Buds, Leaves and Global Warming

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- <u>www.harvardforest.harvard.edu/schoolyard-lter-program</u>
- <u>www.harvardforest.harvard.edu/buds-leaves-global-</u> warming
- <u>www.harvardforest.harvard.edu/autumn-foliage-color</u>

What is **phenology**?

The science of the relations between climate and periodic biological phenomena (i.e leaf emergence, flowering, leaf senescence/drop, animal migration, hibernation etc.)

Why study phenology?

- Data provide markers to track mass and energy interactions between the atmosphere and biosphere.
- Long-term data sets are records of the biosphere's responses to global change.
- Native species and inter-regional indicator plant (clones) observations can be used to calibrate satellite and 'phenocam' digital data.
- Leafout and leaf senescence in temperate regions influence meteorological phenomena.

What are the main factors affecting the timing of woody species leaf phenology?

Fall leaf drop

- Temperature and frosts
- Day length
- Drought
- Wind
- Spring leafout
 - Cold treatment
 - Cumulative heat sum (growing degree days)
 - Day length



Trees approaching full color at Harvard Forest

As leaves senesce in the fall chlorophyll breaks down and the components are stored for use in the spring. This reveals yellow pigments, carotenoids, which have also been present during the growing season, but masked by chlorophyll.

Many, but not all, trees in our area also have the ability to produce red pigments, called anthocyanins, by using energy from sunlight. These red pigments produce the beautiful orange, red and purple colors that make our forests so beautiful each fall.



Because anthocyanins need sunlight for their production, red leaves tend to develop around the edges of a tree first.

This is not the case for yellow leaves, which are the result of unmasking the already present corotenoids as the chlorophyll breaks down.



For more on fall color see: www.harvardforest.harvard.edu/autumn-foliage-color

Harvard Forest Study

- Started in 1990 (spring) and 1991 (fall, but fall 1992 not done)
- Originally 33 species of trees and shrubs (3-5 individuals per species), but in 2002 decreased to 15 species in fall and 9 species in spring to reduce the time needed for the study
- I observe about weekly, but more often in late April-early May and early October when events are progressing most rapidly
- I observe and estimate % values (leaf emergence, leaf development, leaf color, leaf drop) over the entire tree (rather than a set number of tagged leaves/bids), which is in fact easier but doesn't work with younger students

DATE: 9-2-04 AM MID 605 CLR NAME: Jok

COM NAME	TREE ID	TAG	LF COLOR	LF FALL	FOPEN	FPAST	COMMENTS
SHADBUSH	AMSP-01	PP003	- ?	-			a couple of competition lus.
WHITE ASH	FRAM-01	PP004	~15%?	21% "			yellow
BLK. CHERRY	PRSE-01	PP005	45%?	~1%			cycllow .
RED MAPLE	ACRU-01	PP008	~1% ?	-?			yellowing
SHADBUSH	AMSP-02	PP011	<1%	-			orange lyellow
SUG. MAPLE	ACSA-01	PP012	-	-			and the second
BLK. BIRCH	BELE-01	PP013	~1%	- 7			yellow
YEL. BIRCH	BEAL-01	PP014	~1%.	-7			a furly on and yellow
RED OAK	QURU-01	PP016	~?	-			pour slight yellowing
WHITE OAK	QUAL-04	PP019A		-			Port straint de services
BEECH	FAGR-01	PP020	-	-			Aught fellowing
STR. MAPLE	ACPE-01	PP022	~1 %	~?			a few lys yellow
BLACK OAK	QUVE-01	PP024	-1/0		1		a tra in duing
PAPER BIRCH		PP031	41%	-?	1		a few yellowing Ivs
RED MAPLE	ACRU-02	PP033	- 5%	~1% ?			yellow/red.
STR. MAPLE	ACRE-02	PP035	- 1%	-7			yellow
BLACK GUM	NYSY-04	PP037A	~1%	-			yellow/orange
BEECH	FAGR-05	PP039A	-1/0	~			Acuto a the country
STR. MAPLE	ACPE-03	PP040	- ?	-			
YEL. BIRCH	BEAL-02	PP042	-	-			
BLK. BIRCH	BELE-02	PP043	_				
BEECH	FAGR-06	PP046A	-	-			
SHADBUSH	AMSP-03	PP056	-1%	- ?			yellow (a fearlys)
BLACK GUM	NYSY-02	PP057	<1%	_			
YEL. BIRCH	BEAL-03	PP059	- ?	-			soveral webwern nexts redferring
BLACK GUM	NYSY-03	PP059A	~3%	-?			arrange/red,
RED OAK	QURU-02	PP061	~ 2 18.	-			arange (16 g ,
RED MAPLE	ACRU-02	PP063	L17,	- ?			a few yellowing lus.
STR. MAPLE	ACPE-04	PP067	- 7				
BLACK OAK	QUVE-02	PP069	-	-			Some poling
RED MAPLE	ACRU-04	PP074	~1%	- 7			yellow
WHITE OAK	QUAL-02	PP075	~17.	- 7			Gellow/ 18 .
BLK. BIRCH	BELE-03	PP079	21%	-			Gellow/ 14 d
BLACK OAK	QUVE-03	PP081	~3%	- 7			yellow the man
BLACK OAK	QUVE-03	PP081	~5/1				yellow & rown
RED OAK	QURU-04	PP083	-	-			
BLK. CHERRY		PP086	~10%?	~1%			1.0.0
PAPER BIRCH		PP087	~10 / .	~1/2			Yellow/Anown.
PAPER BIRCH		PP088	-	-			
PAPER BIRCH		PP088	~3%?	-2.12			well
WHITE ASH	FRAM-02	PP089 PP091	-3%:				yellow/levourn.
BEECH	FAGR-04	PP091 PP092		-			
WHITE OAK	QUAL-03	PP092 PP093					
	ACSA-02			1			
		PP095	-	-			
WHITE ASH	FRAM-03	PP096	-				
SUG. MAPLE	ACSA-03	PP103	~ 1%	21%			orange (yellow
	PRSE-04	PP104A	-1%?	- 7			Hillow - Ferend and warm reste
RED OAK	QURU-04	PP105	- ?	-			a few promyyellow lus.
RED MAPLE	ACRU-05	PP106	~ 2%	-?			tinged red.
and the second	FRAM-04	PP108	-fur small	-			

STREAM BY # 10 not flowing a fur small publics. STREAM BY # 42 not flowing - a few publics mud deimp STREAM BY # 84 day invedder STREAM BY # 94 net flowing (no publics Cloved lifer N- polyner STREAM BY # 94 net flowing (no publics Cloved lifer N- polyner S- mut one faller masset

HEMLOCK HOLLOW Small polof very (2.3M acros) <5% fril. E-onymous -lower with -"Singe Nr - - -"Singe Nr - - -

NAME: JOK DATE: 9-30-03 PM UPPER 53'S AC

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COM NAME	TREE ID		LF COLOR	LF FALL	FOPEN	FPAST	COMMENTS
SHADBUSH	AMSP-01	PP003	~ 30%?	~ 3%?			wellow anonge
WHITE ASH	FRAM-01	PP004	~ 75%?	~12%?			sel ou bran a puble
BLK. CHERRY	PRSE-01	PP005	-20%?				
RED MAPLE	ACRU-01	PP008	~ 30% ?				Kellow
SHADBUSH	AMSP-02		~10%?				yellow/rtd.
SUG. MAPLE		PP012	~ 1%?	- 7			Hellew/oron to
BLK. BIRCH	BELE-01	PP013	~ 1A:				yelowing
YEL. BIRCH	BEAL-01	PP014	~30%?				yellow (gold.
RED OAK	QURU-01	PP014	~25%?				yellow igold
WHITE OAK		the second se	~3%?	- ?			vellournic
	QUAL-04	PP019A	U.A.				welow .
BEECH	FAGR-01	PP020	~ 1%?	~1%?			yellowing
STR. MAPLE	ACPE-01	PP022	~5%?	~1%			wellow
BLACK OAK	QUVE-01	PP024	~5%?	~ 3%?			yillow brown
PAPER BIRCH	BEPA-01	PP031	~20%	~ 5%?			yellow / brown
RED MAPLE	ACRU-02	PP033	~ 45%?	~15%?			yellow/red
STR. MAPLE	ACRE-02	PP035	~5%?	~1%			yellow
BLACK GUM	NYSY-04	PP037A	~ 10%	~1%			
BEECH	FAGR-05	PP039A	~ 1%	- ?	-		orange (yellon
STR. MAPLE	ACPE-03	PP040	~7%?	~12.			vellowing
YEL. BIRCH	BEAL-02	PP042	~12%>				yellow
BLK. BIRCH	BELE-02	PP042		~5%?			Hellow
BEECH	FAGR-03	PP043 PP046	~ 10% >	~ 3%?			yellow (gold.
	the second		~100%	~90%?			brown/geld
SHADBUSH	AMSP-03	PP056	~45% ?				vello u/brown forange
BLACK GUM	NYSY-02	PP057	~17% >	~ 2%?			ominique
YEL. BIRCH	BEAL-03	PP059	~65%?	~5%?			yellow
BLACK GUM	NYSY-03	PP059A	~50% ?	~ 5%?			orange (red.
RED OAK	QURU-02	PP061	~3%?	- ?			Hellowing
RED MAPLE	ACRU-03	PP063	~ 20%?				red/yellow
STR. MAPLE	ACPE-04	PP067	~23%?	~ 1%?			tellow/brown.
BLACK OAK	QUVE-02	PP069	~3%?	-2			genon brown.
RED MAPLE	ACRU-04	PP074	~40% ?	~ 5%?			vellow (baun.
WHITE OAK	QUAL-02	PP075	1000	~5% ?			red (yellow.
BLK. BIRCH	BELE-03	PP079	~ 60%?	~2%?			brown/yellow
BLACK OAK	QUVE-03	PP081					yellow / gold
BLACK OAK	QUVE-04		~358.2	~10%?			brown (yellow
RED OAK		PP083	~ 3% ?	- ?			brown (yellow
	QURU-03	PP084	~ 1%?	-?			poling yellow (brown potr /pink
BLK. CHERRY		PP086	~ 33%	~10% ??			yellow bronn sot /pink
PAPER BIRCH		PP087	~8%?	~2%?			yellow brown
PAPER BIRCH		PP088	~10%?	~1%?	-		vellow
PAPER BIRCH		PP089	~45%?	~17%?			Hellow
VHITE ASH	FRAM-02	PP091	~70%?	~3%?			tellow/purple/prown
BEECH	FAGR-04	PP092	~3%?	- 3			gold/brown.
WHITE OAK	a loss of the loss	PP093	232	~1%?			gold brown.
and the second se		PP095	~ 12?	~1%?			red/yellow
VHITE ASH	the second state of the se	PP096	~ 10 21 2	1/1			rellowing
	the second s	PP103	~10%?	~1%?			sellow (brown.
ILK. CHERRY			~38% ?	~15%?		4	arrangel yellow - seeds just starting + d
		PP104A	~40%?	~30%?		4	pelle-U/pink
		PP105	~5%?	~1%?		li	nown (yellow
		PP106	~ 20% ?	~2%?			ed yellow
		PP108	~12%?	~1%?		-	male wellow
TREAM BY # 1 TREAM BY # 4 TREAM BY # 8 TREAM BY # 9	2 flowing	- puddles		OCK HOLL		witch 6	# 60 many fiver open
	1		····· ··· ····························	cloned 111	ace N ~4	58? -7 X	112 Europeneur on lawn 2018 f pliny/bown your 2 33

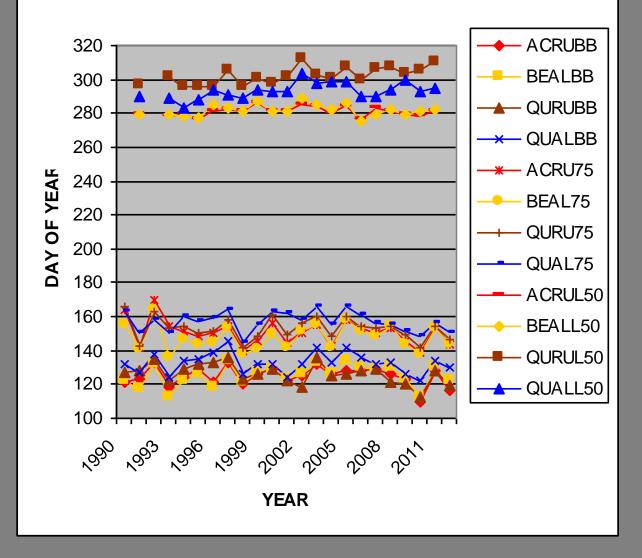
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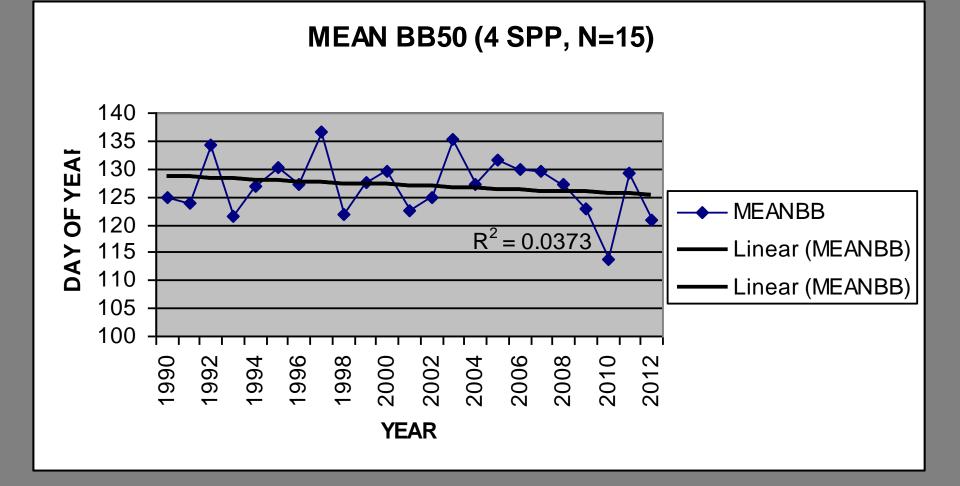
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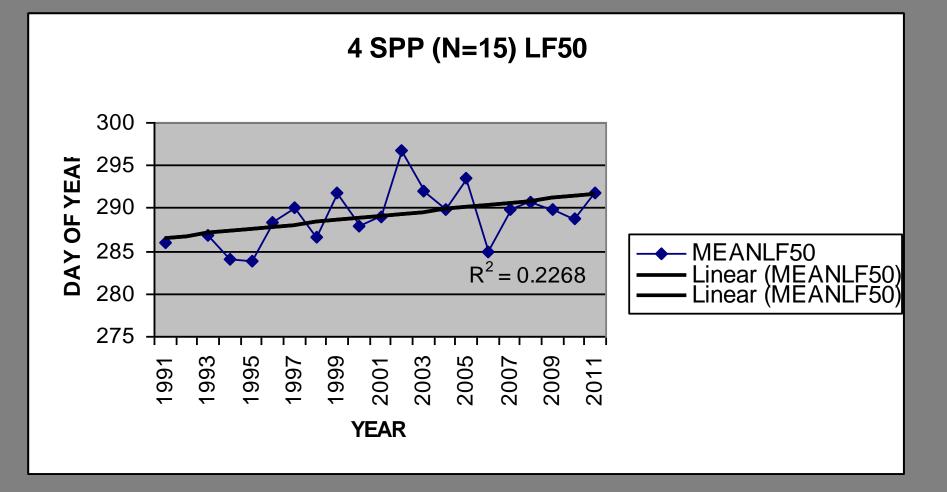
SHADBUSH AMSP-01 PP003 ~~97, 1 ~~167, 1 <th< th=""><th>COM NAME</th><th>TREE ID</th><th></th><th>LE COLOR</th><th></th><th></th><th></th><th></th></th<>	COM NAME	TREE ID		LE COLOR				
WHITE ASH FRAM-01 PP004 100 100 Project BLK. CHERRY PRSE-01 PP005 $\sqrt{652}^2$ -552^2 Lettice Letti		and the second se	and the second state	~ 993	HALL HALL	FOFEN	FFASI	
BLK. CHERRY PRSE-01 PP005 $\sim 652^2$ $\sim 552^2$ uettor pickt //www.spots. RED MAPLE ACRU-01 PP008 $(ao.2, ibo.3, $								an Actorian
RED MAPLE ACRU-01 PP008 (o_2, x) (o_2, x) (o_1, x)								and the first of the second
SHADBUSH AMSP-02 PP011 $\neg qq' \chi^{-2}$ $\neg 3d\chi^{-2}$ $quelles/leven/quelles/leven SUG. MAPLE ACSA-01 PP012 \neg dg' \chi^{-2} \neg d\chi' \chi^{-2} quelles/leven/quelles/leven SUG. MAPLE BELE-01 PP013 \neg dg' \chi^{-2} \neg d\chi' \chi^{-2} quelles/leven/quelles/leven VEL. BIRCH BELA-01 PP014 \neg g' \chi' \chi^{-2} \neg d\chi' \chi^{-2} quelles/leven/quelles/leven WHTE CAK QUAL-04 PP019A \neg dg' \chi^{-2} \neg d\chi' \chi^{-2} quelles/leven/quelles/leven BEECH FAGR-01 PP020 \neg T_{\chi'}\chi^{-2} \neg d\chi' \chi^{-2} quelles/leven/quelles/leven BEECH FAGR-01 PP022 \neg T_{\chi'}\chi^{-2} quelles/leven/quelles/leven BLACK GUM QUEVE-01 PP023 \neg ds' \chi^{-2} qelles/leven/quelles/leven RED MAPLE ACRE-02 PP033 \neg ds' \chi^{-2} qelles/leven/quelles/leven RED CAK UVEVE-01 PP033 \neg ds' \chi^{-2} qelles/leven/quelles/leven RED MAR ACRE-03 PP033 \neg ds' \chi^{-2} qelleven/$				the second s				Wellow pink / snown spots.
SUG. MAPLE ACSA-01 PP012 $\sim 50 \times 7$ $\sim 30 \times 7$ get() get() <thgt()< th=""> get() get(</thgt()<>								11
BLK BIRCH BELE-01 PP013 $\sim qg/2$ $qg/4/(qdlas)$ YEL BIRCH BEAL-01 PP014 $\sim qg/2$ $q_{add}/(qdlas)$ YEL BIRCH BEAL-01 PP014 $\sim qg/2$ $\sim g/2/2$ $q_{add}/(qdlas)$ WHITE CAK QURU-01 PP019A $\sim g/2/2$ $\sim f/2/2$ $q_{add}/(qdlas)$ BEECH FAGR-01 PP020 $\sim 7/2/2$ $\sim f/2/2$ $q_{add}/(qdlas)$ BEECH FAGR-01 PP022 $\sim 7/2/2$ $\sim f/2/2$ $q_{add}/(qdlas)$ BLACK COAK QUVE-01 PP024 $\sim 6/2/2$ $\sim 1/2/2$ $q_{add}/(qdlas)$ BLACK GUM PP033 $rloo 2$ $\sim 7/2/2$ $q_{add}/(qdlas)$ RED MAPLE ACRE-02 PP033 $rloo 2$ $\sim 7/2/2$ $q_{add}/(qdlas)$ RED CH FAGR-05 PP034 $\sim 6/2/2$ $q_{add}/(qdlas)$ $q_{add}/(qdlas)$ RED APLE ACRE-02 PP044 $\sim 6/2/2$ $q_{add}/(qdlas)$ $q_{add}/(qdlas)$ RED ARD BEACK GUM NYSY-04 PP044								
YEL BIRCH BEAL-01 PP014 $\sim 98 \%$ $\sim 78 \%$ $\sim 10 $								yellow/orango/brown.
RED OAK QURU-01 PP016 $\sim 3/2$ $\sim 3/2$ $qrl(s)/(so_{rbo})$ WHITE OAK QUAL-04 PP019A $\sim 6/2$ $\sim 5/2$ red/box(so_{rbo}) STR. MAPLE ACDE-01 PP022 $\sim 7/2$ $\sim 5/2$ $qrl(so_{rbo})$ STR. MAPLE ACDE-01 PP021 $\sim 6/2$ $\sim 1/2$ $qrl(so_{rbo})$ BLACK OAK QUVE-01 PP021 $\sim 6/2$ $\sim 7/2$ $\sim 1/2$ $qrl(so_{rbo})$ BLACK OAK QUVE-01 PP033 $rloo_2$ $\sim 7/2$ $qrl(so_{rbo})$ $qrl(so_{rbo})$ RED MAPLE ACRE-02 PP033 loo_2 $\sim 7/2$ $qrl(so_{rbo})$ $qrl(so_{rbo})$ BLACK GUM NYSY-04 PP037 $a/6/2$ $a/6/2$ $a_{rbo}/2$ $qrl(so_{rbo})$ $qrl(so_{rbo})$ STR. MAPLE ACPE-03 PP043 $a/10/2$ $a/7/2$ $qrl(so_{rbo}/2)$ $qrl(so_{rbo}/2)$ STR. MAPLE ACPE-03 PP066 $loo_2/2$ $a/7/2$ $qrl(so_{rbo}/2)$ $qrl(so_{rbo}/2)$ BLACK GUM NYSY-03 PP0566 $loo/2/2$ $q^2/2$ $qrl(so_{rbo}/2)$ <th></th> <td></td> <th></th> <td></td> <td></td> <td></td> <td></td> <td>gold/yellow</td>								gold/yellow
WHITE OAK QUAL-04 PP019A $\sim 60\%$ $\sim 5\%$ Midd [chown, red how of the construction of the construle of the construction of the construle construction of the co								Ensign / Stellow
BEECH FAGR-01 PP020 $\sim 7\chi_2^{-2}$ $\sim 5\chi^2$ light operation BLACK OAK QUVE-01 PP022 $\sim 7\chi_2^{-2}$ $\sim 5\chi^2$ light operation BLACK OAK QUVE-01 PP022 $\sim 6\chi^2_2$ $\sim 10\chi^2_2$ light operation PAPER BIRCH BEPA-01 PP031 $\sim 10\pi\chi^2_2$ light operation light operation STR. MAPLE ACRU-02 PP031 $loo \chi$ $\sim 70\chi^2_2$ light operation STR. MAPLE ACRE-02 PP035 $loo \chi$ $\sim 70\chi^2_2$ light operation BLACK GUM NYSY-04 PP037A $\sim 60\chi^2_2$ logg operation light operation STR. MAPLE ACRE-02 PP042 $\sim 60\chi^2_2$ light operation light operation STR. MAPLE ACRE-03 PP042 $\sim 100\chi^2_2$ $\sim 17\chi^2_2$ light operation STR. MAPLE ACR-06 PP046A $\sim 15\chi^2_2$ light operation light operation BLACK GUM NYSY-03 PP056 $loo \chi$ 97χ light operatidion <t< th=""><th></th><td></td><th></th><td></td><td></td><td></td><td></td><td>yellow (brown</td></t<>								yellow (brown
STR. MAPLE ACPE-01 PP022 $\sim 75 g.^{2}$ $\sim 5\chi^{2}$ utilized BLACK OAK QUVE-01 PP031 $\sim 60 \chi^{2}$ $\sim 02 \chi^{2}$ $\sim 10 \chi^{2}$ $\downarrow closs_{1} (4closs)$ PAPER BIRCH BEPA-01 PP031 $\sim 100 \chi$ $\sim 70 \chi^{2}$ $\downarrow closs_{1} (4closs)$ RED MAPLE ACRU-02 PP035 100χ $\sim 70 \chi^{2}$ $\downarrow closs_{1} (4closs)$ BLACK GUM NYSY-04 PP037A $\sim 60 \chi^{2}$ $oo graph (1closs)$ $oo graph (1closs)$ BEECH FAGR-05 PP039A $\sim 33 \chi^{2}$ $\sim 5 \chi^{2}$ $\downarrow closs_{1} (closs)$ STR. MAPLE ACRE-03 PP040 $\sim 100 \chi$ $\sim 7 \chi^{2}$ $\downarrow closs_{1} (closs)$ BEECH FAGR-06 PP040 $\sim 100 \chi$ $\sim 7 \chi^{2}$ $\downarrow closs_{1} (closs)$ STR. MAPLE ACR-06 PP040 $\sim 100 \chi$ $\sim 7 \chi^{2}$ $\downarrow closs_{1} (closs)$ BECH FAGR-06 PP046A $\sim 15 \chi^{2}$ $\downarrow closs_{1} (closs)$ $elloss_{1} (closs)$ BLK. BIRCH BELE-02 PP057 $loo \chi$ $-7 \chi^{2}$ $\downarrow closs_{1} (clos)$ BLACK GUM NY								red brown lot law
BLACK OAK QUVE-01 PP024 $\sim 6 \circ \chi$ $\sim 1 \circ \chi^2$ $\sim 1 \circ 1 \circ \chi^2$ $\sim 1 \circ \chi^2$ $\sim 1 \circ 1 \circ \chi^2$ $\sim 1 \circ \chi^2$ $\sim 1 \circ 1 $	and the second se							yellow brown.
PAPER BIRCH BEPA-01 PP031 $\sim loo x$ $\sim 72\%$? $qetteu/brave RED MAPLE ACRE-02 PP035 loo x \sim 72\%? getteu/brave STR. MAPLE ACRE-02 PP037A \sim 40\%? \sim 72\%? getteu/brave BLACK GUM NYSY-04 PP037A \sim 40\%? \sim 53\%? getteu/brave BEECH FAGR-05 PP039A \sim 33\%? getteu/brave getteu/brave BEECH FAGR-05 PP042 \sim 100\% \sim 97\%? getteu/brave getteu/brave BLK. BIRCH BEL-02 PP043 \sim 100\% \sim 97\%? getteu/brave getteu/brave BLK. BIRCH BEL-02 PP043 \sim 100\% \sim 97\%? getteu/brave getteu/brave SHADBUSH AMSP-03 PP056 loo \% 99\%? brave/brave getteu/brave getteu/brave<$								
RED MAPLE ACRU-02 PP035 160 % 100 %								brown/yellow
STR. MAPLE ACRE-02 PP035 100χ $-70 \chi^2_1$ yellwurgsd/(trown) BLACK GUM NYSY-04 PP037A $-x507.^2$ $x607.^2$ $x607.^2$ $yellwurgsd/(trown)$ BEECH FAGR-05 PP039A $-33 \chi^2_1$ $yellwurgsd/(trown)$ $yellwurgsd/(trown)$ BEECH FAGR-05 PP040 $x105 \chi$ $-75 \chi^2_1$ $yellwurgsd/(trown)$ STR. MAPLE ACPE-03 PP042 -100χ $-77 \chi^2_1$ $yellwurgsd/(trown)$ BLK. BIRCH BELC-02 PP043 -100χ $-77 \chi^2_1$ $yellwurgsd/(trown)$ SHADBUSH AMSP-03 PP056 100χ $-77 \chi^2_1$ $yellwurgsd/(trown)$ BLACK GUM NYSY-02 PP057 100χ $-71 \chi^2_1$ $yersen_{2} \xi_2$ BLACK GUM NYSY-03 PP059 100χ $-71 \chi^2_1$ $yersen_{2} \xi_2$ BLACK GUM NYSY-02 PP063 $x-90 \chi^2_1$ $x70 \chi^2_1$ $yersen_{2} (yerlow)$ RED MAPLE ACRU-03 PP063 $x00 \chi^2_1$ $x70 \chi^2_1$ $yersen_{2} (yerlow)$ RED MAPLE ACRU-04 PP075								yellow/brown
BLACK GUM NYSY-04 PP037A $\sim 60\%$ $\sim 60\%$ $order (1)$ BEECH FAGR-05 PP039A $\sim 33\%$ $\sim 5\%$ $order (1)$ $order (1)$ STR. MAPLE ACE-03 PP040 $\sim 100\%$ $\sim 35\%$ $order (1)$ $order (1)$ STR. MAPLE ACE-02 PP042 $\sim 100\%$ $\sim 75\%$ $order (1)$ $order (1)$ BLK. BIRCH BELE-02 PP043 $\sim 100\%$ $\sim 75\%$ $order (1)$ $order (1)$ BLCK GUM NYSY-03 PP056 100% 97% $thrown (1)$ $thrown (1)$ BLACK GUM NYSY-03 PP059 100% 97% $thrown (1)$ $thrown (1)$ BLACK GUM NYSY-03 PP059 100% 97% $thrown (1)$ $thrown (1)$ BLACK AURU-02 PP063 100% 100% 100% $thrown (1)$ $thrown (1)$ RED MAPLE ACRU-03 PP067 $\sim 100\%$ $\sim 75\%$ $thrown (1)$ $thrown (1)$ BLACK AGK Q				100%				
BEECH FAGR-05 PP039A $\sim 33 \%$? $\omega 5 \%$? gettaul/topic/ STR. MAPLE ACPE-03 PP040 $\sim 100\%$ $\sim 35\%$? gettaul/topic/ STR. MAPLE BEL-02 PP042 $\sim 100\%$ $\sim 7\%$? gettaul/topic/ BLK. BIRCH BEL-02 PP043 $\sim 100\%$ $\sim 7\%$? gettaul/topic/ BLCK GUM MSP-03 PP057 100% $\sim 7\%$? gettaul/topic/ SHADBUSH BARCH BEAL-03 PP059 100% 99% brows/ford-get BLACK GUM NYSY-02 PP057 100% 91% brows/ford-get SHADBUSH BEACU QURU-02 PP063 100% 91% brows/ford-get YEL. BIRCH BEAL QURU-02 PP063 100% 91% brows/ford-get RED OAK QURU-02 PP063 $\sim 90\%$ $\sim 55\%$? brows/ford-get BLACK OAK QUVE-02 PP063 $\sim 65\%$? brows/ford-get WHITE OAK QUAL-02 PP075		in the second						
STR. MAPLE ACPE-03 PP040 $1/60\%$ $-35\%^2$ $400\%/(m_m)$ YEL, BIRCH BEAL-02 PP042 100% $97\%^2$ $900\%/(m_m)$ BLK, BIRCH BELE-02 PP043 100% $97\%^2$ $900\%/(m_m)$ BLK, BIRCH BELE-02 PP043 100% $97\%^2$ $900\%/(m_m)$ SHADBUSH AMSP-03 PP056 100% 99% $100\%/(m_m)$ $900\%/(m_m)$ SHADBUSH AMSP-03 PP057 100% 99% $100\%/(m_m)$ $90\%/(m_m)$ BLACK GUM NYSY-02 PP0591 100% 91% $100\%/(m_m)$ $00\%/(m_m)$ BLACK GUM NYSY-03 PP05951 100% $91\%/(m_m)$ $00\%/(m_m)$ RED MAPLE ACRU-03 PP063 100% 100% 100% $100\%/(m_m)$ RED MAPLE ACRU-04 PP074 100% $75\%^2$ $100\%/(m_m)$ BLACK OAK QUVE-02 PP069 $99\%/(m_m) / m_m/(m_m)$ $100\%/(m_m) / m_m/(m_m)$ BLACK OAK QUVE-04 PP075 $100\%/(m_m/m) / m_m/(m_m) / m_m/(m_m)$ $100\%/($					~ 60%?			orange (brown.
YEL. BIRCH BEAL-02 PP042 -100% -97% gettion brown BLK. BIRCH BELC-02 PP043 $\sim 10\%$ $\sim 7\%$ gettion brown BEECH FAGR-06 PP046A $\sim 15\%$ 3% ? gettion brown BEECH FAGR-06 PP056 100% -97% brown for an end of the second seco			the second s					
BLK. BIRCH BELE-02 PP043 $\sim 10^{9}$ %, $\sim 72\%$? getlow(how methods) BEECH FAGR-06 PP046A $\sim 15\%$? 3% ? yetlow(how methods) BEECH FAGR-06 PP067 100%, 99%, Lhow methods) BLACK GUM NYSY-02 PP057 100%, 99%, Lhow methods) BLACK GUM NYSY-02 PP059 100%, 99%, Grave field. SHADBUSH AMSP-03 PP059 100%, 99%, Grave field. BLACK GUM NYSY-02 PP061 ~9%, 7.4%, Grave field. BLACK AGUM NYSY-03 PP0631 100%, 7.6%, Drawn (yetlow) RED OAK QURU-02 PP061 ~9%, ~7.5%, Low (yetlow) STR. MAPLE ACRU-04 PP077 ~100%, ~75%, Low (yetlow) BLACK OAK QUVE-02 PP063 $\sim 05\%$, $\sim 05\%$, Low (yetlow) BLACK OAK QUVE-02 PP075 ~100%, $\sim 05\%$, Low (yetlow) BLACK OAK QUVE-03 PP081 $\sim 95\%$,								yellow/brown
BLK. BIRCH BELE-02 PP043 $\sim 10^{9}$ %, $\sim 72\%$? getlow(how methods) BEECH FAGR-06 PP046A $\sim 15\%$? 3% ? yetlow(how methods) BEECH FAGR-06 PP067 100%, 99%, Lhow methods) BLACK GUM NYSY-02 PP057 100%, 99%, Lhow methods) BLACK GUM NYSY-02 PP059 100%, 99%, Grave field. SHADBUSH AMSP-03 PP059 100%, 99%, Grave field. BLACK GUM NYSY-02 PP061 ~9%, 7.4%, Grave field. BLACK AGUM NYSY-03 PP0631 100%, 7.6%, Drawn (yetlow) RED OAK QURU-02 PP061 ~9%, ~7.5%, Low (yetlow) STR. MAPLE ACRU-04 PP077 ~100%, ~75%, Low (yetlow) BLACK OAK QUVE-02 PP063 $\sim 05\%$, $\sim 05\%$, Low (yetlow) BLACK OAK QUVE-02 PP075 ~100%, $\sim 05\%$, Low (yetlow) BLACK OAK QUVE-03 PP081 $\sim 95\%$,				~100%	~ 97%?			sellowbown
BEECH FAGR-06 PP046A $\sim 15\%$? $\sim 3\%$? yeller/finite SHADBUSH AMSP-03 PP056 100% 97% 6mm/finite SHADBUSH AMSP-03 PP057 100% 97% 6mm/finite YEL. BIRCH BEAL-03 PP059 100% 97% 6mm/finite BLACK GUM NYSY-03 PP059 100% 97% 6mm/finite BLACK GUM NYSY-03 PP059 100% 97% 6mm/finite RED MAPLE ACRU-03 PP063 100% 97% 6mm/finite RED MAPLE ACRU-04 PP067 ~100% 78% 98% 95% 100% BLACK OAK QUVE-02 PP069 ~98% ~55% 6mm/finite 100%			PP043	~104%				yellowllooun
SHADBUSH AMSP-03 PP056 $loo \%$ 99% $low m/low rige BLACK GUM NYSY-02 PP057 loo \% 99\% loo model field YEL. BIRCH BEAL PP059 loo \% 99\% loo model field BLACK GUM NYSY-03 PP0590 lio \% 99\% loo model field BLACK GUN NYSY-03 PP0691 -90\% emodel field loo model field RED OAK QURU-02 PP061 -90\% -90\% loo \% loo \% RED MAPLE ACRU-04 PP067 -loo \% word (ythou) loo \% BLACK OAK QUVE-02 PP075 -loo \% -ds\% loo million (ythou) WHITE OAK QUAL-02 PP075 -loo \% loo \% loo \% BLACK OAK QUVE-03 PP081 -sS\% loo million (ythou) loo \% BLACK OAK QUVE-04 PP083 -75\% loo million (ythou) loo \% BLACK OAK QUVE-04 P$	BEECH	FAGR-06	PP046A	~15%?	~3 %?			sellow/bonn
BLACK GUM NYSY-02 PP057 100 % 99 % how - /rel. YEL. BIRCH BEAL-03 PP059 100 % 97 % 6 mount / rel. BLACK GUM NYSY-03 PP059A 100 % 97 % 6 mount / rel. BLACK GUM NYSY-03 PP059A 100 % 97 % 6 mount / rel. BLACK GUM QURU-02 PP061 $\sim 90 \%$ 4 % % 6 mount / rel. RED OAK QURU-02 PP063 100 % 100 % 6 mount / rel. BLACK OAK QUVE-02 PP069 $\sim 95 \%$ 100 % 78 % ? Vellew/ brown BLACK OAK QUVE-02 PP074 100 % $\sim 05 \%$ 100 % 100 % WHITE OAK QUAL-02 PP075 ~100 % ~65 % ? 100 % 100 % BLACK OAK QUVE-03 PP081 $\sim 85 \%$? 100 % 100 % 100 % BLACK OAK QUVE-03 PP081 $\sim 85 \%$? 100 % 100 % 100 % BLACK OAK QUVE-04<	SHADBUSH	AMSP-03	PP056	100%				
YEL. BIRCH BEAL-03 PP059 100% 91% 60%	BLACK GUM	NYSY-02	PP057	100%				
BLACK GUM NYSY-03 PP059A $(10\% - \sqrt{97\%})$ $00\% \sqrt{7}$ $00\% 7$	YEL. BIRCH	BEAL-03	PP059	100%				
RED OAK QURU-02 PP061 $\sim q_0 \chi_{1}^{2}$ $\wedge 49 \chi_{1}^{2}$ brown (gitter) RED MAPLE ACRU-03 PP063 100 % 100 % 100 % 100 % STR. MAPLE ACPE-04 PP067 $\sim 160 \%$ 90 % 90 % 90 % 90 % STR. MAPLE ACPE-04 PP067 $\sim 160 \%$ $\sim 75 \%^{2}$ 90 % 90 % RED MAPLE ACRU-04 PP074 100% $\sim 05 \%^{2}$ 90 % 90 % RED MAPLE ACRU-04 PP075 $\sim 100 \%$ $\sim 05 \%^{2}$ 90 % 90 % RED MAPLE ACRU-04 PP079 $\sim 91 \%$ $\sim 65 \%^{2}$ 90 % 90 % SLACK OAK QUVE-03 PP081 $\sim 85 \%^{2}$ $\sim 75 \%^{2}$ 90 % 90 %		NYSY-03	PP059A					
RED MAPLE ACRU-03 PP063 100 % 100 % 100 % STR. MAPLE ACPE-04 PP067 ~100 % ~78 % Vellew/brown BLACK OAK QUVE-02 PP069 ~98 % ? ~55 % ? Vellew/brown BLACK OAK QUVE-02 PP074 100 % 100 % 100 % WHITE OAK QUAL-02 PP075 ~100 % 100 % 100 % WHITE OAK QUAL-02 PP075 ~100 % 100 % 100 % BLACK OAK QUVE-03 PP081 $\sim 85 \%$? $egl(sur/gels/brown 100 % BLACK OAK QUVE-03 PP081 \sim 85 \% ? \sim 75 \% ? brown/rel / yellow BLACK OAK QUVE-03 PP083 ~70 % ? \sim 52 \% ? brown/rel / yellow BLACK OAK QUVE-03 PP084 \sim 40 \% ? \sim 33 \% ? brown/rel / yellow BLACK OAK QUVE-03 PP084 \sim 40 \% ? \sim 35 \% ? yellow/leftow brown/rel / yellow BLACK OAK QUVE-03 PP084 \sim 70 \% ? \sim 95 \% ? yellow/leftow brown/rel / yellow $	RED OAK		PP061					
STR. MAPLE ACPE-04 PP067 $\sim 100\%$ $\sim 78\%^2$ $\psi ll_4 \omega / \delta roum$ BLACK OAK QUVE-02 PP069 $\sim 98\%^2$ $\sim 55\%^2$ $l_{roum} r \psi r ll_{0\omega}$ RED MAPLE ACRU-04 PP074 $loo\%$ $v o 5\%^2$ $l_{roum} r \psi r ll_{0\omega}$ WHITE OAK QUAL-02 PP075 $\sim 100\%$ $v o 5\%^2$ $l_{roum} r \psi r ll_{0\omega}$ BLACK OAK QUVE-03 PP079 $\sim 97\%$ $\sim 65\%^2$ $l_{roum} r \psi r ll_{0\omega}$ BLACK OAK QUVE-03 PP081 $\sim 85\%^2$ $\sim 75\%^2$ $l_{roum} r \psi r ll_{0\omega}$ BLACK OAK QUVE-04 PP083 $\sim 70\%^2$ $n 15\%^2$ $l_{roum} r \psi r ll_{0\omega}$ BLACK OAK QUVE-03 PP084 $\sim 70\%^2$ $n 5\%^2$ $l_{roum} r \psi r ll_{0\omega}$ BLACK OAK QUVE-03 PP084 $\sim 70\%^2$ $n 5\%^2$ $l_{vlou} ll_{vlou}$ BLACK OAK QUVE-04 PP083 $\sim 70\%^2$ $n 5\%^2$ $l_{vlou} ll_{vlou}$ BLACK OAK QUVE-04 PP084 $\sim 70\%^2$ $n 5\%^2$ $l_{vlou} ll_{vlou}$ BLACK OAK QUVE-04 PP086 $\sim 73\%^2$ <th>RED MAPLE</th> <th></th> <th>PP063</th> <th></th> <th></th> <th></th> <th></th> <th>Didwint grindre</th>	RED MAPLE		PP063					Didwint grindre
BLACK OAK QUVE-02 PP069 $\sim q_{9}\chi$? $\sim 5\chi$? I.count (yet low) RED MAPLE ACRU-04 PP074 100% 100% Icount (yet low) WHITE OAK QUAL-02 PP075 ~100% Icount (yet low) BLK. BIRCH BELE-03 PP079 ~97% ~63%? Icount (yet low) BLK. BIRCH BELE-03 PP079 ~97% ~63%? Icount (yet low) BLK. BIRCH BELE-03 PP079 ~97% ~63%? Icount (yet low) BLK. BIRCH BELE-03 PP081 ~85%? ~75%? Icount (yet low) BLK. CHERRY PRSE-02 PP086 ~75%? Icount (yet low) Icount (yet low) BLK. CHERRY PRSE-02 PP086 ~13%? ~12%? Icount (yet low) PAPER BIRCH BEPA-02 PP087 ~96%? ~95%? Icount (yet low) PAPER BIRCH BEPA-03 PP089 ~100% ~95%? Icon (low) Icount (yet low) PAPER BIRCH BEPA-04 PP0991 ICO ICO ICO Icount (yet low) Icount (yet low) Icount								yellow brown
RED MAPLE ACRU-04 PP074 100 % 100 % 100 % 100 % WHITE OAK QUAL-02 PP075 ~100 % 65% biown/red/yellow BLK. BIRCH BELC03 PP079 ~19 % ~65%? biown/red/yellow BLACK OAK QUVE-03 PP081 ~85%? ~75 %? biown/red/yellow BLACK OAK QUVE-04 PP083 ~70 %? ~3%?? biown/red/yellow BLACK OAK QUVE-04 PP083 ~70 %? ~3%?? biown/red/yellow BLACK CAK QUVE-04 PP086 ~10 %? ~3%?? biown/red/yellow RED OAK QUVE-04 PP086 ~10 %? ~3%?? yellow/biown PAPER BIRCH BEPA-02 PP086 ~13 %? ~60 %? yellow/biown PAPER BIRCH BEPA-03 PP088 /00 % ~00 %? yellow/biown PAPER BIRCH BEPA-04 PP099 ~100 % ~95 %? yellow/biown WHITE ASH FRAM-02 PP091 (00 (00 yellow/biown yellow/biown SUG. MAPLE ACSA-02								
WHITE OAK QUAL-02 PP075 ~100 % ~65%? brown/rcl/yd/low BLX.K BIRCH BELE-03 PP079 ~99% ~63%? ydf/ar/gd/lown gdf/ar/gd/lown BLACK OAK QUVE-03 PP081 ~85%? ~75%? brown/rcl/yd/lown BLACK OAK QUVE-03 PP081 ~85%? ~75%? brown/rcl/yd/lown BLACK OAK QUVE-04 PP083 ~75%? brown/rcl/yd/lown brown/rcl/yd/lown RED OAK QURU-03 PP084 ~90%? ~3%?? yd/low/gd/lown BLK. CHERRY PRSE-02 PP086 ~13%? ~62%? yd/low/gd/lown PAPER BIRCH BEPA-02 PP087 ~90%? ~95%? yd/low/gd/lown PAPER BIRCH BEPA-04 PP089 ~100% ~95%? yd/low/gd/lown PAPER BIRCH BEPA-04 PP089 ~100% ~95%? yd/low/gd/lown WHITE ASH FRAM-02 PP091 (.00 (.00 100 100 SUG. MAPLE ACSA-02 PP095 ~6%?? ~3%?? brown/yd/lown 100% SUG. MA								6 rown period
BLK. BIRCH BELE-03 PP079 $\sim 91\%$ $\sim 63\%$			the second s					ha alreitveller
BLACK OAK QUVE-03 PP081 $\sqrt{g_{X_1}^2}$ $\sqrt{75}$ %? Import of the form of the for								usorifical groce w
BLACK OAK QUVE-04 PP083 ~ 702.2 $\sim 12\%2.2$ boows (rfd.) RED OAK QURU-03 PP084 $\sim 40\%2$ $\sim 3\%2.2$ yellow (boows) BLK. CHERRY PRSE-02 PP086 $\sim 73\%2$ $\sim 62\chi2.2$ yellow (boows) PAPER BIRCH BEPA-02 PP087 $\sim 90\%2.2$ $qellow (boows)$ PAPER BIRCH BEPA-03 PP088 $(eo\%)$ $(eo\%)$ PAPER BIRCH BEPA-04 PP089 $\sim 100\%$ $\sim 95\%2.2$ $qellow (boows)$ PAPER BIRCH BEPA-04 PP089 $\sim 100\%$ $\sim 95\%2.2$ $qellow (boows)$ PAPER BIRCH BEPA-04 PP089 $\sim 100\%2.2$ $\sim 95\%2.2$ $qellow (boows)$ PAPER BIRCH BEPA-04 PP099 $\sim 100\%2.2$ $\sim 95\%2.2$ $qellow (boows)$ PAPER BIRCH BEPA-04 PP0991 $<00\%2.2$ $qellow (boows)$ $qellow (boows)$ PAPER BIRCH BEPA-04 PP0992 $\sim 10\%2.2$ $\sim 5\%2.2$ $qellow (boows)$ BEEC OAK QUAL-03 PP093 $\sim 50\%2.2$ $\sim 5\%2.2$ $qellow (boows)$ $qellow (boows)$ <th></th> <td></td> <th></th> <td></td> <td></td> <td></td> <td></td> <td>general provident</td>								general provident
RED OAK QURU-03 PP084 $\sim 40\%$? $\sim 3\%$? $y the first fir$								
BLK. CHERRY PRSE-02 PP086 $\sim 13\%$? $\sim 62\%$? getter form PAPER BIRCH BEPA-02 PP087 $\sim 90\%$? $\sim 95\%$? $getter form PAPER BIRCH BEPA-03 PP087 \sim 90\%? \sim 95\%? getter form PAPER BIRCH BEPA-04 PP088 100\% \sim 100\% P007 WHITE ASH FRAM-02 PP091 100\% \sim 95\%? getter form BEECH FAGR-04 PP092 \sim 10\%? \sim 5\%? getter form BEECH FAGR-04 PP092 \sim 10\%? \sim 5\%? getter form WHITE OAK QUAL-03 PP093 \sim 50\%? \sim 3\%?? boxcm/(stime/tedcom/stim/stim/tedcom/stime/tedcom/stim/stime/tedcom/sti$								
PAPER BIRCH BEPA-02 PP087 $\sim 90\%?$ $\sim 95\%?$ with the sum PAPER BIRCH BEPA-03 PP088 100% 100% 100% PAPER BIRCH BEPA-04 PP089 $\sim 100\%$ 100% 100% WHITE ASH FRAM-02 PP091 100% 100% 100% BEECH FAGR-04 PP092 $\sim 5\%?$ 100% 100% WHITE OAK QUAL-03 PP092 $\sim 5\%?$ 100% 100% SUG. MAPLE ACSA-02 PP095 $\sim 60\%?$ $-3\%?$ 50% $50\%?$ $3\%?$ SUG. MAPLE ACSA-03 PP096 $\sim 100\%$ $7\%?$ $-3\%?$ 50% $50\%?$ $50\%?$ SUG. MAPLE ACSA-03 PP103 $\sim 71\%?$ $-3\%?$ 50% $50\%?$	and a second							yellow brown
PAPER BIRCH BEPA-03 PP088 $(e \circ \chi)$ $e \circ (o \circ \chi)$ $e \circ (o \circ \chi)$ PAPER BIRCH BEPA-04 PP089 $e \circ (o \circ \chi)$ $e \circ (s \circ \chi)$ $\forall e(t \circ (s \circ (s \circ \chi)))$ WHITE ASH FRAM-02 PP091 $(\odot \circ \chi)$ $(\odot \circ \chi)$ $\forall e(t \circ (s \circ (s \circ \chi)))$ BEECH FAGR-04 PP092 $e \circ (s \circ \chi)$ $e \circ (s \circ \chi)$ $\forall e(t \circ (s \circ $								Selim (b DWn
PAPER BIRCH BEPA-04 PP089 $\sim 100\%$ $\sim 95\%$? $\forall 1100\%$ $\forall 100\%$ $\forall 91100\%$ $\forall 1100\%$ $\forall 100\%$ $\forall 100\%$ <								ganow wawn
WHITE ASH FRAM-02 PP091 100								a.k. //
BEECH FAGR-04 PP092 $\sim 6 \times 2^{\circ}$ $\sim 5 \times 2^{\circ}$ Yellow/ brown WHITE OAK QUAL-03 PP093 $\sim 5 \times 2^{\circ}$ $\forall x = 1 \times 2^{\circ}$ $\forall x = 1 \times 2^{\circ}$ SUG. MAPLE ACSA-02 PP095 $\sim 6^{\circ} 7 \times 2^{\circ}$ $3 \times 2^{\circ}$ $b = 0 \times 2^{\circ} \times 2^{\circ}$ $b = 0 \times 2^{\circ} \times 2^{\circ}$ WHITE ASH FRAM-03 PP096 $\sim 10^{\circ} 2^{\circ}$ $9 \times 2^{\circ}$ $b = 0 \times 2^{\circ} \times 2^{\circ}$ $b = 0 \times 2^{\circ} \times 2^{\circ}$ SUG. MAPLE ACSA-03 PP103 $\sim 72 \times 2^{\circ}$ $\psi = 1 \times 2^{\circ} \times 2^{\circ}$ $b = 0 \times 2^{\circ} \times 2^{\circ}$ SUG. MAPLE ACSA-03 PP103 $\sim 72 \times 2^{\circ} \times 4^{\circ} \times 2^{\circ}$ $a = 0 \times 2^{\circ} \times 2^{\circ} \times 2^{\circ}$ $a = 0 \times 2^{\circ} \times 2^{\circ} \times 2^{\circ}$ BLK. CHERRY PRSE-04 PP104A $\sim 80 \times 2^{\circ} - 55 \times 2^{\circ}$ $g = 0 \times 2^{\circ} \times 2^{\circ} \times 2^{\circ} \times 2^{\circ}$ $g = 0 \times 2^{\circ} \times 2^{$								Junan BUNN
WHITE OAK QUAL-03 PP093 $\sim 50\%$? $\sim 3\%$?? browner/vellow/red. constraints SUG. MAPLE ACSA-02 PP095 $\sim 67\%$? $\sim 3\%$? browner/vellow/red. constraints WHITE ASH FRAM-03 PP096 $\sim 100\%$ 98 %? browner/vellow/red. SUG. MAPLE ACSA-03 PP103 $\sim 97\%$? $\sim 42\%$? browner/vellow/red. BLK. CHERRY PRSE-04 PP104A $\sim 80\%$? $\sim 55\%$? prink/vellow/red. RED OAK QURU-04 PP106 $\sim 50\%$? $\sim 5\%$? yether/browner/vellow/red. RED MAPLE ACRU-05 PP106 $\sim 100\%$ $\sim 96\%$? vellow/locate WHITE ASH FRAM-04 PP108 $\sim 80\%$? $\sim 55\%$? vellow/locate								
SUG. MAPLE ACSA-02 PP095 $\sim 67\%$ $\sim 3\chi^2$ orange (yellow) WHITE ASH FRAM-03 PP096 $\sim 67\%$ $\sim 3\chi^2$ orange (yellow) SUG. MAPLE ACSA-03 PP096 $\sim 60\%$ 98% orange (yellow) SUG. MAPLE ACSA-03 PP103 $\sim 97\%^2$ $\sim 42\%^2$ orange (yellow) SUG. MAPLE ACSA-04 PP104A $\sim 80\%^2$ $\sim 42\%^2$ orange (yellow) SED. CHERRY PRSE-04 PP104A $\sim 80\%^2$ $\sim 55\%^2$ prink (yellow) RED OAK QURU-04 PP105 $\sim 50\%^2$ $\sim 5\%^2$ yellow) RED MAPLE ACR-05 PP106 $\sim 100\%$ $\sim 90\%^2$ iced (yellow) WHITE ASH FRAM-04 PP108 $\sim 80\%^2$ $\sim 55\%^2$ yellow)								yellow/ brown.
WHITE ASH FRAM-03 PP096 ~ 100% 98%? bread SUG, MAPLE ACSA-03 PP103 ~ 97%? ~ 42%? Deceme / 42%								brown (rellian (red. (por S's faller))
SUG. MAPLE ACSA-03 PP103 $\sqrt{27 \chi^2}$ $\sqrt{42 \chi^2}$ arcmits (yellow) (sd. BLK. CHERRY PRSE-04 PP104A $\sim 80 \chi^2$ $\sim 55 \chi^2$ prink (yellow) RED OAK QURU-04 PP105 $\sim 50 \chi^2$ $\sim 52 \chi^2$ getted (yellow) RED MAPLE ACR-05 PP106 $\sim 100 \chi$ $\sim 90 \chi^2$ ted (yellow) WHITE ASH FRAM-04 PP108 $\sim 80 \chi^2$ $\sim 55 \chi^2$ yellow) (brown)						_		
BLK. CHERRY PRSE-04 PP104A ~ 80 % ? ~ 55 % ? Prink [vellow] RED OAK QURU-04 PP105 ~ 55 % ? gellow [vellow] gellow [vellow] RED MAPLE ACRU-05 PP106 ~ 100 % ~ 10 % ? gellow [vellow] WHITE ASH FRAM-04 PP108 ~ 80 % ? ~ 55 % ? vellow [vellow]								
RED OAK QURU-04 PP105 ~ 50 % ? ~ 50 % ? getting (brown (rec. 7% for f. ?)) RED MAPLE ACRU-05 PP106 ~ 100 % ~ 10 % ? red fighting WHITE ASH FRAM-04 PP108 ~ 80 % ? ~ 55 % ? Wellow (brown (rec. 7% for f. ?))								
RED MAPLE ACRU-05 PP106 ~ 100 % ~ 10 % red fullion WHITE ASH FRAM-04 PP108 ~ 80 % ~ 55 % ted fullion								
VHITE ASH FRAM-04 PP108 ASON ASSA?	the second se	and the second se						
STREAM BY # 10 flowing very well sconymous lower with the					~55%7			yellow/ how /perple
STREAM BY # 84 Jay Invest and provent HEMLOCK HOLLOW of full Cloud have N on 150 - 5	STREAM BY # 1 STREAM BY # 4	0 flowing 2 flowing	y very we gently P	ll whiles a full a p formar day		LOW	~ full	Everymous laws - Esta - 15%

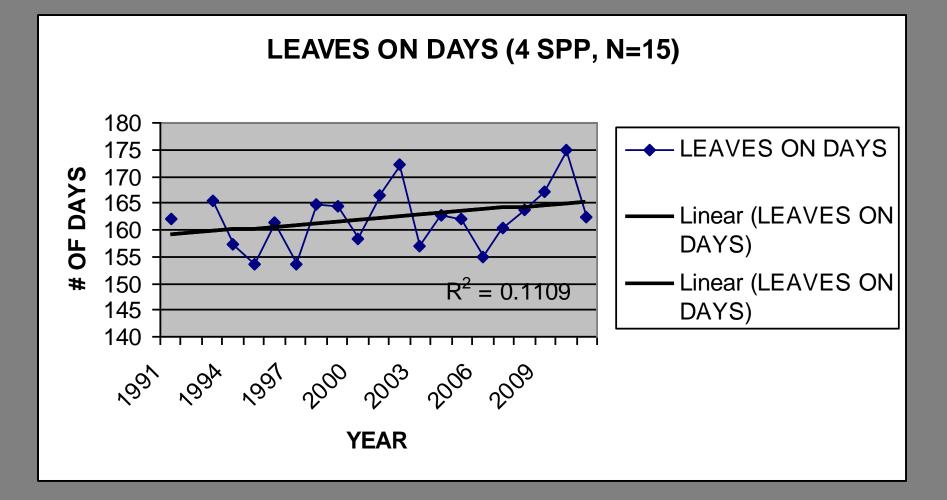
DATE TREE ID	TAG	LF COLOR L	F FALL FOPEN	FPAST	COMMENTS	CIRCUIT
9/2/2004 AMSP-01	PP003	0	0			1
9/7/2004 AMSP-01	PP003	1	0			1
9/16/2004 AMSP-01	PP003	3	1			1
9/23/2004 AMSP-01	PP003	5	1			1
9/30/2004 AMSP-01	PP003	23	2			1
10/7/2004 AMSP-01	PP003	45	5			1
10/12/2004 AMSP-01	PP003	95	35			1
10/16/2004 AMSP-01	PP003	99	92			1
10/22/2004 AMSP-01	PP003	100	100			1
10/28/2004 AMSP-01	PP003	100	100			1
11/4/2004 AMSP-01	PP003	100	100			1
11/16/2004 AMSP-01	PP003	100	100			.1
9/2/2004 FRAM-01	PP004	15	0			2
9/7/2004 FRAM-01	PP004	18	1			2
9/16/2004 FRAM-01	PP004	50	5			2
9/23/2004 FRAM-01	PP004	65	8			2
9/30/2004 FRAM-01	PP004	95	70			2
10/7/2004 FRAM-01	PP004	100	98			2
10/12/2004 FRAM-01	PP004	100	100			2
10/16/2004 FRAM-01	PP004	100	100			2
10/22/2004 FRAM-01	PP004	100	100			2
10/28/2004 FRAM-01	PP004	100	100			2
11/4/2004 FRAM-01	PP004	100	100			2
11/16/2004 FRAM-01	PP004	100	100			2
9/2/2004 PRSE-01	PP005	3	1			3
9/7/2004 PRSE-01	PP005	3	1			3
9/16/2004 PRSE-01	PP005	18	5			3
9/23/2004 PRSE-01	PP005	18	15			3
9/30/2004 PRSE-01	PP005	15	17			3
		17	27			3
10/7/2004 PRSE-01	PP005					
10/12/2004 PRSE-01	PP005	40	50			3
10/16/2004 PRSE-01	PP005	65	55			3
10/22/2004 PRSE-01	PP005	80	73			3
10/28/2004 PRSE-01	PP005	95	85			3
11/4/2004 PRSE-01	PP005	100	100			3
11/16/2004 PRSE-01	PP005	100	100			3
9/2/2004 ACRU-01	PP008	1	0			4
9/7/2004 ACRU-01	PP008	1	0			4
9/16/2004 ACRU-01	PP008	7	1			4
9/23/2004 ACRU-01	PP008	10	2			4
9/30/2004 ACRU-01	PP008	22	8			4
10/7/2004 ACRU-01	PP008	80	15			4
10/12/2004 ACRU-01	PP008	100	90			4
10/16/2004 ACRU-01	PP008	100	100			4
10/22/2004 ACRU-01	PP008	100	100			4
10/28/2004 ACRU-01	PP008	100	100			4
11/4/2004 ACRU-01	PP008	100	100			4
11/16/2004 ACRU-01	PP008	100	100			4
9/2/2004 AMSP-02	PP011	0	0			5
9/7/2004 AMSP-02	PP011	0	0			5
9/16/2004 AMSP-02 9/16/2004 AMSP-02	PP011	3	0			5
9/23/2004 AMSP-02	PP011	3	0			5
9/30/2004 AMSP-02	PP011	7	1			5
10/7/2004 AMSP-02	PP011	20	2			5
10/12/2004 AMSP-02	PP011	90	10			5
10/16/2004 AMSP-02	PP011	99	30			5
10/22/2004 AMSP-02	PP011	100	82			5

50% bud break(BB) 75% leaf development(75) and 50% leaf fall(L50) for 4 species (Acer rubrum-ACRU, Betula alleghaniensis-BEAL, Quercus rubra-QURU and Q. alba-QUAL)



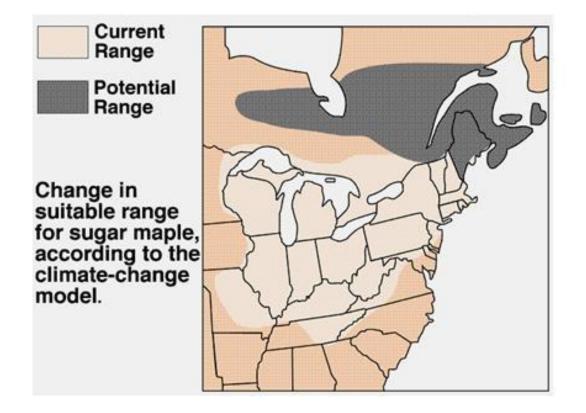




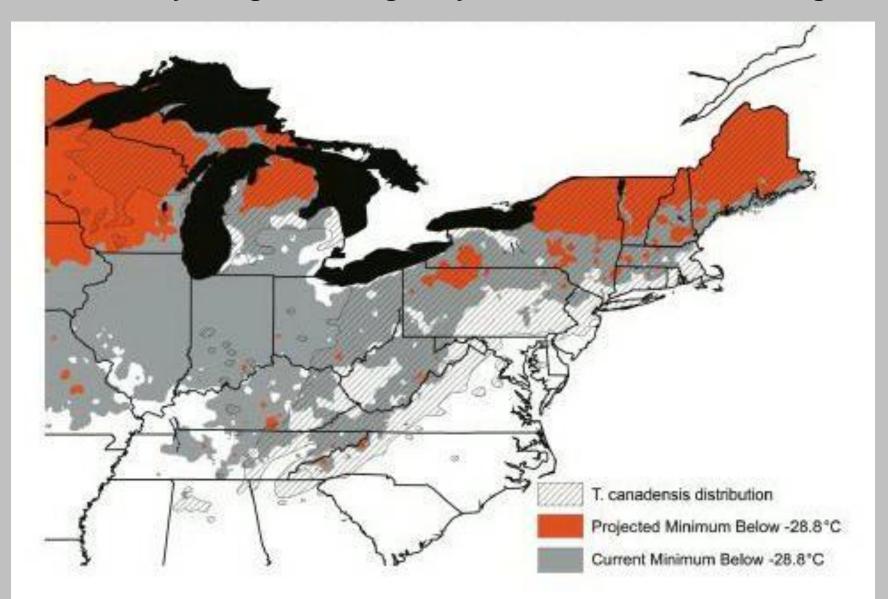


Impacts of Climate Warming

Climate models predict that most of New England will be outside the range of sugar maple by the end of this century



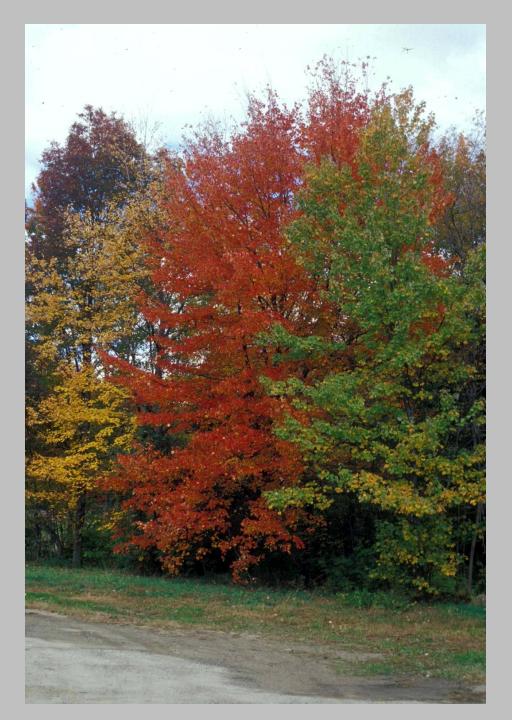
The occurrence of temperatures cold enough to limit the survival of hemlock woolly adelgid will be greatly reduced in central New England



Choosing a Site and Trees

- **Sites** with a variety of native trees (when possible) with branches in easy reach of students, located in an easily monitored area, are best.
- **Trees in reach**-each study tree should have two or more branches on which students can reach and monitor 6 leaves.
- **Trees that will last**-try to pick trees that will have a low chance of being cut for maintenance or vandalized. This can be a challenge!
- **Tree variety**-a variety of native tree species is best, especially for comparing results across the region.
- **Tree branches**-try to use two or more branches on each tree (for replication), with one branch for each student research team.

A site with maples and birches having many branches within easy reach for this study.



Tree ID tips

- The first thing to look at is the arrangement of leaves, buds and branches. Are they opposite each other or staggered alternately along the branch or stem.
- Only a few native trees (maples, ashes, dogwoods MAD) have opposite leaves/branches. The rest are alternate.
- Are the leaves simple (each leaf has a bud at the base of its stem or petiole) or compound (the leaf stem that is attached to the woody twig next to the bud has many leaflets along it)? The ashes, boxelder(ashleaf maple), hickories, walnut, butternut and sumacs are the main compound leaf species in this region.
- Then look at leaf shape, edges and vein pattern, bud shape and check for twig smell and bark characteristics.

Site preparation

- You will need one branch with 6 leaves/buds for each student team participating in the study.
- Label (with flagging) each tree in your study, 1 through X (X= total number of trees) and record the species of each tree. Plan to observe at least two branches on each study tree.
- Label (with flagging) each branch being studied on each tree with a letter, A, B, C,...etc. So each study branch will be identified with a tree number and branch letter (i.e. 1A, 1B, 1C, 2A etc.)
- If a branch (or tree) dies, not that unusual, try to pick another branch on that tree and use the next letter, pick a branch on another study tree of the same species and use the next letter for that tree, or try to find another tree of that species and add it to your study with new tree and branch labels.

Labeling leaves/buds

- This is probably the hardest part of this study, but it is necessary to ensure consistency in data collection. The teacher should choose and label trees and branches (6 leaves/buds per branch) before bringing students to the site.
- Branches are labeled by tying a piece of flagging or tape (with the tree and branch number/letter) just behind the 6 study leaves/buds on the branch.
- When choosing and labeling leaves/buds do not use the terminal/tip leaf/bud, but start counting at the next leaf from the tip as #1, then the next as #2, etc. On opposite leaved trees #1 and #2 will be paired across from each other. If there is a side branch on your main branch before you reach #6, use the tip bud on the side branch as the next # and continue using buds down the side branch until you reach #6 or, if necessary, return to leaves on the main branch. Note, you do use the tip bud on side branches, just not on the main branch.



Tagging a gray birch branch



Tag placed below the sixth leaf/bud (not counting the terminal leaf/bud).

Fall Data Collection

- Start data collection about the second week in Sept. and continue until all leaves have fallen or turned brown (many oaks and beech), in late Oct. or early Nov.
- Try to collect data once a week.
- Each student team will observe the 6 leaves closest to the branch tip (skipping the terminal leaf if there is one) that have been previously labeled.
- One the first visit they will also measure the length (not including the petiole or stem) and width of the leaves for comparison in the spring, being careful not to pull any leaves off.
- They will record approximately what fraction (see data sheet) of each leaf is not green or if the leaf has fallen.
- They will record what fraction of the leaves on the whole tree are not green.
- The teacher will combine all data for each tree and submit to Harvard Forest.

Field Notes/Observations

- These notes are optional and not submitted, but represent the type of observations scientists make when they are collecting their data.
- Typical observations might include temperature, cloud cover, precipitation, wildlife observations, any unusual conditions or recent events/changes such as a strong windstorm or frost/freeze.



Harvard Forest Schoolyard Ecology Buds, Leaves, and Global Warming

Autumn Student Data Sheet

December 2007

Name:			Da	te:						
Teacher:	School:									
Tree Number: Tree Species:						Please measure leaves only once at beginning of season.				
	Leaf 1	Leaf 2	Leaf 3	Leaf 4	Leaf 5	Leaf 6				
Leaf Length (cm.)										
Leaf Width(cm.)										

Put a check mark in the correct column below to show Leaf Color and Leaf Drop

Leaf #	Fraction/	Percent of I	eaf Color (I	not green)	Leaf Drop
	0 - 25%	26 - 50%	51 – 75%	76 - 100%	0-not fallen 1- fallen
14					
2					
3					
4					
5					
6					
Whole Tree					N/A

Total number of study leaves observed per branch (fallen and not fallen)

Total number of leaves fallen

Teacher note: Remember that the branch total above must be added with branch totals from all branches on the same tree to get the total number of leaves dropped per tree to submit to Harvard Forest to post online.

Optional Field Notes:

Weather Notes:

Animal/ Plant notes:

Buds, Leaves and Global Warming

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- <u>www.harvardforest.harvard.edu/schoolyard-lter-program</u>
- <u>www.harvardforest.harvard.edu/buds-leaves-global-</u> warming
- <u>www.harvardforest.harvard.edu/autumn-foliage-color</u>