

Forest Ecology

Course Objectives:

The goal of this course is for students to develop a basic understanding in ecology with an emphasis on forest structure and management. In this course, we will cover topics such as ecosystem dynamics, abiotic and biotic factors, trophic cascades, human impact and climate change, and population dynamics. At the end of this course, I expect students to have mastered the basic ecological models (e.g. the exponential population growth model) and to feel comfortable collecting data in the field.

The overall aim of this course is for students to learn how to design an ecological study in forest systems, feel confident in the field using various basic tools and to understand terrestrial ecosystem processes and how they change under environmental and biotic changes.

We will meet every Monday and Wednesday from 11:30a - 1:00p.

Resources:

- Gotelli, N.J. *A Primer of Ecology*. 2008. Sinauer Associates, Inc., Sunderland, MA (ECO)
- Chapin III, F.S., Matson, P.A., and Vitousek, P.M. *Principles of Terrestrial Ecosystem Ecology*. 2011. Springer Science+Business Media, New York, NY. (CMV) (**There are many copies available at the library.**)

Additional Reading: Additional primary literature articles will be available for students on the website and are listed in the ‘*Reading*’ column of the schedule below. Full citations are also listed.

Field/Lab Sessions: Each week, students will have a lab session for two hours to learn basic ecology fieldwork and labwork. The aim is to provide students with a firm foundation in preparing for fieldwork, basic tool use, and greenhouse and growth chamber use. Students will need to first complete the lab safety module before the first lab session in order to participate. The module can be found on the course website.

Schedule:

Class	Topic	Reading
M: 10 Sept	Intro to Forest Ecology	CMV: 3-21 & Gilliam (2007)
W: 12 Sept	Forest Management	CMV: 423-446 & Johnson & Curtis (2001)
F: 14 Sept	Lab 1: Preparing for the field	
M: 17 Sept	Thermal & Water Relations	CMV: 93-121 & Arian & Lechowicz (2002)
W: 19 Sept	Soils Properties	CMV: 63-89 & Prentice <i>et al.</i> (1992)
F: 21 Sept	Lab 2: Plant Presses	
M: 24 Sept	Canopy structure & Light	Farrior <i>et al.</i> (2016) & Jiquan Chen (2014)
W: 26 Sept	Succession & Recruitment	ECO: 179-201 & CMV: 351-365
F: 28 Sept	Lab 3: Dichotomous Key - trees	
M: 1 Oct	Trophic Dynamics	CMV: 297-319 & Moore <i>et al.</i> (2004)
W: 3 Oct	Disturbances	CMV: 339-350 & Gu <i>et al.</i> (2008) & Bailey & Whitham (2002)
F: 5 Oct	Lab 4: Dichotomous Key - grass	
M: 8 Oct	Nutrient Cycling	CMV: 229-256 & Sardans <i>et al.</i> (2016)
W: 10 Oct	Carbon Cycles	CMV: 123-155 & Grassi <i>et al.</i> (2017)
F: 12 Oct	Lab 5: Field Surveys	
M: 15 Oct	Dispersal & Seed Predation	Clark <i>et al.</i> (1999) & Smith (1987)
W: 17 Oct	Reproduction & Growth	Primack (1987) & Aizen & Feinsinger (1994)
F: 19 Oct	Lab 6: Seed Collection	
M: 22 Oct	Phenology	Basler & Korner (2014) & Chuine (2010)
W: 24 Oct	Fire Ecology	Whitlock <i>et al.</i> (2003) & Larson & Churchill (2012)
F: 26 Oct	Lab 7: Succession	
M: 29 Oct	Strategies & Adaptations	Poorter & Bongers (2006) & Lindner <i>et al.</i> (2010)
W: 31 Oct	Invasive Species	MacDougall & Turkington (2005) & Stachowicz <i>et al.</i> (2002)
F: 2 Nov	Lab 8: Growth Facilities	
M: 5 Nov	Trees at Extremes	Sass-Klaassen <i>et al.</i> (2016) & Niemelä <i>et al.</i> (1996)
W: 7 Nov	Climate Change Impacts	CMV: 23-59 & 401-421 & Walther <i>et al.</i> (2002)
F: 9 Nov	Lab 9: Phenology	

Class	Topic	Reading
M: 12 Nov	Competition & Herbivory	ECO: 99-123 & Ettinger & HilleRisLambers (2017)
W: 14 Nov	Facilitation & Mutualisms	Booth & Hoeksema (2010) & Jandér <i>et al.</i> (2016)
F: 16 Nov	Lab 10: SLA & DBH	
M & W: 19-23 Nov	Thanksgiving Break!	
M: 26 Nov	Landscape Ecology	CMV: 369-396 & Roxburgh <i>et al.</i> (2004)
W: 28 Nov	Patch Dynamics & Edge Effects	ECO: 155-176 & Forman & Godron (1981)
F: 30 Nov	Lab 11: GPS Mapping	
M: 3 Dec	Diversity & Population Dynamics	ECO: 203-223 & CMV: 321-335
W: 5 Dec	Human Impact & Regeneration	Honnay <i>et al.</i> (2005) & McGill <i>et al.</i> (2006) & Dupouey <i>et al.</i> (2002)
F: 7 Dec	Lab 12: Edge Effects	

Grading Rubric:

Type	Percent of Grade
Participation & Discussion	15
Lab Sessions	15
Midterm	30
Final Exam and Project	40

References

- Aizen, M.A. & Feinsinger, P. (1994) Forest fragmentation, pollination, and plant reproduction in a chaco dry forest, argentina. *Ecology* **75**, 330–351.
- Arii, K. & Lechowicz, M.J. (2002) The influence of overstory trees and abiotic factors on the sapling community in an old-growth fagus-acer forest. *Écoscience* **9**, 386–396.
- Bailey, J. & Whitham, T. (2002) Interactions among fire, aspen, and elk affect insect diversity: reversal of a community response. *Ecology* **83**, 1701–1712.
- Basler, D. & Korner, C. (2014) Photoperiod and temperature responses of bud swelling and bud burst in four temperate forest tree species. *Tree Physiology* **34**, 377–388.
- Booth, M.G. & Hoeksema, J.D. (2010) Mycorrhizal networks counteract competitive effects of canopy trees on seedling survival. *Ecology* **91**, 2294–2302.
- Chaine, I. (2010) Why does phenology drive species distribution? *Philosophical Transactions of the Royal Society B: Biological Sciences* **365**, 3149–3160.
- Clark, J.S., Silman, M., Kern, R., Macklin, E. & HilleRisLambers, J. (1999) Seed dispersal near and far: Patterns across temperate and tropical forests. *Ecology* **80**, 1475–1494.
- Dupouey, J.L., Dambrine, E., Laffite, J.D. & Moares, C. (2002) Irreversible impact of past land use on forest soils and biodiversity. *Ecology* **83**, 2978–2984.
- Ettinger, A. & HilleRisLambers, J. (2017) Competition and facilitation may lead to asymmetric range shift dynamics with climate change. *Global Change Biology* **23**, 3921–3933.
- Farrior, C.E., Bohlman, S.A., Hubbell, S. & Pacala, S.W. (2016) Dominance of the suppressed: Power-law size structure in tropical forests. *Science* **351**, 155–157.
- Forman, R.T.T. & Godron, M. (1981) Patches and structural components for a landscape ecology. *BioScience* **31**, 733–740.
- Gilliam, F.S. (2007) The ecological significance of the herbaceous layer in temperate forest ecosystems. *BioScience* **57**, 845–858.
- Grassi, G., House, J., Dentener, F., Federici, S., den Elzen, M. & Penman, J. (2017) The key role of forests in meeting climate targets requires science for credible mitigation. *Nature Climate Change* **7**, 220–226.
- Gu, L., Hanson, P., Post, W., Kaiser, D., Yang, B., Nemani, R., Pallardy, S. & Meyers, T. (2008) The 2007 eastern us spring freeze: increased cold damage in a warming world? *BioScience* **58**, 253–262.
- Honnay, O., Jacquemyn, H., Bossuyt, B. & Hermy, M. (2005) Forest fragmentation effects on patch occupancy and population viability of herbaceous plant species. *New Phytologist* **166**, 723–736.
- Jandér, K.C., Dafoe, A. & Herre, E.A. (2016) Fitness reduction for uncooperative fig wasps through reduced offspring size: a third component of host sanctions. *Ecology* **97**, 2491–2500.

- Jiquan Chen, B.S. (2014) Spatial relationships between canopy structure and understory vegetation of an old-growth douglas-fir forest. *Forest Research: Open Access* **03**.
- Johnson, D.W. & Curtis, P.S. (2001) Effects of forest management on soil c and n storage: meta analysis. *Forest Ecology and Management* **140**, 227–238.
- Larson, A.J. & Churchill, D. (2012) Tree spatial patterns in fire-frequent forests of western north america, including mechanisms of pattern formation and implications for designing fuel reduction and restoration treatments. *Forest Ecology and Management* **267**, 74–92.
- Lindner, M., Maroschek, M., Netherer, S., Kremer, A., Barbati, A., Garcia-Gonzalo, J., Seidl, R., Delzon, S., Corona, P., Kolström, M. & et al. (2010) Climate change impacts, adaptive capacity, and vulnerability of european forest ecosystems. *Forest Ecology and Management* **259**, 698–709.
- MacDougall, A.S. & Turkington, R. (2005) Are invasive species the drivers or passengers of change in degraded ecosystems? *Ecology* **86**, 42–55.
- McGill, B.J., Enquist, B.J., Weiher, E. & Westoby, M. (2006) Rebuilding community ecology from functional traits. *Trends in Ecology & Evolution* **21**, 178–185.
- Moore, J.C., Berlow, E.L., Coleman, D.C., Ruiter, P.C., Dong, Q., Hastings, A., Johnson, N.C., McCann, K.S., Melville, K., Morin, P.J. & et al. (2004) Detritus, trophic dynamics and biodiversity. *Ecology Letters* **7**, 584–600.
- Niemelä, J., Haila, Y. & Punttila, P. (1996) The importance of small-scale heterogeneity in boreal forests: Variation in diversity in forest-floor invertebrates across the succession gradient. *Ecography* **19**, 352–368.
- Poorter, L. & Bongers, F. (2006) Leaf traits are good predictors of plant performance across 53 rain forest species. *Ecology* **87**, 1733–1743.
- Prentice, I.C., Cramer, W., Harrison, S.P., Leemans, R., Monserud, R.A. & Solomon, A.M. (1992) Special paper: A global biome model based on plant physiology and dominance, soil properties and climate. *Journal of Biogeography* **19**, 117–134.
- Primack, R.B. (1987) Relationships among flowers, fruits, and seeds. *Annual Review of Ecology and Systematics* **18**, 409–430.
- Roxburgh, S., Shea, K. & Wilson, J. (2004) The intermediate disturbance hypothesis: patch dynamics and mechanisms of species coexistence. *Ecology* **85**, 359–371.
- Sardans, J., Bartrons, M., Margalef, O., Gargallo-Garriga, A., Janssens, I.A., Ciais, P., Obersteiner, M., Sigurdsson, B.D., Chen, H.Y.H. & Peñuelas, J. (2016) Plant invasion is associated with higher plant-soil nutrient concentrations in nutrient-poor environments. *Global Change Biology* **23**, 1282–1291.
- Sass-Klaassen, U., Fonti, P., Cherubini, P., Gričar, J., Robert, E.M.R., Steppe, K. & Bräuning, A. (2016) A tree-centered approach to assess impacts of extreme climatic events on forests. *Frontiers in Plant Science* **7**, 1069.

- Smith, T.J. (1987) Seed predation in relation to tree dominance and distribution in mangrove forests. *Ecology* **68**, 266–273.
- Stachowicz, J.J., Fried, H., Osman, R.W. & Whitlatch, R.B. (2002) Biodiversity, invasion resistance, and marine ecosystem function: Reconciling pattern and process. *Ecology* **83**, 2575–2590.
- Walther, G.R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T.J.C., Fromentin, J.M., Hoegh-Guldberg, O. & Bairlein, F. (2002) Ecological responses to recent climate change. *Nature* **416**, 389 EP –.
- Whitlock, C., Shafer, S.L. & Marlon, J. (2003) The role of climate and vegetation change in shaping past and future fire regimes in the northwestern us and the implications for ecosystem management. *Forest Ecology and Management* **178**, 5–21.