

Arctic Vegetation Ecology
Masaryk University, Spring Semester 2011

Syllabus

Instructor: Prof. D.A. (Skip) Walker, Alaska Geobotany Center, University of Alaska Fairbanks

Course description:

This course will examine the tundra ecosystems using my experience from five main studies in arctic Alaska, Canada, and Russia. The major goal is to provide students with a basic understanding of the Arctic tundra biome and its role in the total global system. The emphasis will be on the factors controlling arctic vegetation patterns. The first lecture provides an overview of the Arctic. The second lecture describes the environments of the Prudhoe Bay region, AK, a tundra pH gradient, and modern loess ecosystems that have elements of the Mammoth Steppes that once covered much of Beringia. The third lecture focuses on permafrost, patterned ground and how the vegetation plays a major role shaping patterned-ground ecosystems and how these ecosystems vary along the Arctic bioclimate gradient. The fourth lecture focuses on the cumulative social-ecological effects of the giant oil fields at Prudhoe Bay, AK and Bovanenkova, Russia, primarily in reference to the vegetation, but also touching on other aspects of the total system including consequences to wildlife and the indigenous people. The fifth lecture focuses on the challenges of vegetation mapping in the Arctic at several scales, from small plots up to the circumpolar Arctic biome. The sixth lecture discusses global changes to tundra ecosystems primarily in relationship to climate changes and the ongoing changes in the Arctic Ocean's sea-ice cover and some recent attempts to track long-term changes to tundra vegetation.

Course time: 2 hours/week, 6 weeks

Prerequisites: None

Course calendar:

Week	Topic	Readings
1	Overview of Arctic Ecosystems: The role of climate, permafrost, and topography	Callaghan et al. 2005. Bliss et al. 1997 Chernov and Matveyeva 1997
2	The role of soil pH in Arctic Vegetation: Loess ecosystems and the Mammoth Steppe	Walker and Everett 1991 Walker, Auerbach et al. 1998; Walker et al. 2001
3	Biocomplexity of patterned ground ecosystems: Interrelationships between climate, geomorphology, permafrost, soils, and vegetation	Walker, Epstein et al. 2008 Walker, Kuss, et al. (in press)
4	Socio-ecological effects of oil and gas development in the Arctic: Comparison of the Prudhoe Bay, Alaska and Bovanenkova, Russia regions	NRC 2003 (look at whole book, focus on chapter 7) Forbes et al. 2009 Walker, Forbes et al. 2011
5	Plant to planet mapping of Arctic Vegetation: the Arctic Geobotanical Atlas	Dangermond & Harnden 1990 Raynolds et al. 2006

		Walker, 1999 Walker & Maier 2008 Walker, Reynolds, et al. 2005 Walker, Reynolds et al. 2009
6	Greening of the Arctic: Climate change and circumpolar Arctic vegetation	Bhatt et al. 2010

Student expectations:

Students are expected to attend each lecture and participate in class discussion. No exams. Readings are resources for students. For the large chapters, at least skim the material and figure captions. Read in more depth based on your interest in the topic. The course will be Pass/Fail.

Course reading materials (available on line at <http://www.geobotany.uaf.edu/>).

- Bhatt, U.S., Walker, D.A., Reynolds, M.K., Comiso, J.C., Epstein, H.E., Jia, G.J., Gens, R., Pinzon, J.E., Tucker, C.J., Tweedie, C.E., and Webber, P.J., 2010, Circumpolar Arctic tundra vegetation change is linked to sea-ice decline: *Earth Interactions*, v. 14, p. 1-20.
- Bliss, L.C., 1997, Arctic Ecosystems of North America, in Wielgolaski, F.E., ed., *Polar and Alpine Tundra: Ecosystems of the World*: Amsterdam, Elsevier, p. 551-683.
- Callaghan, T. V., et al. 2005. Chapter 7, Arctic tundra and polar desert ecosystems, pp. 243-352, in *Arctic Climate Impact Assessment - Scientific Report*, edited by C. Symon, L. Arris and B. Heal, Cambridge University Press, Cambridge.
- *CAVM Team, 2003, Circumpolar Arctic Vegetation Map: Anchorage, AK, Conservation of Arctic Flora and Fauna (CAFF) Map No. 1, U.S. Fish and Wildlife Service.
<http://www.arcticatlas.org/maps/themes/cp/>.
- Chernov, Y.I., and Matveyeva, N.V., 1997, Arctic ecosystems in Russia, in Wielgolaski, F.E., ed., *Polar and Alpine Tundra*, Volume 3: Amsterdam, Elsevier, p. 361-507.
- *Dangermond, J., and Harnden, E., 1990, Map data standardization: a methodology for integrating thematic cartographic data before automation: *ARC News*, v. 12, p. 16-19.
- *Forbes, B.C., Stammer, F., Kumpula, T., Meschytyb, N., Pajunen, A., and Kaarlejärvi, E., 2009, High resilience in the Yamal-Nenets social-ecological system, west Siberian Arctic, Russia: *Proceedings of the National Academy of Sciences*, v. 106, p. doi: 10.1073/iti5209106, 22041-22048.
- NRC, 2003, Cumulative environmental effects of oil and gas activities on Alaska's North Slope: Washington, DC, The National Academic Press, p. 304.
- *Reynolds, M.K., Walker, D.A., and Maier, H.A., 2006, Alaska Arctic Tundra Vegetation Map, Conservation of Arctic Flora and Fauna (CAFF) Map No. 2: Anchorage, AK, U.S. Fish and Wildlife Service. <http://www.arcticatlas.org/maps/themes/ak/index>.
- *Walker, D.A., 1999, An integrated vegetation mapping approach for northern Alaska (1:4 M scale): *International Journal of Remote Sensing*, v. 20, p. 2895-2920.
- Walker, D.A., Auerbach, N.A., Bockheim, J.G., Chapin, F.S., III, Eugster, W., King, J.Y., McFadden, J.P., Michaelson, G.J., Nelson, F.E., Oechel, W.C., Ping, C.L., Reeburg, W.S., Regli, S., Shiklomanov, N.I., and Vourlitis, G.L., 1998, Energy and trace-gas fluxes across a soil pH boundary in the Arctic: *Nature*, v. 394, p. 469-472.
- Walker, D.A., Barbour, E.M., and Maier, H.A., 2011, Arctic Geobotanical Atlas: A plant-to-planet volume of maps and related information produced by the Alaska Geobotany Center:
<http://www.arcticatlas.org/>.
- Walker, D.A., Bockheim, J.G., Chapin, F.S., III, Eugster, W., Nelson, F.E., and Ping, C.L., 2001, Calcium-rich tundra, wildlife, and "the Mammoth Steppe": *Quaternary Science Reviews*, v. 20, p. 149-163.
- Walker, D.A., Epstein, H.E., Romanovsky, V.E., Ping, C.L., Michaelson, G.J., Daanen, R.P., Shur, Y., Peterson, R.A., Krantz, W.B., Reynolds, M.K., Gould, W.A., Gonzalez, G., Nicolsky, D.J.,

- Vonlanthen, C.M., Kade, A.N., Kuss, P., Kelley, A.M., Munger, C.A., Tarnocai, C.T., Matveyeva, N.V., and Daniëls, F.J.A., 2008, Arctic patterned-ground ecosystems: A synthesis of field studies and models along a North American Arctic Transect: *Journal of Geophysical Research - Biogeosciences*, v. 113, p. G03S01.
- Walker, D.A., and Everett, K.R., 1991, Loess ecosystems of northern Alaska: regional gradient and toposequence at Prudhoe Bay: *Ecological Monographs*, v. 61, p. 437-464.
- Walker, D.A., Forbes, B.C., Leibman, M.O., Epstein, H.E., Bhatt, U.S., Comiso, J.C., Drozdov, D.S., Gubarkov, A.A., Jia, G.J., Karlejaärvi, E., Kaplan, J.O., Khumutov, V., Kofinas, G.P., Kumpula, T., Kuss, P., Moskalenko, N.G., Reynolds, M.K., Romanovsky, V.E., Stammer, F., and Yu, Q., 2011, Cumulative effects of rapid land-cover and land-use changes on the Yamal Peninsula, Russia in Gutman, G., and Reissel, A., eds., *Eurasian Arctic Land Cover and Land Use in a Changing Climate, Volume VI*: New York, Springer, p. 206-236.
- Walker, D.A., Kuss, P., Epstein, H.E., Kade, A.N., Vonlanthen, C.M., Reynolds, M.K. Daniëls, F.J.A. 2011 in press, Vegetation and patterned-ground relationships along the Arctic bioclimate gradient in North America. *Applied Vegetation Science*.
- *Walker, D.A., and Maier, H.A., 2008, Vegetation in the Vicinity of the Toolik Lake Field Station, Alaska Fairbanks, AK, *Biological Papers of the University of Alaska, No. 28*, Institute of Arctic Biology, University of Alaska. <http://www.arcticatlas.org/maps/themes/ku/index>.
- Walker, D.A., Reynolds, M.K., Daniëls, F.J.A., Einarsson, E., Elvebakk, A., Gould, W.A., Katenin, A.E., Kholod, S.S., Markon, C.J., Melnikov, E.S., N.G., M., Talbot, S.S., Yurtsev, B.A., and CAVM Team, 2005, The Circumpolar Arctic Vegetation Map: *Journal of Vegetation Science*, v. 16, p. 267-282.
- Walker, D.A., Reynolds, M.K., Maier, H.A., Barbour, E.M., and Neufeld, G.P., 2009, Circumpolar geobotanical mapping: a web-based plant-to-planet approach for vegetation-change analysis in the Arctic Mapping and Monitoring of Nordic Vegetation and Landscapes: *Hveragerði, Iceland*, 4 pp.