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Supplementary Information for

Trait velocities reveal that mortality has driven widespread coordinated shifts in forest hydraulic trait composition

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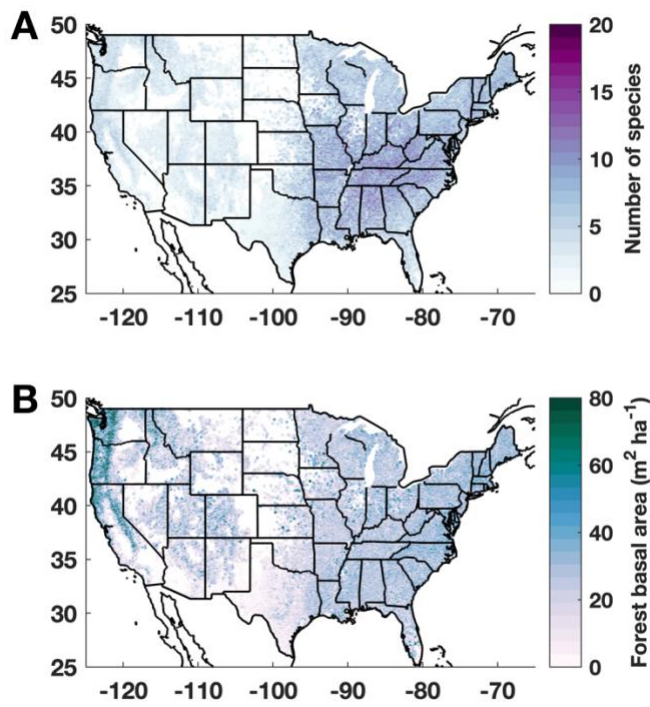


Fig. S1: Species diversity (**A**) and forest basal area (**B**) at the most recent census derived from the U.S. Forest Service Forest Inventory and Analysis (FIA) long-term permanent plot network.

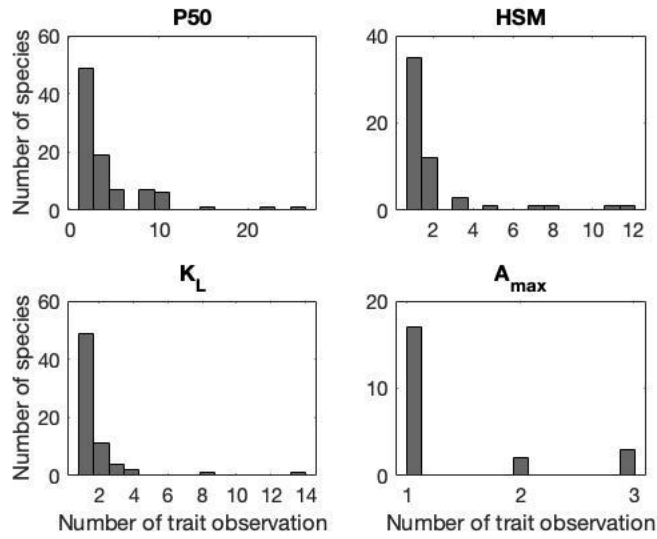


Fig. S2. Trait observations and species frequency of FIA species in the Xylem Functional Traits database.

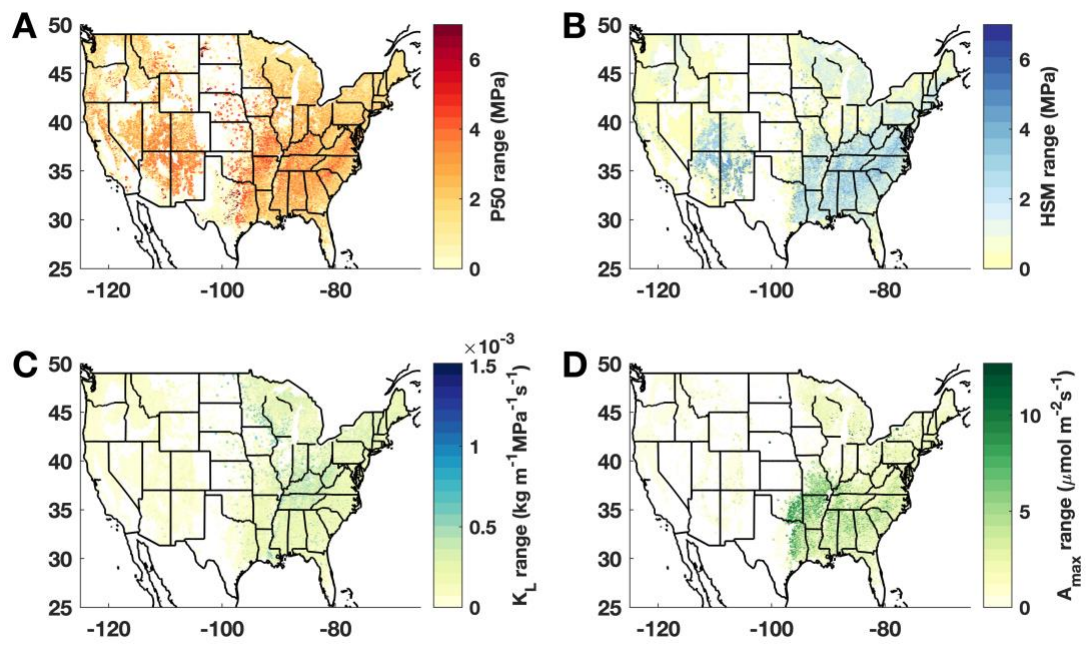


Fig. S3: Same as Fig. 2 except white space indicates non-forested regions or regions where trait coverage was less than 30% by stand basal area.

Table S1: Shifts in population mean P50 and HSM (in MPa) between the first and last inventory for different forest types and trait dataset versions including the base version (Base), phylogenetically imputed version (P-imputed), and strict quality control version (Strict Q-control). See Methods for further details. Significance values from Wilcoxon sign-ranked test are indicated in parentheses. NS indicates no significant shift in population mean.

Forest group	Base	P-imputed	Strict Q-control
$\Delta P50$ (MPa)			
Total	-0.0097 ($\ll 0.0001$)	-0.011 ($\ll 0.0001$)	-0.0080 ($\ll 0.0001$)
Angiosperm	0.0020 (0.017)	0.0018 ($\ll 0.0001$)	-0.0081 ($\ll 0.0001$)
Gymnosperm	-0.0196 ($\ll 0.0001$)	-0.024 ($\ll 0.0001$)	-0.0080 ($\ll 0.0001$)
ΔHSM (MPa)			
Total	NS	0.018 ($\ll 0.0001$)	_____
Angiosperm	-0.0073 (0.030)	0.014 ($\ll 0.0001$)	_____
Gymnosperm	NS	0.0211 ($\ll 0.0001$)	_____

Table S2: Response coefficients and significance levels of trait velocities calculated between the first and last inventory (MPa yr⁻¹) associated with mortality and time of final census for different forest types and regions, including eastern and western U.S., angiosperm-dominated forests, gymnosperm-dominated forests, and excluding plots dominated by trees known to suffer from major pest or pathogen mortality in recent years (piñon pine, lodgepole pine, red and white oak, eastern hemlock, and green and white ash), for trait dataset versions including the base version (Base), phylogenetically imputed version (P-imputed), and strict quality control version (Strict Q-control), with and without outliers that drive overdispersion diagnosed using Q-Q plots (OE = outliers excluded). See Methods for further details. Significance values are indicated in parentheses and NS indicates no significant association. The number of plots included in each model is detailed in Table S5.

Forest group		Base	Base (OE)	P-imputed	P-imputed (OE)	Strict Q-control	Strict Q-control (OE)
ΔP50 (MPa yr⁻¹)							
Total	Mort	-0.000636 (<0.001)	-0.000865 (<<0.0001)	-0.000620 (<0.0001)	-0.000612 (<<0.0001)	-0.000774 (<<0.0001)	-0.00102 (<<0.0001)
	Time	-0.000342 (0.044)	NS	-0.000314 (0.032)	NS	NS	0.000162 (0.021)
Angio	Mort	-0.001831 (<0.0001)	-0.00155 (<<0.0001)	-0.00162 (<<0.0001)	-0.00127 (<<0.0001)	-0.000776 (0.0026)	-0.00130 (<<0.0001)
	Time	NS	0.000400 (0.0025)	NS	0.000236 (0.033)	0.000552 (0.032)	0.000294 (0.013)
Gymno	Mort	NS	-0.000388 (0.0023)	NS	NS	-0.000762 (0.00018)	-0.000830 (<<0.0001)
	Time	-0.000543 (0.023)	-0.000369 (0.0023)	-0.000559 (0.0052)	-0.000216 (0.028)	-0.000549 (0.0066)	NS
West	Mort	NS	-0.00102 (<<0.0001)	NS	-0.00102 (<<0.0001)	NS	-0.00112 (<<0.0001)
	Time	-0.000960 (0.034)	NS	-0.00179 (<<0.0001)	-0.000389 (0.013)	NS	NS
East	Mort	-0.00101 (<<0.0001)	-0.000697 (<<0.0001)	-0.000696 (<0.0001)	-0.000485 (<<0.0001)	-0.000812 (<<0.0001)	-0.000992 (<<0.0001)
	Time	NS	NS	NS	NS	NS	0.000221 (0.0035)
No Piñon	Mort	-0.000462 (0.0069)	-0.000805 (<<0.0001)	-0.000510 (<0.001)	-0.000589 (<<0.0001)	-0.000437 (0.0035)	-0.000986 (<<0.0001)
	Time	NS	NS	NS	NS	NS	0.000207 (0.0019)
No Lodgepole	Mort	-0.000582 (<0.001)	-0.000855 (<<0.0001)	-0.000596 (<0.0001)	-0.000608 (<<0.0001)	-0.000731 (<<0.0001)	-0.00100 (<<0.0001)
	Time	-0.000341 (0.047)	NS	-0.000315 (0.033)	NS	NS	0.000156 (0.029)
No Oak	Mort	-0.000628 (<0.001)	-0.000915 (<<0.0001)	-0.000546 (<0.001)	-0.000614 (<<0.0001)	-0.000792 (<<0.0001)	-0.00104 (<<0.0001)
	Time	-0.00041482 (0.021)	NS	-0.00036554 (0.021)	NS	NS	0.000146 (0.039)
No Hemlock	Mort	-0.000644 (<0.001)	-0.000889 (<<0.0001)	-0.000636 (<<0.0001)	-0.000627 (<<0.0001)	-0.000774 (<<0.0001)	-0.00103 (<<0.0001)
	Time	-0.000340 (0.047)	NS	-0.000314 (0.034)	NS	NS	0.000163 (0.022)
No Ash	Mort	-0.000649 (<0.001)	-0.000879 (<<0.0001)	-0.000612 (<0.0001)	-0.000663 (<<0.0001)	-0.000780 (<<0.0001)	-0.00102 (<<0.0001)
	Time	-0.000361 (0.033)	NS	-0.000357 (0.014)	NS	NS	0.000160 (0.022)
ΔHSM (MPa yr⁻¹)							
Total	Mort	0.000833 (0.00082)	0.000594 (<<0.0001)	0.000979 (<<0.0001)	0.00109 (<<0.0001)	_____	_____
	Time	NS	-0.000313 (0.014)	0.000327 (0.036)	NS	_____	_____
Angio	Mort	0.00171 (0.00045)	0.001475 (<<0.0001)	0.00205 (<<0.0001)	0.00202 (<<0.0001)	_____	_____
	Time	NS	NS	NS	NS	_____	_____

Gymno	Mort	NS	NS	NS	0.000324 (0.0048)	_____	_____
	Time	NS	NS	NS	0.000221 (0.048)	_____	_____
West	Mort	0.000930 (0.032)	0.000598 (0.00049)	NS	0.000343 (0.0286)	_____	_____
	Time	0.00113 (0.0081)	0.000404 (0.017)	0.00112 (0.00088)	0.000487 (0.0013)	_____	_____
East	Mort	0.000755 (0.012)	0.000471 (0.0042)	0.00140 (<<0.0001)	0.00147 (<<0.0001)	_____	_____
	Time	-0.000861 (0.0040)	-0.000554 (0.00065)	NS	NS	_____	_____
No Piñon	Mort	0.000483 (0.050)	0.000518 (<0.0001)	0.000743 (<<0.0001)	0.00105 (<<0.0001)	_____	_____
	Time	-0.000677 (0.0058)	-0.000432 (<0.001)	NS	NS	_____	_____
No Lodgepole	Mort	0.000896 (<0.001)	0.000628 (<<0.0001)	0.001058 (<<0.0001)	0.00117 (<<0.0001)	_____	_____
	Time	NS	-0.000314 (0.017)	0.00033529 (0.033)	NS	_____	_____
No Oak	Mort	0.000758 (0.0031)	0.000500 (<0.001)	0.000900 (<<0.0001)	0.000905 (<<0.0001)	_____	_____
	Time	NS	-0.000290578 (0.024)	0.000397407 (0.018)	NS	_____	_____
No Hemlock	Mort	0.000833 (<0.001)	0.000594 (<0.0001)	0.000981 (<<0.0001)	0.00109 (<<0.0001)	_____	_____
	Time	NS	-0.000306 (0.016)	0.000330 (0.034)	NS	_____	_____
No Ash	Mort	0.000819 (0.0010)	0.000590 (<<0.0001)	0.000978 (<<0.0001)	0.00109 (<<0.0001)	_____	_____
	Time	NS	-0.000313 (0.014)	0.000316 (0.043)	NS	_____	_____

Table S3: Standardized response coefficients and significance levels of trait velocities calculated between the first and last inventory (MPa yr⁻¹) and CWD for different forest types, regions, and trait dataset versions including the base version (Base), phylogenetically imputed version (P-imputed), and strict quality control version (Strict Q-control), with and without outliers that drive overdispersion diagnosed using Q-Q plots (OE = outliers excluded). See Methods for further details. Significance values are indicated in parentheses and NS indicates no significant association.

Forest group	Base	Base (OE)	P-imputed	P-imputed (OE)	Strict Q-control	Strict Q-control (OE)
ΔP50 (MPa)						
Total	-0.127 (0.00051)	-0.0839 (<<0.0001)	-0.159 (<0.0001)	-0.0817 (<<0.0001)	-0.0943 (0.012)	-0.0628 (<0.0001)
Angiosperm	NS	NS	-0.122 (0.0016)	-0.0504 (0.00090)	NS	NS
Gymnosperm	-0.105 (<0.0085)	-0.0706 (<<0.0001)	-0.169 (<<0.0001)	-0.0415 (0.0018)	-0.0937 (0.021)	-0.0836 (<<0.0001)
West	-0.109 (0.043)	-0.0524 (0.017)	-0.127 (0.010)	-0.0580 (0.010)	NS	-0.0478 (0.034)
East	NS	NS	NS	NS	NS	NS
ΔHSM (MPa)						
Total	0.0900 (0.024)	0.0504 (0.0043)	0.145 (<0.0001)	0.0864 (<<0.0001)	_____	_____
Angiosperm	NS	NS	0.120 (0.0019)	0.0655 (<0.0001)	_____	_____
Gymnosperm	0.0904 (0.038)	0.0673 (0.00014)	0.111 (0.0040)	0.0948 (<<0.0001)	_____	_____
West	NS	NS	NS	NS	_____	_____
East	NS	NS	NS	NS	_____	_____

Table S4: Correlation (Spearman's rho) between trait velocities (MPa yr⁻¹) in P50 and HSM between the first and last inventory for different forest types calculated using the base version trait dataset. Significance values are indicated in parentheses.

Forest group	Spearman's rho
Total	-0.516 ($<<0.0001$)
Angiosperm	-0.565 ($<<0.0001$)
Gymnosperm	-0.460 ($<<0.0001$)

Table S5: Number of plots included in trait velocity analyses with trait coverage >80% by basal area at the first inventory for different trait dataset versions including the (Base), phylogenetically imputed version (P-imputed), and strict quality control version (Strict Q-control). See Methods for additional details.

Forest group	Base	P-imputed	Strict Q-control
$\Delta P50$ (MPa yr⁻¹)			
Total	34,874	59,842	22,614
Angio	16,859	30,239	7,956
Gymno	18,015	29,603	14,658
West	6,788	12,350	5,760
East	27,974	47,148	16,742
No Piñon	34,020	58,954	21,775
No Lodgepole	34,350	59,177	22,092
No Oak	31,475	53,902	22,166
No Hemlock	34,442	59,075	22,278
No Ash	34410	58,345	22,488
ΔHSM (MPa yr⁻¹)			
Total	16,384	45,889	-
Angio	5,797	22,283	-
Gymno	10,587	23,606	-
West	4,142	10,643	-
East	12,183	35,170	-
No Piñon	15,873	44,942	-
No Lodgepole	15,906	45,277	-
No Oak	15,161	40,533	-
No Hemlock	16,382	45,823	-
No Ash	16,294	45,300	-