

Crouch CD, Grady AM, Wilhelmi NP, Hofstetter RW, Moore MM, Waring KM. Extent, impacts, and drivers of oystershell scale invasions in aspen ecosystems. *NeoBiota*.

Supplementary table 1. Means and standard errors for the 92 continuous variables considered as potential influencing factors of plot-level OSS abundance, summarized across each of the seven major areas in our study.

Influencing factor	Mean (standard error)						
	North Kaibab	South Kaibab	Flagstaff	Prescott	Mogollon Rim	White Mountains	Coronado
Stand structure							
Aspen basal area ^a	4.2 (4.2)	6.4 (9.7)	13.0 (13.5)	8.8 (11.6)	3.0 (7.2)	11.1 (10.7)	11.4 (20.2)
All hosts basal area	4.2 (4.2)	6.4 (9.7)	13.0 (13.5)	9.0 (11.7)	3.0 (7.2)	11.1 (10.7)	11.4 (20.2)
Non-host basal area	12.0 (14.2)	7.6 (9.1)	9.8 (15.5)	4.4 (4.7)	12.5 (10.8)	13.5 (17.0)	19.7 (25.9)
Aspen overstory density ^b	28.8 (41.7)	105.2 (167.2)	213.9 (275.6)	73.1 (98.1)	126.3 (303.6)	282.5 (304.5)	63.9 (110.1)
Aspen sapling density	586.4 (890.9)	76.5 (203.5)	468.3 (1,063)	479.8 (867.3)	91.8 (276.8)	95.5 (223.3)	0.0 (0.0)
Aspen tall regeneration density	4,419 (7,335)	1,018 (1,858)	1,924 (9,285)	3,885 (4,868)	244.9 (521.0)	4,456 (11,177)	2,757 (5,284)
Aspen short regeneration density	8,471 (13,683)	6,802 (7,215)	9,164 (20,734)	3,242 (2,107)	9,427 (4,314)	8,220 (20,026)	22,310 (14,194)
All hosts overstory density	28.8 (41.7)	105.2 (167.2)	213.9 (275.6)	73.1 (98.1)	126.3 (303.6)	282.5 (304.5)	63.9 (110.1)
All hosts sapling density	586.4 (890.9)	76.5 (203.5)	468.3 (1,063)	514.9 (892.6)	91.8 (276.8)	95.5 (223.3)	0.0 (0.0)
All hosts tall regeneration density	4,419 (7,335)	1,018 (1,858)	1,924 (9,285)	4,669 (4,822)	244.9 (521.0)	4,456 (11,177)	2,757 (5,284)
All hosts short regeneration density	8,471 (13,683)	6,802 (7,215)	9,164 (20,734)	3,909 (2,421)	9,427 (4,314)	8,220 (20,026)	22,310 (14,194)
Non-host overstory density	188.5 (238.3)	74.6 (99.7)	110.9 (170.9)	58.5 (66.3)	118.6 (145.8)	147.2 (180.7)	156.3 (207.9)

Influencing factor	North Kaibab	South Kaibab	Flagstaff	Prescott	Mogollon Rim	White Mountains	Coronado
Non-host sapling density	167.5 (370.8)	76.5 (169.5)	37.0 (111.4)	46.8 (111.9)	107.1 (208.9)	87.5 (230.3)	85.3 (156.5)
Non-host tall regeneration density	293.2 (575.7)	191.3 (451.8)	40.5 (157.6)	1,029 (2,346)	168.3 (352.6)	127.3 (344.0)	596.8 (961.0)
Non-host short regeneration density	3,958 (8,123)	1,224 (2,314)	498.2 (1,454)	1,720 (2,765)	3,015 (4,526)	1,384 (5,698)	5,741 (8,153)
Ungulates							
Browse ^c	0.37 (0.28)	0.32 (0.35)	0.30 (0.34)	0.25 (0.20)	0.25 (0.26)	0.33 (0.24)	0.28 (0.30)
Ungulate barking ^c	0.00 (0.01)	0.06 (0.17)	0.03 (0.10)	0.00 (0.00)	0.06 (0.15)	0.00 (0.02)	0.00 (0.00)
Total ungulate scat ^d	8.4 (9.6)	3.0 (5.5)	1.1 (3.0)	0.4 (0.7)	3.1 (5.0)	6.0 (3.6)	3.0 (3.9)
Elk scat	0.0 (0.0)	2.8 (5.5)	0.4 (1.0)	0.0 (0.0)	3.1 (5.0)	5.0 (3.7)	0.0 (0.0)
Deer scat	8.0 (8.7)	0.2 (0.5)	0.3 (0.8)	0.4 (0.7)	0.0 (0.0)	0.6 (1.0)	3.0 (3.9)
Cattle scat	0.4 (1.4)	0.0 (0.0)	0.4 (2.3)	0.0 (0.0)	0.0 (0.0)	0.3 (0.7)	0.0 (0.0)
Damaging agents^c							
Sucking & gall-forming insects	0.16 (0.14)	0.05 (0.08)	0.07 (0.13)	0.09 (0.09)	0.16 (0.26)	0.11 (0.20)	0.08 (0.10)
Bark beetles	0.00 (0.01)	0.00 (0.01)	0.01 (0.03)	0.00 (0.00)	0.00 (0.00)	0.02 (0.05)	0.00 (0.00)
Wood-boring insects	0.48 (0.24)	0.24 (0.21)	0.17 (0.19)	0.30 (0.17)	0.16 (0.20)	0.24 (0.19)	0.03 (0.04)
Defoliating insects	0.60 (0.19)	0.56 (0.21)	0.55 (0.31)	0.61 (0.24)	0.68 (0.15)	0.75 (0.17)	0.85 (0.15)
Cytospora canker	0.01 (0.02)	0.03 (0.07)	0.02 (0.04)	0.03 (0.04)	0.02 (0.04)	0.03 (0.07)	0.00 (0.00)
Hypoxylon canker	0.00 (0.00)	0.00 (0.00)	0.00 (0.01)	0.00 (0.00)	0.00 (0.00)	0.01 (0.02)	0.00 (0.00)
Ceratocystis canker	0.04 (0.05)	0.00 (0.02)	0.01 (0.03)	0.02 (0.02)	0.01 (0.03)	0.08 (0.10)	0.00 (0.01)
Sooty bark canker	0.00 (0.00)	0.00 (0.00)	0.00 (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.01)	0.00 (0.00)
All cankers	0.53 (0.14)	0.32 (0.24)	0.34 (0.26)	0.09 (0.11)	0.11 (0.16)	0.54 (0.19)	0.03 (0.05)
Foliar & shoot diseases	0.18 (0.14)	0.24 (0.19)	0.18 (0.27)	0.06 (0.08)	0.19 (0.13)	0.14 (0.13)	0.74 (0.18)
Decay diseases	0.01 (0.04)	0.02 (0.04)	0.05 (0.11)	0.05 (0.06)	0.00 (0.00)	0.03 (0.05)	0.00 (0.01)
Abiotic damage	0.00 (0.01)	0.01 (0.03)	0.02 (0.07)	0.02 (0.04)	0.01 (0.01)	0.00 (0.01)	0.00 (0.01)
Other animal damage	0.01 (0.04)	0.01 (0.02)	0.01 (0.02)	0.00 (0.00)	0.00 (0.00)	0.01 (0.02)	0.00 (0.00)
Site factors							
Elevation (m above sea level)	2697 (67)	2393 (139)	2582 (159)	2059 (46)	2305 (51)	2853 (119)	2582 (159)

Influencing factor	North Kaibab	South Kaibab	Flagstaff	Prescott	Mogollon Rim	White Mountains	Coronado
Aspect ^e	0.75 (0.66)	1.21 (0.65)	0.87 (0.71)	1.71 (0.35)	0.77 (0.74)	0.78 (0.76)	1.79 (0.20)
Slope (°)	4.9 (4.5)	11.6 (10.0)	8.0 (7.2)	7.1 (4.3)	2.7 (3.0)	7.0 (2.5)	16.3 (7.4)
Heat load (MJ/cm ² /yr)	0.99 (0.02)	0.96 (0.07)	0.98 (0.08)	0.95 (0.03)	1.00 (0.03)	1.00 (0.05)	0.87 (0.10)
Radiation (MJ/cm ² /yr)	0.99 (0.04)	0.92 (0.12)	0.96 (0.08)	0.94 (0.05)	1.00 (0.01)	1.00 (0.04)	0.84 (0.09)
UTM easting	396422 (1886)	410677 (8727)	434335 (5411)	364491 (8218)	494638 (13092)	650996 (18608)	520833 (1262)
UTM northing	4039131 (8562)	3909453 (7935)	3910738 (4513)	3807999 (14347)	3805194 (7929)	3759419 (11454)	3589789 (621)
Soils							
Soil pH in H ₂ O (pHx10)	65.6 (4.3)	65.3 (2.6)	63.0 (1.7)	63.2 (2.1)	62.4 (1.7)	64.0 (1.1)	57.0 (1.7)
CEC (mmol(c)/kg at pH 7)	205.9 (9.7)	241.2 (12.1)	235.1 (7.5)	178.7 (2.6)	254.0 (9.4)	263.3 (6.0)	223.5 (20.7)
Nitrogen (cg/kg)	97.4 (12.2)	96.6 (16.3)	105.3 (13.8)	133.6 (36.8)	108.7 (14.3)	123.6 (16.7)	166.0 (21.2)
Soil organic carbon (dg/kg)	126.9 (6.8)	125.8 (20.6)	138.2 (21.5)	118.8 (28.5)	115.9 (15.1)	156.0 (18.8)	144.0 (12.4)
Bulk density (cg/cm ³)	149.0 (3.2)	151.7 (4.0)	148.0 (4.1)	150.0 (6.1)	151.7 (5.2)	140.3 (2.9)	132.1 (2.0)
Sand content (g/kg)	413.0 (9.2)	240.2 (28.8)	298.2 (57.8)	407.0 (66.7)	253.9 (25.6)	352.0 (68.2)	565.6 (25.7)
Clay content (g/kg)	265.1 (10.8)	336.7 (27.3)	255.7 (24.1)	302.1 (51.4)	357.1 (32.4)	226.6 (36.6)	153.8 (22.6)
Coarse fragments (cm ³ /dm ³)	170.2 (38.2)	146.0 (60.9)	166.0 (63.1)	188.4 (30.9)	188.4 (36.3)	247.0 (19.5)	258.3 (20.3)
Climate							
Degree-days below 0°C	332.2 (20.4)	285.4 (41.1)	389.9 (63.3)	112.6 (1.2)	168.6 (20.4)	323.3 (53.2)	181.6 (36.8)
Degree-days above 5°C	2,039 (77.9)	1,987 (152.8)	1,670 (148.8)	2,783 (22.6)	2,478 (67.2)	1,595 (125.2)	2,255 (241.9)

Influencing factor	North Kaibab	South Kaibab	Flagstaff	Prescott	Mogollon Rim	White Mountains	Coronado
Degree-days below 18°C	3,745 (91.7)	3,679 (194.5)	4,121 (225.0)	2,685 (12.5)	3,057 (98.9)	4,031 (210.2)	3,196 (271.3)
Degree-days above 18°C	185.7 (5.8)	159.6 (10.2)	88.6 (6.0)	373.8 (5.9)	288.4 (14.2)	46.9 (15.2)	171.5 (11.3)
Degree-days 10 – 40°C	1,059 (56.2)	990.1 (105.9)	773.9 (103.1)	1,493 (18.1)	1,307 (40.1)	662.4 (74.8)	1,106 (168.5)
Number of frost-free days	190.4 (5.8)	174.6 (10.2)	159.2 (6.0)	255.2 (5.9)	249.2 (14.2)	178.9 (15.2)	237.7 (11.3)
Frost-free period	133.1 (6.2)	108.4 (9.3)	93.7 (4.7)	173.9 (5.4)	173.7 (12.1)	107.7 (16.0)	158.2 (10.0)
Winter temperature (max) ^f	5.1 (0.3)	7.0 (0.9)	5.3 (1.1)	10.1 (0.4)	6.8 (0.7)	5.9 (0.5)	6.5 (0.9)
Spring temperature (max)	13.2 (0.3)	14.7 (0.8)	13.2 (0.8)	17.3 (0.3)	14.8 (0.5)	12.9 (0.7)	14.5 (1.1)
Summer temperature (max)	25.5 (0.3)	26.7 (0.8)	24.7 (1.3)	28.2 (0.1)	26.2 (0.3)	22.2 (0.7)	23.6 (1.2)
Autumn temperature (max)	16.5 (0.3)	18.0 (0.9)	16.1 (1.3)	18.9 (0.3)	17.2 (1.0)	15.6 (0.7)	17.2 (1.1)
Winter temperature (min)	-7.3 (0.3)	-7.3 (0.7)	-8.4 (0.6)	-2.2 (0.4)	-2.8 (1.1)	-7.9 (1.2)	-3.2 (0.6)
Spring temperature (min)	-0.9 (0.5)	-1.4 (0.6)	-2.4 (0.7)	3.1 (0.4)	3.0 (0.7)	-1.6 (0.9)	1.4 (0.8)
Summer temperature (min)	11.2 (0.4)	8.8 (0.6)	7.8 (0.4)	13.5 (0.3)	13.1 (0.6)	8.1 (0.7)	11.8 (0.9)
Autumn temperature (min)	1.8 (0.4)	0.4 (0.7)	-0.7 (0.3)	5.6 (0.3)	5.3 (0.9)	0.8 (1.0)	5.6 (0.7)
Winter temperature (mean)	-1.1 (0.2)	0.1 (0.7)	-1.3 (0.9)	4.0 (0.0)	2.3 (0.5)	-0.9 (0.7)	2.3 (0.7)
Spring temperature (mean)	5.9 (0.3)	6.8 (0.7)	5.6 (0.8)	10.5 (0.1)	9.1 (0.3)	5.5 (0.7)	8.5 (0.9)
Summer temperature (mean)	18.2 (0.4)	17.7 (0.7)	16.2 (0.9)	21.0 (0.1)	19.7 (0.2)	14.9 (0.5)	17.6 (1.0)
Autumn temperature (mean)	8.6 (0.3)	9.2 (0.7)	7.7 (0.8)	12.8 (0.1)	11.5 (0.4)	7.8 (0.6)	11.2 (0.9)
Precipitation as snow (annual) ^g	152.7 (24.5)	93.6 (20.3)	151.6 (73.0)	29.0 (7.6)	66.8 (3.5)	131.3 (53.3)	83.2 (29.9)
Winter precipitation ^e	208.7 (24.9)	211.2 (26.0)	226.8 (50.5)	274.0 (76.3)	357.7 (52.2)	228.6 (44.1)	397.4 (20.7)
Spring precipitation	165.1 (7.0)	122.0 (11.9)	135.4 (23.8)	123.0 (14.4)	134.7 (19.4)	97.1 (26.4)	104.1 (5.5)

Influencing factor	North Kaibab	South Kaibab	Flagstaff	Prescott	Mogollon Rim	White Mountains	Coronado
Summer precipitation	111.1 (4.5)	160.6 (11.0)	175.2 (13.9)	259.6 (13.9)	261.9 (32.7)	230.7 (25.4)	345.9 (27.2)
Autumn precipitation	84.6 (2.7)	113.3 (12.9)	111.2 (20.6)	188.4 (21.7)	228.3 (55.3)	153.9 (13.6)	232.9 (12.3)
Winter relative humidity ^h	53.0 (0.6)	48.2 (1.7)	48.8 (1.3)	56.9 (2.6)	64.1 (4.0)	48.5 (4.0)	62.9 (0.5)
Spring relative humidity	53.9 (1.0)	49.0 (0.9)	49.6 (1.0)	55.8 (1.9)	62.2 (2.7)	52.7 (2.5)	57.8 (0.7)
Summer relative humidity	57.1 (0.6)	48.2 (1.0)	50.2 (2.4)	57.7 (1.0)	60.7 (2.6)	57.3 (2.5)	62.4 (0.5)
Autumn relative humidity	53.7 (0.6)	46.1 (1.8)	47.5 (2.9)	58.6 (1.6)	62.4 (4.3)	53.2 (3.8)	63.4 (1.1)
Winter reference evaporation ^g	0.0 (0.0)	46.3 (26.9)	13.3 (15.6)	121.7 (3.1)	86.8 (3.4)	0.0 (0.0)	98.4 (13.9)
Spring reference evaporation	259.2 (13.3)	291.8 (10.0)	264.7 (23.7)	314.8 (5.9)	275.0 (8.6)	260.4 (20.9)	287.6 (14.2)
Summer reference evaporation	454.0 (3.4)	500.8 (14.6)	465.9 (25.4)	490.4 (5.0)	457.1 (12.8)	413.0 (15.8)	426.0 (18.2)
Autumn reference evaporation	213.9 (1.5)	240.9 (9.6)	222.3 (13.8)	237.4 (4.1)	217.0 (13.9)	217.0 (9.4)	224.3 (10.7)
Winter CMD ^g	0.0 (0.0)	11.5 (8.2)	5.9 (7.2)	21.3 (6.1)	3.5 (2.6)	0.0 (0.0)	0.0 (0.0)
Spring CMD	178.7 (3.9)	170.4 (21.7)	147.5 (14.7)	206.3 (7.5)	159.2 (14.5)	186.1 (24.8)	182.0 (12.5)
Summer CMD	355.5 (5.7)	393.1 (45.9)	353.9 (57.8)	260.6 (2.9)	281.0 (61.0)	204.8 (26.6)	209.4 (27.0)
Autumn CMD	150.3 (2.5)	169.4 (23.0)	154.5 (31.0)	100.6 (5.0)	103.8 (31.5)	79.8 (18.9)	121.7 (7.2)
Winter CMI ^g	17.4 (2.6)	15.6 (2.2)	18.7 (5.5)	17.8 (8.0)	29.0 (5.5)	18.3 (4.8)	31.9 (3.1)
Spring CMI	0.2 (1.0)	-8.2 (1.9)	-3.4 (4.3)	-13.1 (2.1)	-7.0 (2.5)	-6.4 (3.7)	-10.9 (2.7)
Summer CMI	-33.0 (0.7)	-33.2 (2.3)	-26.5 (4.0)	-21.4 (1.0)	-16.0 (4.8)	-14.1 (3.7)	-1.7 (5.0)
Autumn CMI	-14.0 (0.6)	-15.3 (1.8)	-11.4 (3.9)	-9.6 (2.8)	-1.2 (6.6)	-5.5 (2.1)	-0.1 (3.1)
Annual dryness index ⁱ	0.08 (0.01)	0.07 (0.01)	0.06 (0.01)	0.06 (0.01)	0.05 (0.01)	0.06 (0.01)	0.04 (0.01)
Annual heat moisture index ^j	44.3 (3.1)	35.3 (4.6)	33.1 (7.1)	24.2 (2.4)	23.6 (5.8)	25.5 (4.9)	20.8 (2.2)

Influencing factor	North Kaibab	South Kaibab	Flagstaff	Prescott	Mogollon Rim	White Mountains	Coronado
Summer heat moisture index ^k	224.3 (8.6)	143.6 (34.5)	124.6 (35.0)	61.1 (0.7)	83.8 (28.2)	56.9 (9.1)	72.0 (9.4)

^a basal area = m² ha⁻¹

^b density = trees ha⁻¹

^c proportion of aspen stems affected by damaging agent

^d scat = pellet piles/plot

^e 0–2 (0 = 225°, 1 = 135° or 315°, 2 = 45°)

^f temperature = °C

^g precipitation, evaporation, CMD, CMI = mm

^h relative humidity = %

ⁱ annual dryness index = annual degree days above 5°C ÷ annual precipitation

^j annual heat moisture index = (annual temperature + 10) ÷ (annual precipitation ÷ 1000)

^k summer heat moisture index = warmest month temperature ÷ (summer precipitation ÷ 1000)

Seasons for climate variables are winter (December – February), spring (March – May), summer (June – August), autumn (September – November).