

CURRICULUM VITAE

WILLIAM KIRBY SMITH

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EDUCATION

- 1968 California State University, San Diego, B.S. (biology/physics)
 1969-71 California State University, San Diego, M.S.(animal physiological and biophysical ecology)
 Advisor, Professor Phillip C. Miller (deceased)
 1972-77 University of California, Los Angeles, Ph.D. (plant biophysical/physiological ecology),
 Advisor, Distinguished Professor Park S. Nobel

MILITARY

- 1968-69 Commissioned Naval Aviator, U.S. Naval Air Station, Pensacola, Florida; active duty U.S.S. Coral Sea, Honorable Disability Discharge

ACADEMIC POSITIONS

- 1979- Assistant Professor of Botany, University of Wyoming
 1983 (Spring Semester) Visiting Assistant Professor of Botany, University of Hawaii
 1983-88 Associate Professor of Botany, University of Wyoming
 1985 (Spring semester) Visiting Associate Professor of Botany, University of Hawaii
 1988-98 Professor of Botany, University of Wyoming
 1988-99 1992 (Spring semester) Visiting Professor of Botany, University of Western Australia, Perth
 1995-6 Professor and Interim Head, Department of Botany, UW
 1998-pres Charles H. Babcock Endowed Chair in Botany, Department of Biology, Wake Forest University
 2002-3 Visiting Fellow, Japanese Society for the Promotion of Science, Tokyo, Japan
 2003-4 Visiting Scholar, Republic of Georgia Institute of Botany, Tbilisi, Georgia (FSU)

ADMINISTRATIVE EXPERIENCE

Univ Wyoming

- 1977-1981 Faculty Senator for Botany Department
 1979-1986 Supervisor, Botany Department Greenhouse (Now the UW Conservatory), U Wyoming
 1979-1986 Biological Field Station Co-director (with G.J. Baxter), University of Wyoming
 1981-1983 Tenure and Promotion Committee, College of Arts and Sciences
 1981-1984 Executive Nominating Committee, AAAS (Southwest and Rocky Mountain section)
 1982-4 President, Colorado-Wyoming Academy of Sciences
 1982-3 Vice-chairman, Botanical Sciences Section, Southwestern and Rocky Mountain Section of AAAS
 1983-4 Chair, Botanical Sciences Section, Southwestern and Rocky Mountain Section of AAAS
 1986-8 Chair, Arts and Sciences Central Committee (faculty advisory committee to Dean)
 1987-8 Chair, University Review Committee for new Department of Plant, Soil and Insect Sciences, UW
 1989-1991 Chair, Faculty Summer Fellowship Award Committee, Arts and Sciences
 1990-1 Interdisciplinary Speakers Committee
 1990-2 Chair, University Tenure and Promotion Committee
 1994-6 Chair, University Review Committee for Department of Geography and Recreation, UW
 1995-6 Chair, University Review Committee for Facilities Planning and Architecture Department
 1995-6 Interim Head, Department of Botany
 1996-7 member, Arts and Sciences Review Committee for review of all A&S departments
 1997-2000 member, review panel, Agricultural Experiment Station Grant Competition (Hatch funds)

Wake Forest Univ

- 1998-2000, 2006 Member, Science Research Fund Committee, A&S
 1998- 2002 Greenhouse Supervisor
 2005- Chair, Vecellio Graduate Research Award Committee
 2011-present Associate Director- Center for Energy, Environment and Sustainability;

TEACHING RESPONSIBILITIES

-University of Wyoming (1977-1998)--While at Wyoming I taught Biol. 1000 or 1010 and Bot. 5720 both semesters and have alternated Bot. 4750 with Bot. 5760 during the spring semester. I also taught Bot. 5750 every fall semester and Bot. 5770 about once every three years, and Bot. 673D during summers (5 wk session) each summer from 1978 to 1985. I have always received very good to excellent student and peer evaluations of my teaching and was nominated for a Golden Apple Award on three different occasions in both the majors and non-majors freshmen biology course.

-Wake Forest University (1998-present)—primary courses: Biol 113 (Ecology and Evolutionary Biology); Biol. 347-8 (Plant Physiological Ecology); Biol. 777 (Biophysical Ecology).

| <u>CURRENT (Lect/Seminar) COURSES</u> <u>(WFU)</u> | <u>CREDITS</u> | <u>ENROLLMEN</u> <u>T</u> |
|---|----------------|------------------------------|
| Bio 113 Gen. Biol. | 4 | 200-300 |
| Bio 347-8 Plant Physiological Ecology | 3-4 | 15-20 |
| Bio 777 Biophysical Ecology | 3 | 10 - 20 |
| Bio 732 Plant Evolution Seminar | 2 | 10- 20 |
| Bio 724 Research in Plant Physiological Ecology | 1-3 | 1-3 |
| Bio 744 Independent Study in Plant Physiol Ecol | 1-6 1-3 | 1-3 1-3 |
| Bio 390 Research Experiences for Undergraduates | | |
| Bio 114 Comparative Physiology | 4 | 72 |

RESEARCH INTEREST

Plant adaptation to harsh or unusual environments; plant ecophysiology (temperature, water and carbon relations, water use efficiency); environmental biophysics (microclimate effects on plant growth and distribution); structural/functional relationships of plant leaves; light absorption efficiency of plant crowns and canopies; spectral signatures of plant stress; radiation frosts, low temperature photoinhibition (including UV effects), mechanisms of UV absorption, eddy diffusion and stable isotope analysis of CO₂ and H₂O exchange from native and crop species, aerial sensing of spectral properties and CO₂ exchange of plants.

CURRENT RESEARCH PROJECTS/ACTIVITIES

Effects of global climate change on **high elevation forests** with an emphasis on timberlines/treelines in the western US and the relic spruce-fir forests of the southern Appalachian Mountains; mechanisms of young seedling survival and forest regeneration; impacts of extreme, episodic events on the vegetative stability of **barrier island ecosystems**; effects of **cloud-immersion** on mountaintop forest species; **anthocyanin pigments** in leaves and photoinhibition of photosynthesis.

AWARDS AND HONORS

Burlington Northern Award for Academic Achievement, 1990. Univ of Wyoming Presidential Award for Distinguished Faculty Scholarship, Univ. of Wyoming, 1991.

Doctoral Dissertation Mentor Excellence Award 1996, Special (first-time) award from the Graduate School, University of Wyoming.

Meritorious Award for Research, Department of Botany, UW (1992, 1994, 1995, 1997)

Nominated for Apple Award for Teaching in large freshman courses (Gen. Biol.), UW (1990, 1992, 1994)

Doctoral Dissertation Advisor Award, College of Arts & Sciences, University of Wyoming (1986, 1988, 1991, 1993, 1995, and 1996).

INVITED PUBLIC ENGAGEMENT

- "Plants in the Understory", 1996. Discovering Life Series, The Private Life of Plants, David Attenborough, BBC. Segment describing our research on sunlight processing by leaves, leaf surface water repulsion, etc. (with TC Vogelmann)
- "Ecophysiological adaptations in alpine plants", 1996. Excerpt (pg. 620) in *Biology*, 4th edition, P. Raven and R. Johnson, featuring work done by undergraduate and graduate students in my laboratory.
- "Colorful Snow May Yield Secrets for Hardy Crops", 1998. Science and Technology section, The Christian Science Monitor, Wends. Jan. 8, 1998.
- "Light and Leaves", 1998. Invited article, "The Future of Science, Encyclopedia Britannica, Annual Volume: 1231-1233.
- "The Alpine Forest" Smith, WK., Reinhardt, KA, and DM Johnson. 2006. The Alpine Forest. *In The Encyclopedia of Ecology*: Elsevier, NY.
- "Why are evergreen trees pyramid shaped" Earth Sky Broadcasts



Why are evergreen trees pyramid shaped » Radio Podcasts EarthSky.mht

- "Alpine flowers can predict rainfall" Indiana Univ Radio



Bynum Indiana radio.mht

EDITORIAL POSITIONS

- Editorial Board, *Ecology* (1992-96)
- Subject Editor, *Tree Physiology* (1990-present)
- Editor, *Physiological Ecology of Coniferous Forest*, Physiological Ecology Series, Academic Press, NY. 376 pgs. (1994)
- Editor, *Resource Physiology of Conifers: Acquisition, Allocation and Utilization*. Physiological Ecology Series, Academic Press, NY. 336 pgs. (1994)
- Editor, *Photosynthetic Adaptation: Chloroplast to Landscape*, Ecological Studies 178, Springer, NY, 316p (2004).
- Editorial Board, *Tree Physiology* (2003-2007)
- Editorial Advisory Committee, *Eurasian Journal of Forest Research*, 2005-present
- Nature Reader, 2008-present
- Editorial Board, *J Botany* 2007-present
- Co-Editor with Eric De La Cabrerria. 2008. *Current Perspectives in Biophysical Ecophysiology*, Univ Calif Press, in press.

AGENCY REVIEW PANELS

- Physiological Ecology and Population Biology, NSF (1984, 1988, 1992, 1994, 1996, 1998)
- Plant Response to the Environment, USDA Competitive Grants Program (1990, 1995)
- Ecosystem Response Program, DOE (1993-4)

Ecology Panel, NSF (1993-5)
 Committee on Atmospheric Climate Change, Batelle Scientific, DOE (1992-94)
 EPSCoR Review Committee, NSF (1994-6)
 Science Review Board, US Forest Service, Fort Collins, CO (1990-present)
 Joint Program on Terrestrial Ecology and Global Change, NSF ,DOE, NASA, U.S.
 EPA and USDA (1995-8)
 Doctoral Dissertation Awards in Ecology, NSF (1997-2000)
 Agricultural Experiment Station Review Panel, USDA Forest Service (1996-2004)
 Science and Technology Centers, Integrative Partnerships panel, NSF (2001-2003)
 Ecological and Evolutionary Physiology, Environmental Systems and Structure
 panel, NSF (2006- 2007, 2010)
 Global Change Biology review panel, DOE (2013-14)
 Graduate predoctoral fellowship panel, NSF (2012-14)

REFEREED PUBLICATIONS

- Smith, W.K. and P.C. Miller. 1973. The thermal ecology of two south Florida fiddler crabs, *Uca rapax* Smith and *U. pugilator* Bosc. *Physiol. Zool.* 46(3): 186-207.
- Smith, W.K., Roberts, S.W. and P.C. Miller. 1974. Calculating the nocturnal energy expenditure of an incubating Anna's hummingbird. *Condor* 76(2): 176-183.
- Nobel, P.S., Zaragoza, L.J. and W.K. Smith. 1975. Relation between mesophyll surface area, photosynthetic rate, and illumination level during development for leaves of *Plectranthus parviflorus* Henckel. *Plant Physiol.* 55: 1067-1070.
- Smith, W.K. and P.S. Nobel. 1977. Temperature and water relationships for sun and shade leaves of a desert broadleaf *Hyptis emoryi*. *J. Exp. Bot.* 28: 171-185.
- Smith, W.K. and P.S. Nobel. 1978. Influence of seasonal changes in leaf morphology on water use efficiency for three desert broadleaf shrubs. *Ecology* 58: 1033-1043.
- Smith, W.K. 1978. Leaf Temperatures of desert plants: Another perspective on the adaptability of leaf size. *Science* 201: 614-616.
- Smith, W.K. and P.S. Nobel. 1978. Influence of irradiation, soil water potential, and leaf temperature on leaf morphology of a desert broad leaf, *Encelia farinosa* Gray (*Compositae*) *Amer. J. Bot.* 75:429-4320
- Smith, W.K. And G.N. Geller. 1979. Plant transpiration at high elevations: theory, field measurement, and comparisons with desert plants. *Oecologia* 41: 109-122.
- Young, D.R. and W.K. Smith. 1979. Influence of sunflecks on the temperature and water relations of two subalpine understory congeners. *Oecologia* 43: 194-205.
- Smith, W.K. 1980. Importance of aerodynamic resistance to water use efficiency in three conifers under field conditions. *Plant Physiol.* 65: 132-135.
- Smith, W.K. and G.N. Geller. 1980. Leaf and environmental parameters influencing transpiration at high elevation: Theory and field measurement. *Oecologia* 46: 308-314.
- Young , D.R. and W. K. Smith. 1980. Influence of sunlight on photosynthesis, water relations, and leaf structure in the understory species *Arnica cordifolia*. *Ecology.* 60:1380-1390.
- Smith, W.K. 1981 Temperature and water relation patterns in subalpine understory plants. *Oecologia* 48: 353-359.
- Allen, M.F., Smith, W.K., Moore, T.S. and M. Christensen. 1981. Comparative water relations and photosynthesis of mycorrhizal and non-mycorrhizal *Bouteloua gracilis*. *New Phytologist* 88: 683-693.
- Knapp, A.K. and W.K. Smith. 1981. Water relations and succession in subalpine conifers in

- southeastern Wyoming. *Botanical Gazette* 142: 502-511.
- Geller, G.N. and W.K. Smith. 1982. Influence of leaf size, orientation, and arrangement on temperature and transpiration in three high elevation, large-leaved herbs. *Oecologia* 53: 227-234.
- Young, D.R. and W.K. Smith. 1982. Simulation studies of the influence of understory location on transpiration and photosynthesis in *Arnica cordifolia* Hook. *Ecology* 63: 1761-1771.
- Knapp, A.K. and W.K. Smith. 1982. Factors influencing understory seedling establishment of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) in southeast Wyoming. *Canadian Journal of Botany* 60: 2753-2761.
- Hadley, J.L. and W.K. Smith. 1983. Influence of wind exposure on needle desiccation and mortality in timberline conifers in Wyoming, U.S.A. *Arctic and Alpine Res.* 15: 127-135.
- Young, D.R. and W.K. Smith. 1983. Effect of cloudcover on photosynthesis and transpiration in the subalpine understory species *Arnica latifolia*. *Ecology* 64: 681-687.
- Smith, W.K., Knapp, A.K., Pearson, J.A., Varman, J.H., Yavitt J.B. and D.R. Young. 1983. Influence of microclimate and growth form on plant temperatures of early spring species in a high elevation prairie community. *American Midland Naturalist* 109: 380-389.
- Stahl, P. and W.K. Smith. 1984. Effects of different geographic isolates of *Glomus* on water relations of *Agropyron smithii*. *Mycologia* 76: 261-267.
- Smith, W.K. 1984. Environmental limitations on leaf conductance in central Rocky Mountain conifers, USA. In: Establishment and Tending of Subalpine Forests (H. Turner and W. Tranquillini, eds.). *Eidg. Anst. Forstl. Versuchswes. Rev.* 270: 95-101.
- Smith, W.K., Young, D.R., Carter, G.A., Hadley, J.L. and G.M. McNaughton. 1984. Autumn stomatal closure in six conifer species of the central Rocky Mountains. *Oecologia* 63: 237-243.
- Huang, R.S., Yost, R.S. and W.K. Smith. 1983. Influence of VA mycorrhiza on growth, nutrient absorption and water relations in *Leucaena leucocephala*. (LAM) *Dewit Leucaena-Research-reports*. 4: 86-87.
- Huang, R.S., Smith, W.K. and R.S. Yost. 1985. Influence of vesicular-arbuscular mycorrhizae on growth, water relations, and leaf orientation in *Leucaena leucocephala* (LAM) *Dewit. New Phytologist* 99: 229-243.
- Foster, J.R. Smith, W.K. (1985) Influence of stomatal distribution on transpiration in low-wind environments. *Plant, Cell and Environment* 9, 751-759. [Links](#)
- Carter, G.A. and W.K. Smith. 1985. Influence of shoot structure on light interception and photosynthesis in conifers. *Plant. Physiol.* 79: 1038-1042.
- Smith, W.K. 1985. Chapter 5: Montane forests. In: The Physiological Ecology of North American Plant Communities (B.F. Chabot and H.A. Mooney, eds.). Chapman and Hall, Ltd., pp. 95-126.
- Hadley, J.L. and W.K. Smith. 1986. Wind effects on needles of timberline conifers; seasonal influence on mortality. *Ecology* 67: 12-19.
- DeLucia, E.H. and W.K. Smith. 1987. Air and soil temperature limitations on photosynthesis in Engelmann spruce during summer. *Can. J. For. Res.* 17: 527-533.
- Knapp, A.K. and W.K. Smith. 1987. Stomatal and photosynthetic responses to sun/shade transitions in subalpine plants: influence on water use efficiency. *Oecologia* 74: 62-67.
- Carter, G.A. and W.K. Smith. 1987. Stomatal conductance in three conifer species at different elevations during summer in Wyoming. *Can. J. For. Res.* 18: 242-246.
- Hadley, J.L. and W.K. Smith. 1987. Influence of krummholz mat microclimate on needle physiology and survival. *Oecologia* 73: 82-90.

- Smith, W.K., E.H. DeLucia and A.K. Knapp. 1987. Environmental limitations to photosynthesis in subalpine plants of the Rocky Mountains. In: Management of Subalpine Forests: Building on 50 Years of Research. USDA, *USFS Public* 1463, 253 pp.
- Smith, W.K. and G.A. Carter. 1988. Shoot structural effects of needle temperature and photosynthesis in conifers. *Amer. J. Bot.* 75: 496-500.
- Knapp, A.K. and W.K. Smith. 1988. Effect of water stress on stomatal and photosynthetic responses to cloud pattern in subalpine plants. *Amer. J. Bot.* 75: 851-858.
- Carter, G.A., W.K. Smith and J.L. Hadley. 1988. Stomatal conductance in three conifer species at different elevations during summer in Wyoming. *Can. J. For. Res.* 18: 242-246.
- Vogelmann, T.C., Knapp, A.K., McClean T.M. and W.K. Smith. 1988. Measurement of light within thin plant tissues using fiber optic microprobes. *Physiol. Plant* 72: 623-630.
- Knapp, A.K., Vogelmann, T.C., McClean, T.M. and W.K. Smith. 1988. Light and chlorophyll gradients within *Curcubita* cotyledons. *Pl. Cell Environ.* 11: 257-263.
- Carter, G.A. and W.K. Smith. 1987. Microhabitat comparisons of transpiration and photosynthesis in three subalpine conifers. *Can. J. Botany* 66: 963-969.
- Knapp, A.K. and W.K. Smith. 1989. Influence of growth form on ecophysiological responses to variable sunlight in subalpine plants. *Ecology* 70: 1069-1082.
- Smith, W.K. and T.M. McClean. 1989. Adaptive relationship between leaf water repellency, stomatal distribution, and gas exchange. *Amer. J. Botany* 76: 465-469.
- Henkel, T.W., Smith, W.K. and M. Christensen. 1989. Infectivity and effectivity of indigenous vesicular arbuscular mycorrhizal fungi from contiguous soils in southeast Wyoming, USA. *New Phytol.* 112: 205-214.
- Smith, W.K., Knapp, A.K. and W.A. Reiners. 1989. Penumbral effects on sunlight penetration in plant communities. *Ecology* 70: 1603-1609.
- Hadley, J.L., and W.K. Smith. 1989. Wind erosion of leaf surface wax in alpine timberline conifers. *Artic. Alp. Res.* 21: 392-398.
- Day, T.A., E.H. DeLucia and W.K. Smith. 1989. Influence of cold soil and snow cover on photosynthesis and conductance in two Rocky Mountain conifers. *Oecologia* 80:546-552.
- Knapp, A.K., Smith, W.K. and D.R. Young. 1989. Importance of intermittent shade to the ecophysiology of subalpine herbs. *Funct. Ecol.* 3: 753-758.
- Day, T.A., DeLucia, E.H. and W.K. Smith. 1990. Dorsiventrality of the photosynthetic light response in naturally occurring C₃ dicots. *Current Research in Photosynthesis* 4:883-886.
- Knapp, A.K. and W.K. Smith. 1990. Stomatal and photosynthetic responses to variable sunlight. *What's New in Plant Physiology, Physiol. Plant* 78: 160-165.
- Hadley, J.L. and W.K. Smith. 1990. Influence of leaf surface wax and leaf area-to-water content ratio on cuticular transpiration in conifers. *Can. J. For. Res.* 20:1306-1311.
- Knapp, A.K. and W.K. Smith. 1990. Contrasting stomatal and photosynthetic responses to variable sunlight in two subalpine herbs. *Amer. J. Bot.* 77:226-231.
- Smith, W.K. and A.K. Knapp. 1990. Ecophysiology of high elevation forests. In: Plant Biology of the Great Basin and Range. C.B. Osmond and L. Pitelka, eds., Ecological Studies Series, Springer-Verlag, London, p. 87-142.
- Foster, JR and WK Smith. 1990. Stomatal conductance patterns and environment in high elevation phreatophytes in Wyoming. *Canadian J Botany* 69: 647-655.
- Cui, M. and W.K. Smith. 1990. Photosynthesis and water relations of young seedlings of *Abies lasiocarpa* with high natural mortality. *Tree Physiol.* 8:37-46.
- Day, T.A., DeLucia, E.H. and W.K. Smith. 1990. Effect of soil temperature on stem sap flow, shoot gas exchange and water potential in *Picea engelmannii* during snowmelt: *Oecologia*.

- 84:474-481.
- Smith, W.K. and D. Hollinger. 1990. Stomatal behavior. In: *Ecophysiology of Forest Trees: Techniques and Methodologies* (J.P. Lassoie and T.M. Hinckley, eds.). CRC press, NY pp. 141-176.
- Smith, W.K., Schoettle, A.W. and M. Cui. 1991. Importance of leaf area measurement to the interpretation of gas exchange parameters of complex shoots (e.g. conifers). *Tree Physiol.* 8:121-127.
- Cui, M. and W.K. Smith. 1991. Seedling microenvironment, gas exchange and survival during first year establishment in subalpine conifers *Tree Physiol.* 10:44-53.
- Knapp, A.K. and W.K. Smith. 1991. Gas Exchange responses to variable sunlight in two Sonoran Desert herbs: comparison with subalpine species. *Bot. Gaz.* 152(2):269-274.
- Estil, K., R.H. Delaney and W.K. Smith 1991. Water relations and productivity of alfalfa chlorophyll variants. *Crop Science* 31:1229-1239.
- Cui, M., Vogelmann, T.C. and W.K. Smith. 1991. Chlorophyll and light gradients in sun and shade leaves of *Spinacia oleracea*. *Plant, Cell, & Environ.* 14:493-500.
- Brewer, C.A., Smith, W.K. and T.C. Vogelmann. 1991. Functional interaction between leaf trichomes, leaf wettability, and the optical properties of water droplets. *Pl., Cell, & Environ.* 14:955-962.
- Foster, J.R. and W.K. Smith. 1991. Stomatal conductance patterns and environment in high elevation phreatophytes of Wyoming. *Can. J. Bot.* 69:647-655.
- Smith, W.K. and R.A. Donahue. 1991. Simulated influence of altitude on photosynthetic CO₂ uptake potential in plants. *Plant, Cell & Environ.* 14:133-136
- Brewer, C.A., Smith, W.K. and T.C. Vogelmann. 1991. Functional interaction between leaf trichomes, leaf wettability, and the optical properties of water droplets. *Pl., Cell, & Environ.* 14:955-962.
- Schoettle, A.W. and W.K. Smith. 1991. Interrelation between shoot characteristics and solar irradiance in the crown of *Pinus contorta* ssp. *latifolia*. *Tree Physiol.* 9: 245-254.
- Jordan, D.N. and W.K. Smith. 1993. Simulated influence of leaf geometry on sunlight interception and photosynthesis in conifer needles. *Tree Physiol.* 13: 29-39.
- Pennell, WT, et al. 1993. The detection of global climate change, 4th *Symposium on Global Change Studies*, Amer Meteor Society, Boston, MA, Jan 17-22.
- Estill, K., Delaney, R.L., Ditterline, R.H. and W.K. Smith. 1993. Water relations and productivity of alfalfa populations divergently selected for leaf size. *Field Crops Research.* 33:423-434.
- Brewer, C.A., Smith, W.K. 1994. Influence of simulated dewfall on photosynthesis and yield in soybean isolines *Glycine max* L. *Merr.* cv *williams* with different trichome densities. *Int. J. Plant Sci.* 155: 460-466.
- Smith, W.K., Brewer, C.A. 1994. The adaptive importance of shoot and crown architecture in conifer trees. *Amer. Nat.* 143: 528-532.
- Hemmerlein, M.T., Smith, W.K. 1994. Structural scaling of light interception efficiency in *Picea engelmannii* and *Abies lasiocarpa*. *Tree Physiol.* 14:1139-1148.
- Hamerlynk, E.P., Smith, W.K. 1994. Subnivean and emergent microclimate, photosynthesis, and growth in *Erythronium grandiflorum* Pursh, a snowbank geophyte. *Arctic. Apl. Res.* 26: 21-28.
- Jordan, D.N. and W.K. Smith. 1994. Energy balance analysis of nighttime leaf temperatures and frost formation in a subalpine environment *Agric. For. Meteorol.* 71:359-372.
- Smith, W.K., and T.M. Hinckley. 1994. (Eds.) *Resource Physiology of Conifers: Acquisition,*

- Allocation, and Utilization. Academic Press, New York. 412 pp.
- Smith, W.K., and T.M. Hinckley. 1994. (Eds.) *Ecophysiology of Coniferous Forests*. Academic Press, New York. 386 pp.
- Hadley, J.L. and W.K. Smith. 1994. Effects of elevation and foliar age on maximum leaf resistance to water vapor diffusion in conifers of the central Rocky Mountains, USA. *NATO ASI Series 36, Air pollution and the leaf cuticle*. Eds KE Percy, JN Cape, R Jagels and CJ Simpson, Springer Verlag. pp 261-268.
- Jordan, D.N. and W.K. Smith. 1995. Radiation frost susceptibility and the association between sky exposure and leaf size. *Oecologia* 103: 43-48.
- Jordan, D.N. and W.K. Smith. 1995. Microclimate factors influencing the frequency and duration of growth season frost in subalpine plants. *Agric. For. Meteorol* 77: 17-30.
- Brewer, C.A., and W.K. Smith. 1995. Leaf surface wetness and gas exchange in the pond lily *Nuphar polysepalum*. *Amer. J. Bot.* 82: 1271-1277.
- Hadley, J.L., Smith, W.K. 1995. Effect of elevation and foliar age on maximum leaf resistance to water vapor diffusion in conifers of the Central Rocky Mountains, USA. In: *Air Pollutants and the Leaf Cuticle*, K.E. Percy (ed). Springer-Verlag, NATO ASI Series, Vol. G36:261-268.
- Vogelmann, T.C., Nishio, J.N. and W.K. Smith. 1996. Leaves and light capture: Light propagation and gradients of carbon fixation within leaves. *Trends in Plant Science* 1: 65-71.
- DeLucia, E. H., K. Nelson, T. C. Vogelmann, and W. K. Smith. 1996. Contribution of intercellular reflectance to photosynthesis in shade leaves, *Plant, Cell & Environ.* 19: 159-170.
- Brewer, C.A. and W.K. Smith. 1997. Patterns of leaf surface wetness in montane and subalpine plants. *Plant. Cell & Environment* 20: 1-11.
- Smith, W.K., Vogelmann, T.C., Bell, D. T., DeLucia, E. H., and K. A. Shepherd. 1997. Leaf Form and Photosynthesis. *BioScience* 47:785-793.
- Smith, W.K., D.T. Bell and K.A. Shepherd. 1998. Associations between leaf orientation, structure and sunlight exposure in five western Australian communities. *Amer. J. Bot.*, 84: 1698-1707.
- James, S.A., Smith, W.K., and T.C. Vogelmann. 1999. Ontogenetic differences in mesophyll structure and chlorophyll distribution in *Eucalyptus globulus* ssp. *globulus* (Myrtaceae). *Amer. J. Bot.* 86: 198-207.
- Turunen, M.T., TC Vogelmann, WK Smith. 1999. Effective UV-screening in Lodgepole pine (*Pinus contorta* ssp. *latifolia*) cotyledons and needles sampled from field plants. *In Responses of Plant Metabolism to Air Pollution*, LJ DeKok and J. Stulen, [eds.], pp. 463-480, Backhuys Publ., Leiden, The Netherlands. 563 pp.
- Schoettle, A.W. and W.K. Smith. 1999. Interrelationships between light, photosynthesis, and nitrogen in the crown of mature *Pinus contorta* ssp. *latifolia*. *Tree Physiology*, 19:13-22.
- Hättenschwiler, S. and W.K. Smith. 1999. Natural seedling occurrence in treeline conifers: A case study from the central Rocky Mountains, USA. *Acta Oecologia* 20: 219-224.
- Germino, M.J. and W.K. Smith. 1999. Sky exposure, crown architecture, and low temperature photoinhibition in conifer seedlings at alpine treeline. *Plant, Cell & Environment* 22: 407-415.
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- Pataki, DE, Orem, R, and WK Smith. 2000. Sap flux of co-occurring species in a western subalpine forest during seasonal drought. *Ecology* 81:2557-2566.
- Germino, MJ and WK Smith. 2000. Differences in microsite, plant form, and low-temperature photoinhibition in alpine plants. *Artic, Antarctic, and Alpine Research*, 32:388-396
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- Sanchez A, NM Hughes, WK Smith. 2013. Water-use efficiency declines during autumn leaf senescence in three deciduous tree species, North Carolina piedmont, USA. **International Journal of Plant Biology** 4: 16-23..
- Berry ZC, WK Smith. 2013. Experimental cloud immersion and foliar water uptake in saplings of *Abies fraseri* and *Picea rubens*. **Trees: Structure and Function** 1-9 (DOI) 10.1007/s00468-013-0934-5
- Sanchez A, WK Smith. 2013. Plant functional traits: Perspectives from a quantitative literature survey. **Current Trends in Ecology** 3: 25-51. (Invited review)
- Smith WK. A unified paradigm for the climatic elevations of global treelines. **Ecology** 94:767-778.
- Reed JE, WK Smith. 2013. Stomatal frequency, distribution, and needle hydrophobicity in cloud forest spruce and fir, southern Appalachian Mountains, USA. **Review of Undergraduate Research in Agricultural and Life Sciences (RURALS)** 7:1-9. (Jennifer Reed, WFU undergraduate).
- Wieser G, FK Holtmeier, WK Smith. 2012. Treelines in a changing global environment. Forest Ecology in a Climate-change Future. Springer, *in press* (Invited chapter, **delayed** from a promised 2012 publication date)
- Carmichael, MJ, ES Bernhardt, SL Bräuer, and WK Smith. 2013. Conduits, stimulants and synthesizers: the role of vegetation in methane flux to the atmosphere. **Biogeochemistry** <http://link.springer.com/article/10.1007/s10533-014-9974-1>

RESEARCH GRANTS FUNDED OR PENDING

- Smith, W.K. 1979. Water and photosynthetic relations of two subalpine understory congeners. Population Biology and Physiological Ecology Program, National Science Foundation, September 1, 1979, DEB-7923010 (\$68,396, 2 yrs.)
- Christensen, M., T.S. Moore, Jr. and W.K. Smith. 1979. Effects of vesicular-arbuscular mycorrhizae on plant hormone levels, water relations, and photosynthesis. Ecology Panel, National Science Foundation, January 1, 1979, DEB-7825222 (\$44,700, 2 yrs.)
- Smith, W.K. 1979. Seedling establishment in three subspecies of *Artemisia*. U.S. Park Service - University of Wyoming Research Foundation, January 1, 1980, (\$19,340, 2 yrs.)
- Smith, W.K. 1980. Physiological ecology of plant succession and re-establishment in subalpine communities of the Rocky Mountains of Wyoming. U.S. Park Service - University of Wyoming Research Foundation, January 1, 1980, (\$19,086, 2 yrs.)
- Smith, W.K. 1982. Physiological adaptation and reproductive effort in subalpine understory plants of the Rocky Mountains. Population Biology/Physiological Ecology Program, Biotic

- Systems and Resources, NSF,DEB-8200742 (\$109,722/2 yr.)
- Smith, W.K. 1984. Transpirational water loss from phreatophytic, streamside vegetation in Wyoming. Wyoming Water Research Center, University of Wyoming, Laramie. (\$166,450, 3 yrs.)
- Delaney, R. and W.K. Smith. 1984. Water-use efficiency in leaf color variants of alfalfa. USDA, HATCH funds for Ph.D. student, USDA-8441171, (\$38,670, 3 yrs.).
- Vogelmann, T.C. and W.K. Smith. 1986. Light regimes inside leaves: relationship to leaf anatomy and morphology. USDA Competitive Grants, Photosynthesis Panel, USDA-86-CRCR-1-2048 (\$55,690, 2yrs.).
- Vogelmann, T.C., W.K. Smith and R. Middaugh. 1986. Development of fiber optic micro-sensors for measuring light and biochemical parameters within leaves. Biological Instrumentation Program, National Science Foundation, DMB-8606824 (\$161,657, 3 yrs.).
- Vogelmann, T.C. and W.K. Smith. 1986. Ecophysiological adaptations related to the light gradient inside leaves. EPSCoR Program for Land Grant Universities, National Science Foundation, R11-8610680 (\$154,320, 3 yrs.)
- Smith, W.K. 1986. Effects of Acid Mist on leaf cuticles: Influence on water/carbon relations and mortality in high elevation conifers. USDA Competitive Grants Program, Environmental Stress, 86-CRCR-1-2061 (\$139,620, 2 yrs.).
- Smith, W.K. and A.K. Knapp. 1987. Coupling of photosynthetic and transpirational responses during sun/shade transitions. Population Biology and Physiological Ecology Program, Biological Resources Section, National Science Foundation, BSR-8700690 (\$110,816, 2 yrs.).
- DeLucia, E.H. and W.K. Smith. 1987. Environmental factors limiting photosynthesis in subalpine conifers of the Central Rocky Mountains. USDA Competitive Grants Program, Forest Biology, 87-FSTY-9-0261 (\$179,416, 3 yrs.).
- Smith, W.K. 1987. Physiological processes in subalpine tree species. USDA, U.S. Forest Service, Rocky Mountain Experiment Station, Cooperative Agreement No. 27-c7-417 (\$43,500, 2yrs.).
- Vogelmann, T.C. and W.K. Smith. 1988. Importance of epidermal lens cells and mesophyll anatomy to internal light gradients and photosynthesis of leaves. Physiological Processes Program, Cellular Biosciences Division, National Science Foundation, DCB-8908328 (\$173,000, 2 yrs.).
- Smith, W.K. and A.K. Knapp. 1989. Coupling of photosynthesis and stomatal conductance during rapid environmental changes. Population Biology and Physiological Ecology Program, Biotic Systems/Resources Division, National Science Foundation, BSR-8920881 (\$93,000, 2 yrs.)
- Smith, W.K. 1989. Ecophysiological significance of leaf surface wetness. Population Biology and Physiological Ecology Program, Biological Systems/Resources Division National Science Foundation, BSR-8919228 (\$70,000, 2 yrs.)
- Nishio, J., W.K. Smith and T.M. Vogelmann. 1990. A new glasshouse facility for the Department of Botany, University of Wyoming. NSF Facilities Improvement Program, RFO 9021761 (\$1.6 million).
- Smith, W.K. and T.M. Hinkley. 1991. Physiological ecology of coniferous forests :A modern synthesis. Jackson Hole, Wyoming, Sept. 16-19, 1991. Funded partially by the DOE, U.S. Forest Service, NASA, U.S. Park Service, Nat. Paper Council for Stream and Air Improvement, and the U.S. EPA for a total of \$44,400.
- Smith, W.K. 1991. Direct coupling of atmospheric warming to plant ecology: Nocturnal

- radiation exchange, frost occurrence, and plant distribution patterns. NASA Innovative Research Program, IRP 91-181(\$ 272,000 / 3 yrs.)
- Vogelmann, T.C. and W.K. Smith. 1991. Leaf structural properties that influence photosynthesis: Interactions between gradients of light, CO₂, and photosynthetic capacity. Physiological Processes Program, Biotic Systems and Resources, NSF. \$256,908/3 yrs.
- Smith, W.K. and D.T. Bell. 1992. A model of leaf structure/function: photosynthetic symmetry in plant leaves. International Studies Program, The National Science Foundation (\$34,740 for six months, Dec. 1 to June 1, 1992-3).
- Smith, W.K. 1993. Early detection and monitoring of atmospheric warming. Committee on Climate Change, DOE, Batelle Pacific Northwest Laboratories (34,500/ 1 yr.)
- Smith, W.K., T.M. Vogelmann, and G.C. Carter. 1994. Remote detection of plant stress using narrow-band spectroradiometry. NASA-EPSCOR. (\$75,000/ 1 yr.)
- Smith, W.K. and T.C. Vogelmann. 1994-5. Remote sensing of plant stress, NASA-EPSCOR, \$85,000/1yr
- Vogelmann, T.C. and W.K. Smith. Leaf structural properties that influence photosynthesis: Interactions between gradients of light, CO₂, and photosynthetic capacity. NSF Integrative Plant Biology, \$85,000.
- Jenkins, R.A., Vogelmann, T.C. Smith, W.K. and five other co-PIs, Acquisition of a university confocal laser scanning microscope system, Instrumentation and Facilities Improvement Program, NSF, \$128,710, 1995-96.
- Del Rio, C.M., W. K. Smith, 5 Co-PI's 1996. A CHNS Analyzer for the University of Wyoming. NSF Instrumentation Improvement Program, \$65,000.
- Smith, W.K. 1992-5. Radiational frost effects on growth season length in the subalpine: A direct coupling between plant ecology and atmospheric warming. NASA Innovative Grants Program, \$246,000/ 3 yrs.
- Smith, W.K. 1996. Plant responses to multiple stress in the alpine timberline ecotone: Low temperature photoinhibition and global climate change. NSF, Evolutionary and Ecological Physiology Program. \$225,000/2 yrs.
- Vogelmann, TC and WK Smith. 1997. The snow alga *Clamydamona nivalis* : photosynthesis under extremes of high light, UV-B radiation, and low temperature. Life In Extreme Environments (LEXEN) Program, NSF, 225,015/3 yrs (IBN-9714268).
- Smith, WK and TC Vogelmann. 1997. Intergrating multiple stress factors in the alpine timberline ecotone: Direct linkage between adaptive biology and global change. Ecological and Evolutionary Physiology Program, NSF, 135,000/2 yrs (IBN-9741500)
- Smith, WK, RD Kelly, JM Welker, ER Hunt, WA Reiners. 1997. Quantification of carbon sources and sinks for northern plains and mountain landscapes using simultaneous aircraft, tower, and leaf measurements of CO₂ and H₂O vapor flux, and stable isotopes. Joint Program on Terrestrial Ecology and Global Change (TECO), NSF, 1.2 million/3 yrs (IBN-9727796).
- JM Welker. Smith, WK and 4 other Co'PI's. 1998. Acquisition of a stable isotope facility to study terrestrial processes and their interaction with climate and the environment. Major Research Instrumentation Program, National Science Foundation. 678,708/ 3 yrs.
- Smith, WK and TC Vogelmann. 2001. Alpine Treeline Stability in a Changing Global Environment: Mechanisms of Conifer Tree Seedling Establishment. Evolutionary and Ecological Physiology Program, National Science Foundation. Funded for \$305,401/3 yrs.

- Smith, WK, TC Vogelmann, and C Critchley. 2001. Workshop/Edited Book Proposal: Scaling Photosynthesis From The Chloroplast To The Landscape. 12th International Congress On Photosynthesis, Brisbane, Australia, August 18-22, 2001 Proposal submitted to NSF, USDA, and DOE requesting partial funding from each for a total of \$35,000 (All three grants funded).
- Smith, W. K. and Georgi Nakhutsrishvili. 2002. Mechanisms of Upper Treeline Stability: Reproductive Effort, Seed Germination, and Seedling Survival in *Betula litwinowii* of the Caucasian Mountains, Georgia (FSU)., George Institute of Botany, Georgia Academy of Science and Wake Forest University. International Science Cooperative Program, National Science Foundation.(\$35,000/yr for 3 yrs)
- Smith, WK. 2002. Alpine treeline stability in a changing global environment. Ecology and Evolutionary Physiology program, NSF. \$258,000/3 years.
- Smith, WK and TC Vogelmann. 2001. Alpine Treeline Stability in a Changing Global Environment: Mechanisms of Conifer Tree Seedling Establishment. Evolutionary and Ecological Physiology, National Science Foundation. \$305,401/3 yrs.
- Smith, WK, TC Vogelmann, and C Critchley. 2001. Workshop/Edited Book Proposal: Scaling Photosynthesis From The Chloroplast To The Landscape. 12th International Congress On Photosynthesis, Brisbane, Australia, August 18-22, 2001. NSF, USDA, and DOE partial funding from each for a total of \$35,000.
- Smith, W. K. and Georgi Nakhutsrishvili. 2002. Mechanisms of Upper Treeline Stability: Reproductive Effort, Seed Germination, and Seedling Survival in *Betula litwinowii* of the Caucasian Mountains, Georgia (FSU)., George Institute of Botany, Georgia Academy of Science and Wake Forest University. International Science Cooperative Program, National Science Foundation. (128,000/3 yrs.)
- Smith, WK. 2004. Episodic versus daily stress effects on plant resource acquisition, survival, and fitness at the land-sea interface. NC Sea Grant Program, \$5,792/one year.
- Smith, WK. 2004. Mechanisms of Upper Treeline Stability. NSF, Research Experiences for Undergraduates Program, \$5,679/one year (supplement).
- Smith, WK. 2005. Alpine Treeline stability in a changing global environment: Mechanisms of conifer tree seedling establishment. Physiological and Structural Systems, NSF, 287,000/3 yrs
- Smith, W.K. 2005. Research Experiences for K-12 Teachers Program (RET supplement), Proposal #0513604 funded for \$9,904/year.
- Smith, W. K. 2004. Ecological facilitation by *Rhododendron caucasicum* extends the *Betula litwinowii* alpine treeline, Caucasus Mountains of Georgia. George Institute of Botany, Georgia Academy of Science and Wake Forest University, US Civilian Research and Development Foundation (CRDF) and (GRDF), funded for \$42,000/year.
- Smith, WK. 2004-5, Stabilization of Barrier Islands and the Role of Primary Dune Colonizers. NC Sea Grant, NOAA (13,788/ 1yr).
- McCauley, A.K. 2005 (co-PI with others). Addition of a steomicroscope to the Department of Biology, Wake Forest University, Microscopy Laboratory. NSF, Instrumentation and Major Equipment Program. \$74,540.
- Smith, W. K. 2005. Research Experiences for K-12 Teachers, National Science Foundation \$9,874/yr (funded)
- Smith, W. K. 2005.NSF, Partnerships for International Research and Education, Office of International Science and Engineering, Doctoral Dissertation Enhancement Program, \$30,000/2 yrs.

- Smith, WK. 2005. Episodic versus daily stress effects on plant resource acquisition, survival, and fitness at the land-sea interface. NC Sea Grant Program, funded for \$4,792/one year.
- Smith, WK. 2006-2008. Sustaining Relic Spruce-fir Forests of the Southern Appalachian Mountains. Hewlett Foundation and National Commission on Energy Policy, Washington, DC. \$50,000/2 yrs.
- Smith WK, Feagin R, Jackson NL. 2007-2012. Sustaining barrier island ecosystems under global change, Coastal Barrier Island network. NSF, Research Coordination Networks, \$477,000 / 5 yrs.
- Jackson, NL, Feagin, RL, and WK Smith. 44th Symposium on Coastal Geoscience, 2013. Binghamton, NJ, USA.

(not listed: 22 smaller grants totaling \$ 161,811, plus 14 additional NSF grants supporting undergraduate and high school teachers [Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET) Program, NSF].

PARTIALLY-REFEREED PUBLICATIONS

- Smith, WK, JR Foster and DH Knight. 1986. Transpirational water loss from streamside vegetation in Wyoming: High elevation source streams and alluvial/irrigation channels of valleys. Project #5-38679, Wyoming Water Research Center, Laramie, WY. Pp 1-12.
- Carter, GA, JL Hadley, WK Smith and DH Knight. 1983. Summer water relations of *Abies lasiocarpa*, *Picea engelmannii*, and *Pinus contorta* at higher and lower elevations in southeastern Wyoming. Wyoming Water Research Center, Report A-035-WYO US Dept Interior. Pp 1-20.

PUBLISHED BOOK REVIEWS

Review of Physiological and Environmental Plant Physiology by P.S. Nobel, Academic Press, 635 pp. *Bulletin of the American Botanical Society*, November, 1991.

Smith WK. 2013. A unified paradigm for the climatic elevations of global treelines. *Ecology* 94:767-778. (invited book review)

NONSCIENTIFIC PUBLICATIONS

Smith, W.K. 1979. Flora of a parched land. Wyoming Wildlife Magazine, January, Wyoming Game and Fish Commission, pp. 28-32.

(twelve other short articles for various newspapers or periodicals (1981-present) regarding plant adaptations to harsh and extreme environments)

INVITED SEMINARS AND PRESENTATIONS

1979. Plant transpiration and photosynthesis at high elevations. Interdepartmental Seminar Series, Department of Botany, University of Chicago .
1979. Water and photosynthetic relations of understory plants in the Rocky Mountains of Wyoming. Biology Departmental Seminar, Department of Biology, Harvard University, November 27, 1979.

1981. Water stress and photosynthesis under variable light regimes in the subalpine understory. Department of Biology, San Francisco State University, San Francisco, CA
1983. Phenotypic plasticity and water use efficiency in understory plants of the Rocky Mountains. Guest Speaker, Annual Meetings of the Society of Plant Physiologists, University of Hawaii, May 6, 1983.
1984. Environmental factors limiting summer leaf conductance patterns in Rocky Mountain conifers. Invited paper presented to the IUFRO meetings (Subalpine Workshop: Management and Tending of Subalpine Forests) in Zurich, Switzerland, September 2-12, 1984.
1986. Ecophysiological adaptations enhancing carbon gain and water conservation in alpine and subalpine plants. Presented October 10, 1986, to the Department of Botany, Colorado State University.
1987. Ecophysiological adaptations enhancing carbon gain and water conservation in alpine and subalpine plants. Department of Botany, University of Georgia, Athens.
1987. Stomatal and photosynthetic responses to rapid environmental changes in alpine/subalpine habitats. Presented June 29, 1987 to the Department of Biology, University of Pittsburgh, PA.
1987. Non-steady state responses in plants to rapid environmental changes. Presented (December 27, 1987 to the Desert Research Institute, University of Nevada, Reno.
1989. Environmental constraints on carbon gain in alpine/subalpine plants. Presented May 14, 1989, Ecological Seminar Series, Department of Population and Organism Biology, University of Colorado, Boulder, CO. May 14, 1989.
1991. Light and canopy interactions: Effects on carbon gain in alpine and subalpine plants. Ecosystems Northwest Seminar Program: Canopy Processes, University of Washington, Seattle, Nov. 20, 1991.
1993. Leaf structural adaptations for enhanced CO₂ exchange. Department of Botany, University of Western Australia,
1994. Scaling light interception efficiency for photosynthesis from the leaf interior to the canopy. Plant and Soil sciences Department, University of Western Australia, WA (also given in New Zealand, University of Canterbury, Christchurch; and one in own department, UW)
1994. Environmental limitations to photosynthesis in the alpine/subalpine: Implications of global climate change. Division of Forest Resources, CSIRO, Perth, Western Australia.
1995. Scaling light and temperature effects on conifer photosynthesis from the leaf to the canopy. Ministry of Forestry, Canterbury University, Christchurch, New Zealand.
1995. Radiational frosts and climate change. Department of Biology, University of Maryland.
1996. Limitations to photosynthesis due to radiational frosts and dewfall, high irradiance, and UV-B exposure in high elevation species. Department of Plant Sciences, University of Illinois.
1997. Low temperature photoinhibition in alpine plants: linkages to global climate change. Department of Biology, University of Nevada at Las Vegas.
1998. Adaptation to extreme environments: Form versus physiology. Department of Biology, Northern Arizona University, Flagstaff.
1998. Adaptation to multiple stress factors in plants: Scaling from the cell to the canopy. Department of Biology, Wake Forest University, Winston-Salem.
1998. Physiological Ecology: a science for studying organisms or ecosystems. Invited speaker (three total) for Perspectives in Biological Sciences Symposium, Dept. Biology, Wake

- Forest University.
1998. Plant Adaptations to extreme environments from the cell to the canopy. Invited speaker (three invited speakers) for Perspectives in Biological Sciences Symposium, Dept. Biology, Wake Forest University.
1999. Low temperature as an ecological factor and implications for global climate change. Workshop: "The Impact of Global Warming on the Frequency and Intensity of Climatic Extremes", Aspen Institute for Global Change, Aspen, CO.
2000. Scaling photosynthetic adaptations in form and function from the leaf to the landscape. Department of Biology, Duke University. Topics in Ecology Seminar Program. Photosynthetic adaptations from inside the leaf to the ecosystem. Graduate Program in Ecology Seminar Series, Duke University, Durham, NC.
2000. Plenary Speaker, Interactive effects of microsite, plant form, and photosynthetic physiology to low temperature photoinhibition In alpine plants., Third Conference on the Biochemistry, Physiology, Ecology, and Population Biology of Arctic and Alpine Plants, Villar d'Arene- Hautes-Alpine, Grenoble, France. Aug. 31- Sept 3.
2000. Western Carolina University, Dept of Biology
2000. Department of Plant Science, University of Illinois, Urbana.
2001. Methodist College,
2001. Appalachian State University, NC
2001. NC Baptist College, NC
2002. Brevard College, NV
2002. Plenary Speaker, 16th Annual Forestry Science Workshop, Washington State University, Pullmann, WA, June 18-2
2002. Virginia Commonwealth University (Inauguration Speaker for new Biol. Sciences Bldg Dedication)
2002. Merging paleobotanical and ecophysiological approaches for understanding evolution, Ecological Society of America meetings, July4-10, University of Arizona, Tucson.
2003. Jones Ecological Center, GA
2003. Brown University, RI
2003. Dept Biology, Appl State Univ, Boone. NC
2003. Georgia Institute of Botany, Tbilisi, Republic of Georgia (FSU).
2003. Japanese Society for the Promotion of Science in Japan, Hakaido University (3 seminars)
2004. Climate Change Symposium, 13th International Photosynthesis Congress, Montreal Canada. Sept. 2004
2005. Dept of Ecology and Evolutionary Biology, Idaho State Univ.
2005. Symposium on Treeline Ecology, USGS and US Forest Service, Glacier, MT
2006. North Carolina State University, Dept of Botany
2006. Symposium on Sea Level Rise, Texas A&M Univ
2006. Workshop on Climate Change, Hewlett Foundation/Nat Commission on Energy Policy, Washington, DC
2006. Invited speaker, Department of Plant Sciences, Univ Vermont
2007. UNC Charlotte, Dept of Biology Seminar Series
2007. Bennet College, Winston-Salem, NC
2008. Piedmont Club of NC
- 2009 Lenoir-Rhyne College, Dept of Bology
2009. Department of Biology, Idaho State University

(11 various interviews for television and radio stations regarding various topics such as why leaves change color in the fall or the fate of barrier island ecosystems in a warming climate.

WORKSHOPS, PANELS, and SYMPOSIA

- Smith, W.K. and B.F. Chabot. 1981. Department of Botany, University of Wyoming and Section of Ecology and Systematics, Cornell University. Co-sponsors, "Ecology of Forest Understory Species" sponsored by the Botanical Society of America and the Ecological Society of America, American Institute of Biological Sciences meetings, Indiana University, Bloomington, August 1981.
- Invited participant, USA-Australian Workshop on Stomatal Function, East-West Center, University of Hawaii, April 11-15, 1983.
- Invited Panel Member, Symposium on Current Methods of Photosynthetic Measurements in Plant Ecophysiological Research, American Institute of Biological Science meetings, University of North Dakota, Grand Forks, August 7-11, 1983. (With W. Oechel, San Diego State University, and B. Strain, Duke University.)
- Invited participant: Establishment and Tending of Subalpine Forests (H. Turner and W. Tranquillini, organizers) Zurich, Switzerland, September 2-12, 1984.
- Invited to be organizer for panel on water relations, workshop on tree ecophysiology, CRC Press volume, Techniques and Methodology in Forest Tree Ecophysiology. Cornell University, Ithaca, NY, August 17-19, 1986.
- Invited participant, International Workshop on "Closure of the Carbon, Water, and Nutrient Cycles in Temperate Forests". Sponsored by the USDA, U.S. Forest Service, The National Science Foundation, and the Electric Power Research Institute. (M.R. Kaufmann and J.J. Landsberg, organizers) Granby, Colorado, June 10-15, 1990.
- Primary organizer for international workshop "Physiological Ecology of Coniferous Forest: A Contemporary Synthesis" held at the UW/National Park Service Research Center, Jackson Hole, WY., Sept. 16-19, 1991 (Co-organizer Dr. T.M. Hinckley, University of Washington, Seattle.)
- Invited participant, Subcommittee for the Review of the Program for Ecosystem Research, Environmental Sciences Division, Department of Energy, San Diego, CA., June 6-9, 1994.
- Invited participant, Committee on Global Climate Change: Early Detection Methodology, Battelle Pacific Northwest Laboratories, Department of Energy, July, Sept. and Nov. meetings, 1994.
- Invited participant and organizer, National EPSCoR Meeting, Jackson, WY., 1995
- Invited participant, workshop for the National Institute for Global Environmental Change, Great Plains Regional Center, University of Nebraska, Lincoln, Sept. 26-29, 1995.
- Invited participant: Temperature effects of global change and climate variability, Aspen Institute for Global Change, Aspen, Colorado, August 9-22, 1999
- Chair, Ozone effects on forest decline in the Eastern Forests, USA, Air Pollution Conference, Duke University, Durham, NC. November 27-30, 1999.
- Invited participant, The biochemistry, physiology, and population biology of arctic and alpine plants. Lauteret Alpine Institute, Villar d' Arene, Hautess-Alpes, France, Aug. 31-Sept. 2, 2000.
- Lead Organizer for workshop and symposium "Leaf Form/Function as Related to Photosynthetic Performance". Ecological Society of America, Summer, 2001
- Lead Organizer for workshop to be held as a satellite meeting for the 12th International Congress on Photosynthesis (*Scaling Photosynthesis from the Chloroplast to the Landscape*),

- Brisbane, Australia, August 17-24, 2001. (Meeting in support of edited book, Academic Press, Ecological Studies Series).
- Invited participant, *Alpine Treeline Ecosystems*, 2006 USGS and US Forest Service, Glacier, MT.
- Lead Organizer for Workshop *Sustaining Barrier Island Ecosystems and Global Change*, 2006, NSF. April 12-15, Univ Southern Mississippi, Gulfport, MS
- Invited Participant: Workshop on Global Climate Change. 2007. Hewlett Foundation/Nat Commission on Energy Policy, Washington, DC
- Lead Organizer, Coastal Barrier Island Network, Galveston, TX, Jan. 2009.
- Co-organizer, 44th Symposium on Coastal Geomorphology, 2013, New Jersey Institute of Technology, Binghamton, NJ, USA
- Co-organizer, Synthesis Workshop on the Coupling of Vegetation and Geomorphology in Barrier Islands. 2014. South Padre Island, TX

CO-AUTHORED PRESENTATIONS BY COLLEAGUES AND STUDENTS

(1978-1988 only)

- Young, D.R. and W.K. Smith. 1978. Microhabitat variation and ecophysiological differences in *Arnica cordifolia*. Paper presented to the Physiological Ecology Section of the Ecological Society of America meetings, August 20-25, 1978, Athens, GA.
- Young, D.R. and W.K. Smith. 1979. Influence of sunflecks on the water relations for two subalpine understory congeners. Paper presented to the SWARM Division of the AAAS, April 24-28, 1979, Durango, CO.
- Geller, G.N. and W.K. Smith. 1979. Plant transpiration at high elevation: Theory and field measurements, comparisons with desert plants. Paper presented to the SWARM Division of the AAAS, April 24-28, 1979, Durango, CO.
- Young, D.R. and W.K. Smith. 1979. Influence of sunflecks on leaf structure, water, and photosynthetic relations of *Arnica cordifolia*. Paper Presented to the Physiological Ecology Section of the Ecological Society of America, August 12-17, 1979 Stillwater, OK.
- Allen, M.F., P.D. Stahl and W.K. Smith. 1979. Increased transpiration and photosynthetic rates in *Bouteloua gracilis* infected with *Glomus fasciculatus*. Paper presented to the N. Amer. Conference on Mycorrhizae, June 24-27, 1979, Fort Collins, CO.
- Allen, M.F., W.K. Smith and M. Christensen. 1979. Comparative photosynthetic rates and water relations of *Bouteloua gracilis* with and without vesicular-arbuscular mycorrhizae. Paper presented to the AIBS, Mycological Society, August 13-19, 1979, Stillwater, OK.
- Young, D.R. and W.K. Smith. 1980. Optimal leaf sizes for minimizing transpiration indifferent habitats. Paper presented to the SWARM Division of the AAAS, April 9-14, 1980, Las Vegas, NV.
- Geller, G.N. and W.K. Smith. 1980. Optimal leaf sizes for minimizing transpiration in different habitats. Paper presented to the SWARM Division of the AAAS, April 9-14, 1980, Las Vegas, NV.
- Young, D.R. and W.K. Smith. 1980. A simulation model for predicting water and photosynthetic relations of a subalpine, understory species. Paper presented to the Physiological Ecology Section of the Ecological Society of America meetings, August 4-9, 1980, Tucson, AZ.
- Geller, G.N. and W.K. Smith. 1980. The influence of leaf size on transpiration at high elevations in Wyoming. Paper presented to the Physiological Ecology Section of the Ecological Society of America Meetings, August 4-9, 1980, Tucson, AZ.

- Allen, M.F., T.S. Moore, Jr., W.K. Smith and M. Christensen. 1980. The influence of VA mycorrhizae on ecophysiological characteristics and phytohormones of *Bouteloua gracilis*. Paper presented to the Mycological Society of America Meetings, August 4-9, 1980, Tucson, AZ.
- Young, D.R. and W.K. Smith. 1981. The importance of cloudcover to the water and photosynthetic relations of three understory species. Paper presented to the Botanical Sciences Section, Southwestern and Rocky Mountain Division AAAS meetings, April 22-25, 1981, University of Northern Colorado, Greeley.
- Knapp, A.K. and W.K. Smith. 1981. Seasonal and diurnal water relations of three subalpine conifers in understory and open environments. Paper presented to the AAAS meetings, April 22-25, 1981, University of Northern Colorado, Greeley. (Student Paper Award in the Botanical Sciences Section.)
- Knapp, A.K. and W.K. Smith. 1981. Water relations and succession in Wyoming conifers. Paper presented to the Ecological Society of America of AIBS meetings, August 8-12, 1981, Indiana University, Bloomington.
- Hadley, J.L. and W.K. Smith. 1981. Influence of winter needle classification on krummholz growth forms near timberline in Wyoming. Paper presented to the Ecological Society of America, AIBS meetings, August 8-12, 1981, Indiana University, Bloomington.
- Young, D.R. 1981., Simulations of optimal growth and reproductive patterns in western coniferous forests. Symposium entitled "Ecology of Forest Understory Plants" sponsored by the Botanical Society of America, AIBS meetings, August 8-12, 1981, Indiana University, Bloomington.
- Young, D.R. and W.K. Smith. 1982. Intraspecific variation in the reproductive effort to the understory herb, *Arnica cordifolia*. Paper presented to the Colorado-Wyoming Academy of Science, April 23-24, 1982, Fort Collins, CO.
- Hadley, J.L. and W.K. Smith. 1982. Winter wind exposure and water loss of Engelmann spruce at timberline in southeastern Wyoming. Paper presented to the Colorado-Wyoming Academy of Sciences, Botanical Sciences Section, April 23-24, 1982, Fort Collins, CO. (Student Paper Award in Biological Sciences.)
- Young, D.R. and W.K. Smith. 1981. The effect of cloudcover on the light regime, Photosynthesis, and water relations of the understory species *Arnica latifolia*. AIBS meetings, Ecological Society of America, Pennsylvania State University, University Park, PA.
- Hadley, J.L. and W.K. Smith. 1982. Seasonal influence of wind on conifer needle desiccation and death near timberline in Wyoming. AIBS meetings, Ecological Society of America, Pennsylvania State University, University Park, PA.
- Hadley, J.L. and W.K. Smith. 1983. Winter wind exposure and water potential for timberline conifers in Wyoming. AIBS meetings, Ecological Society of America, August 7-11, 1983, University of North Dakota, Grand Forks.
- Cater, G.A., J.L. Hadley, W.K. Smith and D.H. Knight. 1983. Summer water relations of three southeastern Wyoming conifers at high and low elevation sites. AIBS meetings, Ecological Society of America, August 7-11, 1983, University of North Dakota, Grand Forks.
- McNaughton, G.M. and W.K. Smith. 1984. Environmental and plant parameters leading to seasonal stomatal closure in Fall in six conifer species of the central Rocky Mountains. Northwest Science Forest Conference, March 24-28, 1984, University of Montana, Missoula.
- Hadley, J.L. and W.K. Smith. 1984. Microclimate modification in krummholz growth forms:

- influence on survival of timberline conifers. Paper presented at AIBS meetings, Ecological Section, August 5-9, 19084, Colorado State University, Fort Collins.
- Carter, G.A. and W.K. Smith. 1984. Influence of needle and shoot orientation on photosynthesis in *Picea engelmannii*, *Abies lasiocarpa*, and *Pinus contorta* saplings in southeastern Wyoming. Paper presented to the AIBS meetings, Ecology Section, August 5-9, 1984, Colorado State University, Fort Collins.
- Huang, Ruey-Shyang, W.K. Smith and R.M. Yost. 1984. Influence of VA-mycorrhiza on growth, nutrient absorption, and water relations in *Leucaena leucocephala*. 4th International Conference on Mycorrhizae, June 18-24, 1984, Oregon State University, Corvallis, OR.
- Carter, G.A. and W.K. Smith. 1985. Effects of photosynthesis and water relations on subalpine forest development. Paper presented to the Ecological Society of America meetings, June 17-21, 1985, University of Minnesota, Minneapolis.
- Foster, J.R. and W.K. Smith. 1986. Influence of stomatal distribution on transpiration. Paper presented to the ESA meetings, August 11-16, 1986, Syracuse University, Syracuse, NY.
- Estill, D.A., R.L. Delaney and W.K. Smith. 1986. Photosynthetic and water relations of leaf size variants in alfalfa. Presented to the Western Society of Crop Science, June 14-19, 1986, Moscow, ID.
- Foster, J.R. and W.K. Smith. 1987. Daily and seasonal water relations of montane phreatophytes in the central Rocky Mountains. Presented to the symposium Management of Subalpine Forests, USDA, July 6-10, 1987, Silver Creek, CO.
- Hadley, J.L. and W.K. Smith. 1987. Effects of Acid mist on needle physiology and mortality in timberline conifers. Presented to the symposium Management of Subalpine Forests, USDA, July 6-10, 1987, Silver Creek, CO.
- Knapp, A.K. and W.K. Smith. 1987. Effects of cloud pattern on carbon and water relations in subalpine conifers. Management of Subalpine Forests Workshop, USDA/USFS, July 6-10, 1987, Silver Creek, CO.
- McClellan, T.M., T.C. Vogelmann, A.K. Knapp and W.K. Smith. 1987. Measurement of light within thin sections of plant tissue using fiber optics. Presented to the annual meetings of the Botanical Society of America, August 9-13, 1987, Ohio State University, Columbus, OH. (Student Paper Award, Physiology Section).
- Knapp, A.K., T.C. Vogelmann, T.M. McClellan and W.K. Smith. 1987. Measurement of light within thin sections of plant tissue using fiber optics. Presented to the annual meetings of the Botanical Society of America, August 9-13, 1987, Ohio State University, Columbus, OH.
- Knapp, A.K. and W.K. Smith. 1988. Non-steady state coupling of photosynthesis and stomatal behavior during variable sunlight. Presented to the annual meetings of the Ecological Society of America, AIBS meetings, University of California, Davis. August 14-18, 1988.
- McClellan, T.M. and W.K. Smith. 1988. Adaptive relationship between leaf water repellancy, stomatal distribution, and photosynthetic gas exchange. Presented to the Ecological Society of America, AIBS meetings, University of California, Davis. August 14-18, 1988.
- Brown, L.A., A.K. Knapp, W.K. Smith and T.C. Vogelmann. 1988. Distribution of light within sun leaves of *Saxifraga rhomboidea* irradiated on upper and lower surfaces. Presented to the Botanical Society of America, AIBS meetings, University of California, Davis. August 14-18, 1988.

[Since 1988, an additional 79 co-authored presentations have been presented by students or colleagues in the U.S. and abroad. Thirteen of these have received Best Student Paper or Poster Awards in four different scientific societies (one was featured in *BioScience*, 1995-- Michael Byum's MS work on floral movements in the alpine Gentian). Most recently, WFU undergraduate students Craig Brodersen and Scott Graham presented posters at the Assoc. Southeastern Biologists meeting at Appalachian State University, Boone, NC (2002). The latter poster received an Acknowledgement Award (only three total awards given out of 52 competitors). Tom Hancock (PhD student) also received a graduate research award (only two awarded) from the ASB at the same meetings. Also, Dan Johnson was awarded the best student paper in physiology at the Amer Botanical Society meetings at Univ. Texas, Austin, summer 2005, as well as the Odum Award for best paper in ecology at the Southeastern Biology Association meetings in Nashville, TN (2006). Nicole Hughes received the following awards: Gordon A. Melson Award for Outstanding PhD Student in the Wake Forest Graduate School of Arts and Sciences *Wake Forest University* (2009); Physiological Section Award for Best Poster-2008 *Botanical Society of America meeting*; Elton C. Cocke Award for Outstanding Graduate Student in Biology

-*Wake Forest University* (2008); Best Student Paper Presentation In Botany- Awarded by the Southeastern Chapter of the Botanical Society of America at the 2008 meeting of the Association of Southeastern Biologists. Best Student Poster In Botany- Awarded by the Southeastern Chapter of the Botanical Society of America at the 2008 meeting of the Association of Southeastern Biologists; Eugene P. Odum Award for Best Student Paper Presentation in Ecology (runner-up) - Awarded by the Southeastern Chapter of the Ecological Society of America at the 2008 meeting of the Association of Southeastern Biologists; Quarterman-Catherine Keever Award for best Student Poster in Ecology - Awarded by the Southeastern Chapter of the Ecological Society of America at the 2008 meeting of the Association of Southeastern Biologists; Billings Award for Best Ecophysiological Paper Presentation (runner-up) - Awarded by the Ecological Society of America at the 2007 meetin;. Conant Award for Botanical Imaging (third place)- Awarded by the Botanical Society of America at the 2007 meetin;. Eugene P. Odum Award for Best Student Paper in Ecology - Awarded by the Southeastern Chapter of the Ecological Society of America at the 2004 meeting of the Association of Southeastern Biologists.

GRADUATE STUDENTS SUPERVISED

Graduated

Donald R. Young. M.S. 1979, Ph.D. 1982. Professor and Head, Dept. of Biology, Virginia Commonwealth University, Richmond.

Michael F. Allen. Ph.D. 1980. Professor, Dept. of Biology, Calif. State, University at San Diego (co-advised with Dr. Martha Christensen).

Gary N. Geller. M.S. 1980. Ph.D, University of California, 1985; Currently Associate Director, Earth Systems Division, Jet Propulsion Laboratory, Calif. Inst. Technology, Pasadena, CA.

Peter D. Stahl. M.S. 1981, Ph.D. 1989. Assoc Prof, U Wyoming (co-advised with M. Christensen).

Geoffrey N. McNaughton M.S. 1985. *In Situ* Environmental Laboratories, University of Washington, Seattle.

Gregory A. Carter. Ph.D. 1986. Research Scientist, NASA, Birmingham, Alabama; Assoc Prof, Geospatial Center, U South Mississippi.

- Julian L. Hadley, Ph.D. 1986 (**NSF Predoctoral Fellowship**). Research Professor, Harvard Forest, Harvard University, Cambridge, MS.
- Alan K. Knapp. M.S. 1981, Ph.D. 1989. Professor, Department of Biological Sciences, Colorado State University, Fort Collins.
- Kristine Estill. M.S. 1990. Ph.D. Student, University of Arizona.
- Anna W. Schoettle, Ph.D. 1991. Research Scientist, U.S. Forest Service, Fort Collins, Colorado.
- Muyi Cui, Ph. D. 1991. Owner, Software Processes Inc., Salt Lake City, UT.
- Erik Hammerlynck, M.S. 1992. PhD, Kansas State University, Asst Prof., Rutgers University
- Carol Brewer, Ph. D. 1993. Assoc. Professor, Division of Biological Sciences, University of Montana, Missoula.
- Mark T. Hemmerli, M.S. 1994. Research Co-ordinator, Environmental Division, State of Connecticut.
- Kristen Mitchel, M.S. 1994. Research Scientist, Linear Laboratories, Salt Lake, City, UT; Univ of Washington Law School graduate, Seattle, WA
- Amy S. Mueller, M.S. 1995 (**NSF Predoctoral Fellowship**). Teaching Fellow, Polytechnical Institute, Equito, Ecuador
- Dean N. Jordan, Ph.D. 1995. (**DOE Predoctoral Fellowship**), Project Director, Terrestrial Ecology and Global Change Program ,University of Nevada.
- Michael R. Bynum, M.S. 1995. Teaching Faculty, Chadron State Univ, Chadron, NE
- Catie A. Campbell, M.S. 1996; B.A. 1991, Dartmouth College, Nature Conservancy, Houston TX
- Matthew J. Germino, M.S. 1996; B.S. 1994, University of Massachusetts, Amherst
- Michele Slaton, M.S. 1998; B.S. 1996, University of Idaho, Moscow;
- Matthew J. Germino (**NASA Predoctoral Fellowship**)- Associate Professor, Idaho State Univ ; Senior Research Leader, USGS, Boise, ID
- Shelley M. James, PhD student (Australia), M.S. University of Western Australia, Perth
- Michele Slaton, PhD 2001, Univ Wyoming, Lecturer, Western State College, CO; US Forest Service, White Mountain Research Station, Big Pine, CA
- Jerry H. Winslow, PhD 1999, Univ Wyoming, Associate Professor, Texas A.M Univ.
- Cynthia Willson, MS 1999, Univ. Wyoming (**NSF Graduate Fellowship**), PhD student, Duke University, now a physician with a private practice.
- Pat Morgan, MS Univ. Wyoming 1999; PhD student Univ Vermont, Postdoc, NCSU
- Judsen Hill, MS 2000. Wake Forest University; PhD , Idaho State University
- Craig Brodersen MS 2004. Wake Forest Univ, PhD, Univ Vermont; Assistant Prof, Univ Florida; Assist Prof, Yale University, Connecticut
- Daniel Johnson, 2006, PhD (MS, NCSU); Postdoc Oregon State University USFS), Assistant Professor, Ohio University currently Asst Prof, Univ Idaho, Moscow
- Keith Reinhardt, PhD 2009 (MS, Univ Virginia; Assist Prof, Idaho State Univ,., Idaho State Univ)
- Nicole Hughes, PhD 2009 (MS, Appalachian State Univ) WFU Award for best PhD Research; Assistant Professor, High Point University, High Point, NC
- Tom Hancock PhD 2009 (MS, UNC Wilmington), Assistant Professor, Methodist University, Fayetteville, NC.
- Allison Snow, MS (MS, WFU)
- Heather Joesting, PhD (MS, Ohio University; Assistant Professor, Armstrong Atlantic University, Savannah GA)
- Carter Berry, PhD, Postdoc, Univ New Hampshire

Current

Joseph White, PhD

Mary Jane Carmichael, PhD

Melanie Doyle, PhD

POSTDOCTORAL ASSOCIATES

Dr. Jeffery R. Foster, 1984 to 1987, Ph.D. Dartmouth University, 1984.

Dr. Julian L. Hadley, 1986 to 1989, Ph.D. University of Wyoming, 1986.

Dr. Tad Day, 1987 to 1990, Ph.D. Colorado State University, 1987.

Dr. Dean N. Jordan, 1994-5, PhD University of Wyoming

Dr. Minna Turunen, 1996-7, Artic Center, University of Lapland, FINLAND

Dr. Tao Han, 1996-8, Beijing School of Forestry, China

Dr. Adriana Sanchez, 20011-14**UNDERGRADUATE STUDENTS (worked in lab at WFU, not including Bio 340 students)**

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|-----------------|----------------------|
| Emily Walters | John Track |
| David Schindler | Reid Larsen |
| Kelsey McDowell | Christine Manuck |
| Mike Gier | Christine D'Alleinne |
| Mike Sprague | Craig Brodersen |
| Spencer Bisset | Samantha Rieger |
| Judsen Hill | David Harding |
| Wreana Best | Christiana Buckman |
| Scott Graham | Sean Taylor |
| Ben Robb | Joseph Nuigal |

JOURNAL REVIEWS

Ecology, Oecologia Pl. Physiol., Can. J. Forest Research, Forest Science, Arctic, Antarctic & Alpine Research, Can. J. Bot. (now Botany), Botanical Gazette, Crop Science, J. Exp. Botany, Plant Cell & Env., Science, Nature, CRC Press, J. Ecology, Photosynthetica, Photosynthesis Research, Amer. J. Bot., Physiol. Plantarum, Bound. Layer Meterol., New Phytologist, Agric. & Forest. Meteorology., Ecological. Monog., Tree Physiology, Functional Ecology, Forest Ecology and Management, New Zealand Journal of Plant Physiology, New Zealand Journal of Ecology, Ecological Applications, Australian J. Plant Physiology, Amer. Midland Naturalist, Australian J. Plant Ecology, Intern. J. Plant Sciences, Physiologia Plantarum, Oecologia Plantarum, Plant & Soil, J. Range Management, Proc. Nat Acad Sciences, Plant Ecology, For Ecol Management, Can J Forest Res., Trees, Global Climate Change, J Geophysical Res., Global Change Biology, Botany, Plant Ecology, Castanea, Torrey Botanical Club, Botany

GRANT REVIEWS

NSF, USDA, NASA, DOE, U.S. Geological Survey, U.S. EPA, U.S. Forest Service, U.S. Park Service, National Geographic Society, BLM, Office of Mined Land Reclamation, Nature Conservancy, Carnegie-Mellon Foundation.