HSPI The Open Access Publisher

J P S P JOURNAL OF PLANT SCIENCE AND PHYTOPATHOLOGY
ISSN 2575-0135

Opinion

Invasive and native woody plant encroachment: Definitions and debates

Irini Soubry* and Xulin Guo

Department of Geography and Planning, University of Saskatchewan, Saskatoon, Canada

Summary

In this short opinion piece, we discuss the appropriate use of the term 'invasion' for woody plant expansion and refer to the various ways in which the term is being used in the literature. We point out the present confusion and make suggestions for the use of a more appropriate term (i.e., 'woody plant encroachment'). We continue with an overview of the various definitions of 'woody plant encroachment in the literature, we mention associated alternative terms, and we explain the circumstances in which each of these are used. With this piece, we hope to provide more clarity on the use of correct terminology related to woody plant expansion research.

More Information

***Address for Correspondence:** Irini Soubry, Department of Geography and Planning, University of Saskatchewan, Saskatoon, Canada, Email: irini.soubry@usask.ca

Submitted: July 16, 2022
Approved: July 27, 2022
Published: July 28, 2022

How to cite this article: Soubry I, Guo X. Invasive and native woody plant encroachment: Definitions and debates. J Plant Sci Phytopathol. 2022; 6: 084-086.

DOI: 10.29328/journal.jpsp.1001079

The term "invasive", for plants, can have a different meaning depending on the context. From a conservationist point of view, plant invasion is strictly referred to as the expansion of non-native species [1]. However, from a landowner or land manager's point of view, the term "invasion" is often used for the expansion of native woody species into non-preferred (for the landowner and manager) pieces of land. A recent review that looked at the definition of invasive species included both native and non-native species in its final definition [2]. As it seems, there is confusion in the use of this terminology.

The expansion of woody species is a worldwide issue and can include both native and non-native species [3,4]. When referring to this phenomenon, the term "invasive" has been used inconsistently, and other terms used have different meanings depending on the study. For example, scientists have used the term "woody plant invasion" to examine the expansion of native woody species [5,6] and ecologists tend to use the term "woody plant encroachment", which can include native [7] or both native and non-native species [4].

In our view, the term "invasive" cannot be used for the expansion of native species, since they technically do not "invade" an area, but merely increase their cover from already existing stands through various pathways. For such circumstances, we prefer the use of the general term "encroachment". We further support the views of Moutou and Pastoret [1] and Chaneton, et al. [8], in using the term "invasive" only for non-native species that have an expansive character in the ecosystem of study, since not all non-native species have encroached capabilities, and some might be invasive in one area, and not in another [9]. For instance, the genetic potential of a woody plant has a higher chance to be reached under different, more optimal environments (including climate, soil, and nutrients) than in its home range; leading to more vigorous growth [4]. Therefore, we believe that "woody plant encroachment" (WPE) should be used as a more general term, including both the encroachment of native and non-native species, as supported by Archer, et al. [4].

There exist various definitions of WPE in the literature (Table 1). Archer, et al. [4] and Heisler, et al. [10] consider both native and non-native woody species in their definition, whereas Van Auken [11] considers only native. Except for the term "woody plant encroachment", the terms "woody plant invasion", "woody thicketization", "woody plant expansion", "invasion of woody weed", "xerification", and "invasion of shrubs" are also used (Table 2). As mentioned before, the term "woody plant encroachment" seems to be the best way of describing the expansion of woody plants, since it can include both native and non-native woody species. On the other hand, the term "woody plant invasion" or any other term that includes "invasion" is more confusing, since it is being used in the literature for both native and non-native species with an invasive character, even though it is most appropriate to be used for the latter case. Examples in the literature that uses the term "woody plant invasion" for native species are many [12-16], while those addressing non-native species are more [17-25]. Moving further, "woody thicketization" is a term that

Table 1: Definitions used for woody plant encroachment.

Term	Definition	Source
Woody plant encroachment	"The proliferation of trees and shrubs that can be non-native species that were introduced purposely or accidentally or native species that have either increased in abundance within their historic ranges or expanded their geographic range"	[4]
Woody encroachment	"A process that includes recruitment of new species (increase in richness) and the expansion of existing shrubs."	[10]
Brush, shrub or woody plant encroachment	"The increase in density, cover, and biomass of indigenous woody or shrubby plants in various grasslands"	[11]

Table 2: Alternative terms used for woody plant encroachment.

Term	Usual meaning	Example studies
Woody plant invasion	expansion of native and/or non-native woody species with an invasive character	[5,8,33]
Invasion of shrubs		[34-37]
Invasion of woody weed		[38]
Woody thicketization	infilling of shrubs and low stature trees in areas with rainfall > 400 mm	[28-30]
Woody thickening		[39-41]
Xerification	expansion of woody plants in arid environments where the grass is replaced by bare soil (< 400 mm precipitation)	[30,32]
Woody plant expansion	used instead of "woody plant encroachment"	[30,42]
Woody, bush, or shrub regrowth	used by rangeland managers to refer to the expansion of woody species	[5,16,43,44]
Bush encroachment	used instead of "shrub encroachment" in Africa	[45-48]

is related to the densification of shrubs and low-stature trees, which tend to fill the gaps between them, in areas with rainfall higher than 400 mm [26]. Although less common, there are example studies that use this type of terminology [4,27-30]. "Woody plant expansion" is a general term that is a good alternative to use for "woody plant encroachment". Lastly, "xerification" has been connected to the expansion of woody plants in arid environments (e.g., desert shrublands). There, water and nutrients concentrate below the woody canopy, degrading the spaces between them, and causing higher runoff and erosion; a phenomenon referred to as "islands of fertility" [31]. Example studies that use the term "xerification" are those of Archer, et al. [30] and Schreiner-McGraw [32]. Apart from the aforementioned terms, according to the review of Eldridge, et al. [29], other terms that are being used for WPE include "woody thickening", "regrowth", and "bush encroachment" (Table 2). "Woody thickening" is used interchangeably with "woody thicketization", "regrowth" is more commonly used by rangeland managers, while "bush encroachment" is a term that is more popularly used in studies conducted in the African continent. All in all, it seems that "woody plant encroachment" is the overarching term, which can be separated into "thicketization" or "xerification", depending on the precipitation gradient of a region [32].

References

1. Moutou F, Pastoret PP. Defining an invasive species. Rev Sci Tech. 2010 Apr;29(1):37-45, 27-35, 47-56. English, French, Spanish. PMID: 20617646.
2. Kim E, Song W, Yoon E, Jung H. Definition of Invasive Disturbance Species and its Influence Factor: Review. J Korea Soc Environ Restor Technol. 2016; 19(1):155-170.
3. Soubry I, Guo X. Quantifying Woody Plant Encroachment in Grasslands: A Review on Remote Sensing Approaches. Can J Remote Sens. 2022; 1-42.
4. Archer SR, Andersen EM, Predick KI, Schwinning S, Steidl RJ, Woods SR. Woody Plant Encroachment-Causes and Concequences. In: Briske DD, editor. Rangeland Systems-Processes, Management and Challenges. Cham, Switzerland: Springer Series on Environmental Management, Springer; 2017. 25–84.
5. Bond WJ, Midgley GF. A proposed CO2-controlled mechanism of woody plant invasion in grasslands and savannas. Glob Chang Biol. 2000; 6(8):865-869.
6. Mirik M, Chaudhuri S, Surber B, Ale S, James Ansley R. Detection of two intermixed invasive woody species using color infrared aerial imagery and the support vector machine classifier. J Appl Remote Sens. 2013; 7(1):1–13.
7. Van Auken OW. Causes and consequences of woody plant encroachment into western North American grasslands. J Environ Manage. 2009 Jul;90(10):2931-42. doi: 10.1016/j.jenvman.2009.04.023. Epub 2009 Jun 5. PMID: 19501450.
8. Chaneton EJ, Mazia N, Batista WB, Rolhauser AG, Ghersa CM. Woody Plant Invasions in Pampa Grasslands: A Biogeographical and Community Assembly Perspective. In: Ecotones Between Forest and Grassland. New York, USA: Springer; 2012; 115–44.
9. US Forest Service. Current Invasive Species Research at the Pacific Northwest (PNW) Research Station [Internet]. 2018. Available from: https://www.fs.fed.us/outernet/pnw/invasives/index.shtml
10. Heisler JL, Briggs JM, Knapp AK. Long-term patterns of shrub expansion in a C4-dominated grassland: fire frequency and the dynamics of shrub cover and abundance. Am J Bot. 2003 Mar;90(3):423-8. doi: 10.3732/ajb.90.3.423. PMID: 21659135.
11. Van Auken OW. Shrub Invasions of North American Semiarid Grasslands. Annu Rev Ecol Syst. 2000; 31(2000):197–215.
12. Burkinshaw AM, Bork EW. Shrub encroachment impacts the potential for multiple use conflicts on public land. Environ Manage. 2009 Sep;44(3):493-504. doi: 10.1007/s00267-009-9328-2. Epub 2009 Jul 9. PMID: 19588191.
13. Qiao L, Zou CB, Will RE, Stebler E. Calibration of SWAT model for woody plant encroachment using paired experimental watershed data. J Hydrol. 2015; 523:231-239.
14. Leis SA, Blocksome CE, Twidwell D, Fuhlendorf SD, Briggs JM, Sanders LD. Juniper Invasions in Grasslands: Research Needs and Intervention Strategies. Rangelands. 2017; 39(2):64–72.
15. Mirik M, Ansley RJ. Utility of Satellite and Aerial Images for Quantification of Canopy Cover and Infilling Rates of the Invasive Woody Species Honey Mesquite (Prosopis Glandulosa) on Rangeland. Remote Sens. 2012;4(7):1947–62.
16. Ansley RJ, Cooper C, Zhang T. Invasion promotes invasion: Facilitation of C_3 perennial grass dominance in mixed C_3/C_4 grassland by an invasive C_3 woody sprouter (*Prosopis glandulosa*). Ecol Evol. 2019 Nov 5;9(23):13438-13449. doi: 10.1002/ece3.5800. PMID: 31871656; PMCID: PMC6912915.

17. Tiscornia G, Jaurena M, Baethgen W. Drivers, process, and consequences of native grassland degradation: Insights from a literature review and a survey in Río de la Plata grasslands. Agronomy. 2019;9(5):8–12.

18. Hantson W, Kooistra L, Slim PA. Mapping invasive woody species in coastal dunes in the Netherlands: A remote sensing approach using LIDAR and high-resolution aerial photographs. Appl Veg Sci. 2012; 15(4):536-547.

19. Niphadkar M, Nagendra H, Tarantino C, Adamo M, Blonda P. Comparing Pixel and Object-Based Approaches to Map an Understorey Invasive Shrub in Tropical Mixed Forests. Front Plant Sci. 2017 May 31;8:892. doi: 10.3389/fpls.2017.00892. PMID: 28620400; PMCID: PMC5450565.

20. Gavier-Pizarro GI, Kuemmerle T, Hoyos LE, Stewart SI, Huebner CD, Keuler NS, et al. Monitoring the invasion of an exotic tree (Ligustrum lucidum) from 1983 to 2006 with Landsat TM/ETM+ satellite data and Support Vector Machines in Córdoba, Argentina. Remote Sens Environ. 2012; 122: 134-145.

21. Kattenborn T, Lopatin J, Förster M, Braun AC, Fassnacht FE. UAV data as alternative to field sampling to map woody invasive species based on combined Sentinel-1 and Sentinel-2 data. Remote Sens Environ. 2019;227(February):61-73.

22. West AM, Evangelista PH, Jarnevich CS, Young NE, Stohlgren TJ, Talbert C, Talbert M, Morisette J, Anderson R. Integrating Remote Sensing with Species Distribution Models; Mapping Tamarisk Invasions Using the Software for Assisted Habitat Modeling (SAHM). J Vis Exp. 2016 Oct 11;(116):54578. doi: 10.3791/54578. PMID: 27768080; PMCID: PMC5092193.

23. Diao C. Time series remote sensing in monitoring the spatio-temporal dynamics of plant invasions: a study of invasive saltcedar (Tamarix Spp.). University at Buffalo, the State University of New York; 2017.

24. Mazía N, Chaneton EJ, Ghersa CM. Disturbance types, herbaceous composition, and rainfall season determine exotic tree invasion in novel grassland. Biol Invasions. 2019;21(4):1351–63.

25. Kurokawa H, Peltzer DA, Wardle DA. Plant traits, leaf palatability and litter decomposability for co-occurring woody species differing in invasion status and nitrogen fixation ability. Funct Ecol. 2010;24(3):513–23.

26. Leite PA, Wilcox BP, McInnes KJ. Woody plant encroachment enhances soil infiltrability of a Semiarid Savanna. Environ Res Commun. 2020; 2:115005.

27. Archer S, Schimel DS, Holland EA. Mechanisms of shrubland expansion: land use, climate or CO2? Clim Change. 1995; 29(1):91-99.

28. Xiong X, Han X. Application of state and transition models to discussing the thicketization of steppe in Xilin River Basin, Inner Mongolia. Acta Prataculturae Sin. 2006; 15(2):9–13.

29. Eldridge DJ, Bowker MA, Maestre FT, Roger E, Reynolds JF, Whitford WG. Impacts of shrub encroachment on ecosystem structure and functioning: towards a global synthesis. Ecol Lett. 2011 Jul;14(7):709-22. doi: 10.1111/j.1461-0248.2011.01630.x. Epub 2011 May 19. PMID: 21592276; PMCID: PMC3563963.

30. Archer S, Boutton TW, Hibbard KA. Trees in Grasslands: Biogeochemical Consequences Woody Plant Expansion. In: Global Biogeochemical Cycles in the Climate System. Academic Press; 2001; 115-137.

31. Ravi S, D'Odorico P. Post-fire resource redistribution and fertility island dynamics in shrub encroached desert grasslands: A modeling approach. Landsc Ecol. 2008; 24(3):325-335.

32. Schreiner-McGraw AP, Vivoni ER, Ajami H, Sala OE, Throop HL, Peters DPC. Woody Plant Encroachment has a Larger Impact than Climate Change on Dryland Water Budgets. Sci Rep. 2020 May 15;10(1):8112. doi: 10.1038/s41598-020-65094-x. PMID: 32415221; PMCID: PMC7229153.

33. Liao JD, Boutton TW. Soil microbial biomass response to woody plant invasion of grassland. Soil Biol Biochem. 2008;40(5):1207–16.

34. Knapp AK, Briggs JM, Collins SL, Archer SR, Bret-Harte MS, Ewers BE, et al. Shrub encroachment in North American grasslands: Shifts in growth form dominance rapidly alters control of ecosystem carbon inputs. Glob Chang Biol. 2008;14(3):615–23.

35. Brown JR, Archer S. Shrub invasion of grassland: Recruitment is continuous and not regulated by herbaceous biomass or density. Ecology. 1999;80(7):2385-2396.

36. Wang G, Li J, Ravi S. A combined grazing and fire management may reverse woody shrub encroachment in desert grasslands. Landsc Ecol. 2019;34(8):2017-2031.

37. Andersen EM, Steidl RJ. Woody plant encroachment restructures bird communities in semiarid grasslands. Biol Conserv. 2019 Dec 1;240.

38. Ayers D, Melville G, Bean J, Beckers D, Ellis M, Mazzer T, et al. Woody weeds, biodiversity and landscape function in Western New South Wales. Dubbo; 2001.

39. Manea A, Leishman MR. The resprouting response of co-occurring temperate woody plant and grass species to elevated [CO2]: An insight into woody plant encroachment of grasslands. Austral Ecol. 2019; 44(5):917–926.

40. Bond WJ, Midgley GF. Carbon dioxide and the uneasy interactions of trees and savannah grasses. Philos Trans R Soc Lond B Biol Sci. 2012 Feb 19;367(1588):601-12. doi: 10.1098/rstb.2011.0182. PMID: 22232770; PMCID: PMC3248705.

41. Eldridge DJ, Soliveres S, Bowker MA, Val J. Grazing dampens the positive effects of shrub encroachment on ecosystem functions in a semi-arid woodland. J Appl Ecol. 2013;50(4):1028–38.

42. Delgado AS. Assessment of long-term effects of woody plant expansion in a humid, tropical grassland of Venezuela. University of Texas Rio Grande Valley; 2017.

43. Watson PA, Alexander HD, Moczygemba JD. Coastal Prairie Recovery in Response to Shrub Removal Method and Degree of Shrub Encroachment. Rangel Ecol Manag. 2019;72(2):275-282.

44. Fitzgerald ARD, Bailey AW. Control of Aspen Regrowth by Grazing with Cattle. J Range Manag. 1984; 37(2): 156-158.

45. Moleele NM, Ringrose S, Matheson W, Vanderpost C. More woody plants? The status of bush encroachment in Botswana's grazing areas. J Environ Manage. 2002 Jan;64(1):3-11. doi: 10.1006/jema.2001.0486. PMID: 11876072.

46. Oldeland J, Dorigo W, Wesuls D, Jürgens N. Mapping bush encroaching species by seasonal differences in hyperspectral imagery. Remote Sens. 2010;2(6):1416–38.

47. Gil-Romera G, Turton D, Sevilla-Callejo M. Landscape change in the lower Omo valley, southwestern Ethiopia: Burning patterns and woody encroachment in the savanna. J East African Stud. 2011;5(1):108–28.

48. Skowno AL, Thompson MW, Hiestermann J, Ripley B, West AG, Bond WJ. Woodland expansion in South African grassy biomes based on satellite observations (1990-2013): general patterns and potential drivers. Glob Chang Biol. 2017 Jun;23(6):2358-2369. doi: 10.1111/gcb.13529. Epub 2016 Nov 25. PMID: 27732761.