred since previous 6ear+ is recorded. The 5ield 5orm permits entr6 of a ma$imum of three t6pes of damage. *f more damage is noted+ the numbers ma6 be entered in the notes.

"ocation o' bole de'ects

1 - lo#er half 1above the stump+ " cm above ground+ but in the lo#er half of the bole2
2 - upper half 1upper half of the bole+ but belo# cro#n or branch for3s2
" - #hole bole 1defects in both halves or continuous2
; - stump>roots 1defects visible on the buttress roots or

stump #ithin " cm from the ground2
, - #hole tree 1includes bole+ stump+ and roots2

#*pe o' injur*.damage. and de'ects on the bole

&s man6 as three major defects or t6pe of damage on the bole #ere recorded in 1988. Thereafter+ an6 gro#th-impairing injur6 is added annuall6. These defects are registered as:

1at some point #ithin a "-m length+ curve of bole sufficientl6 severe that the curved section is completel6 outside the c6linder+ above and belo#2.
1the s#ollen area e$ceeds one 9uarter of the bole diameter8 slo#l6 healing branch stubs #ith large s#ellings are included2
or stubs 1dead branches larger than 1 cm on the bole or an6 dead stubs of that si0e creating open #ounds8 bole above the base of the cro#n+ or an6 major branch for3+ not included2
1area of e$posed #ood larger than ; $cm^2$8 includes can3ers that have e$posed #ood2
1area of e$posed #ood ; cm^2 or less8 holes created b6 tapping not included2
+ dr6 L tight 1old bruise or other damage e$tending more than 1 cm+ covered b6 dead bar38 includes can3ers2
1bar3 is splintering and separating from the #ood2
1large #ounds healed and completel6 closed as indicated b6 overgro#n live bar38 ma6 include large overgro#n branch stubs2
1elongated narro# #ounds+ at least 1 m+ not more than 2 cm #ide8 open or closed+ including scars2
1damage described in the notes2

(ausal agents 'or trunk or bole de'ects

The probable agents responsible for trun3 or bole defects are entered onl6 #hen the observer is reasonabl6 sure of the cause of damage. *f more detailed identification is possible+ such as #ood-boring insect+ it is recorded in the notes. -bservations such as 0#indthro#0+ 0hail damage0+ 0frost damage0 also are recorded in the notes. (robable agent groups and their designated codes are:

- causal agent not identified8 or no damage present.
1 - insect - *n the notes record #hat signs #ere present.
2 - fungus - Describe fruiting bodies or other signs.
" - #eather - ?lo#do#n+ leafscorch+ hail+ #ater level change+ frost+ etc.
; - animal - :ubbing+ gna#ing+ girdling+ birdpec3ing+ root damage from gra0ing+ etc.
, - human - Dogging+ bla0ing+ girdling+ etc.1Do not include tapping2.
! - fire - 5ire scars near base+ burnt #ood.
) -

diebac3+ cro#n transparenc6+ discoloration+ d#arfed foliage+ and presence of epicormic shoots. These #ere selected for the purpose of measuring annual changes and not to evaluate tree vigor or condition. Therefore+ the emphasis in method selection #as placed on repeatabilit6 of measurements bet#een individual raters and timing of the measurements. *nitiall6+ cro#n condition ratings #ere made for sugar maples onl6. =o#ever+ the follo#ing 6ear 119892 the cooperators agreed to e$pand cro#n condition estimates to include all hard#ood species. *n the original plan+ all the cro#n-condition rating elements #ere considered as critical measurements. =o#ever+ because of difficulties of repeating measurements+ the rating of d#arfed foliage and epicormic shoot measurements #as dropped. . hen the situation suggests that these ma6 provide additional information on tree health+ estimates ma6 be added in the notes.

Bncertaint6 about definitions for discoloration resulted in removal of this measurement from the critical measurement list+ but the measurement continued to be collected.

<stimates of branch diebac3 and foliage transparenc6 of sugar maples are retained as critical measurements. -riginall6 these #ere collected based using a 12-class rating s6stem. *n 2 "+ this #as changed to 21-class rating s6stem that rates cro#n health in , percent categories+ #hich is more compatible #ith other Vermont forest health surve6s 1Table 12. Data 9ualit6 guidelines are follo#ed for

The 5oliage Transparenc6 Crid 15ig. ,b2 is a visual

ata (ollection and #ransmission

/tandard field forms are used to record data 15igs. ;+ !2 in the field. (revious 6ears data are carried for#ard for the first , items on the form. *ndelible ball point pens are used to permit photo cop6ing and prevent erasures. 4hanges are initialed and dated b6 the person ma3ing the change. . hen data must be transcribed because of damage to the original data sheets+ another person chec3s the transcript+ initials+ and dates each page. The original data sheet is attached to the transcript. *n the field+ the recommended practice for the recorder is to repeat measurements audibl6 before data are recorded. &bsence of an item is recorded as 0 0 to indicate that a measurement or an observation #as made. &bsence of an entr6 on the data sheet is considered as missing data unless specificall6 permitted. The cre# leader is responsible for chec3ing completeness of data sheets before leaving the plot. The names of the cre# and the date of collection are recorded on each data sheet.

Data sheets from all clusters are stored in a single envelope #ith proper plot identifications. T#o copies are made of each data sheet. -ne cop6 of the field sheets is 3ept in the office of the field cre#+ a second cop6 is sent to the data entr6 staff+ and the original is mailed to the /tate 4oordinator. ?eginning in 2 !+ all data entr6 #as done b6 the . aterbur6 -ffice staff onl6. Data are entered into <$cel spreadsheets. &ll forms and electronic data are due to the /tate 4oordinator b6 -4T-?<: 1+2).

Entr*. +alidation. and %torage

%& ' (provides information for up to 2! variables on appro$imatel6 ,+ trees of #hich appro$imatel6 8 percent are sugar maples. ?ecause of the si0e of the data set+ it is important that the data be entered correctl6 and that an efficient method of validation be developed to ensure accurac6. The files are stored on hard drives as #ell as on 4Ds #ith the /tate 4oordinator. -nce a file has been entered+ chec3ed+ and validated+ the file is archived on a 4D. &nnuall6+ one cop6 of all files+ in the form of a 4D+ is submitted for storage in a fireproof vault and for public access to the Vermont ' onitoring 4ooperative.

-)A"I*#1 A%%)&AN(E

Aualit6 assurance consists of an organi0ed group of activities defining the #a6 in #hich tas3s are to be performed to ensure an e$pressed level of 9ualit6. These activities assure that the appropriate and documented eff ective measur re9uiring control are defined+ documented+ and implemented. This plan prescribes proper handling of critical e9uipment+ specifications for critical measurements+ training re9uirements to achieve necessar6 data standardi0ation+ and re9uired field chec3s to document and assure data comparabilit6.

ata -ualit*

4ro#n-condition measurements are critical for determining changes in the condition of sugar maple. The cro#n-condition ratings are subjective+ 9uantitative+ ocular estimates. The repeatabilit6 of measurements is assured through intensive training+ standardi0ed guides+ and the use of t#o persons+ minimum+ to rate each tree. The first 2 6ears of cross-chec3ing sho#ed that appro$imatel6 9, and 9 percent of remeasurements #ere #ithin one class for diebac3 and cro#n transparenc6+ respectivel6. Discoloration and d#arfed foliage remeasurements also sho#ed high measurement repeatabilit6+ but a majorit6 of the remeasurements #ere in the ver6 lo# percentage classes. 4re#s are trained and tested annuall6 for satisfactor6 performance. 5ield situations ma6 occur #hen a measurement cannot be ta3en. Documentation must be provided for an6 measurement not ta3en b6 leaving blan3 the space in the record. That portion is deleted in the anal6sis and does not appear as or 1.

%tandards and (ritical Measurements

*n 1988+ the fi ppes6 me0ce in te e in the ver6 lo# percen no oblt

ratings of the t#o is recorded.

2.<ach rater is re9uired to attend an annual training session and pass a rating 9ualifications e$amination. :ecords are maintained from all training sessions+ e$aminations+ and certifications.

&nal6sis of the remeasurement data sho#ed that in 1988 appro$imatel6 , percent of branch diebac3 and 9 percent of foliage transparenc6 remeasurements e$ceeded the allo#able tolerance limits 1?ur3man et al. 199 8 4line et al. 19892. . ith improved training in 1989+ less than , percent and appro$imatel6 8 percent of the remeasurements e$ceeded the tolerance limits 1?ur3man et al. 199 2.

#raining and (erti'ication

&nnual training is provided to the field cre#s involved #ith the cro#n rating. The cro#n raters are re9uired to attend the training and to complete certification for performance. 4ertifications are received #hen a person demonstrates abilit6 to rate diebac3 and foliage transparenc6 #ithin the specified tolerance limits more than 9 percent of the time.

Darge group training re9uires preselection of practice and certification trees. Training is provided in groups of appro$imatel6 five persons under the guidance of an e$perienced cro#n rater. &ppro$imatel6 2 trees are evaluated to achieve proper standardi0ation. Then 2 trees previousl6 rated b6 at least t#o e$perienced cro#n raters+ are rated b6 each trainee. Trees are rated from one side onl6+ usuall6 indicated b6 a tag+ to assure that the persons are rating the same condition. Trainees are given the opportunit6 to rerate a tree #hen their assessment deviates

2. (rovide results on trends in sugar maple and other hard#ood species tree health and potential causes for tree health problems8
". (rovide site specific results on tree health for use b6 lando#ners for sustainable forest management practices.

Tables are used to present summar6 information for each cluster+ and for the entire state. ' uch of this information is in the form of averages: average number of trees per cluster+ average number of tapholes per tree+ average d.b.h.+ and averages of the critical variables 1diebac3+ transparenc6+ and vigor2. The ranges for the variables are given in addition to their averages.

*n addition to averages+ the fre9uenc6 of health6 and unhealth6 trees b6 site+ incidence of defoliation+ and bole and stand damage summaries are calculated.

*n 2)+ the 2 -6ear measurement for the original 2! plot-

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