Craig E. Tweedie

Biography:

Craig was born and raised in Brisbane, Australia, and received all of his university level training at The University of Queensland, graduating BSc, BSc (hons) and a PhD in Botany in 1992, 1995 and 2000 respectively. Craig’s honors degree examined the ecology of vascular epiphytes in sub-tropical rainforests and my PhD examined the autecology of six plant species along altitudinal gradients on sub-Antarctic Macquarie Island, one of Australia’s 4 permanently occupied Antarctic bases. Between 1993 and 1994 Craig was employed by the Queensland National Parks and Wildlife Service to conduct flora surveys and devise fire management plans for several national parks in northeastern Australia. Between 2000 and 2005 Tweedie was employed by Michigan State University as a visiting research associate where his passion for Arctic and functional ecological research and international scientific networking was established.

Refereed Publications:

Walker, M., H. Wahren, L. Alquist, J. Alatolo, S. Bret-Harte, M. Calef, T. Callaghan, A. Carrol, C. Copass, H. Epstein, G. Henry, R.D. Hollister, I.S. Jonsdottir, J. Klein, B. Magnusson, U. Molau, S. Oberbauer, S. Rewa, C. Robinson, G. Shaver, K. Suding, A. Tolvanen, O. Totland, P.L. Turner, C.E. Tweedie, P.J. Webber, P. Wookey. Tundra plant community response to experimental warming: sensitivity in a rapidly changing environment. Submitted to Proceedings of the National Academies of Science.

Hollister, R.D., P.J. Webber, F. Nelson, C.E. Tweedie. (in press) Microenvironments of four experimentally warmed arctic tundra communities. Arctic, Antarctic and Alpine Research.

Hollister, R.D., P.J. Webber, C.E. Tweedie. 2005. Vegetation change in northern Alaska following experimental warming: Separation of initial and secondary responses. Global Change Biology, 11(4):525-536.

Hinzman, R.D., N. Bettez, F.S. Chapin, M. Dyurgerov, C. Fastie, B. Griffith, R.D. Hollister, A. Hope, H. Huntington, A. Jensen, D. Kane, A. Lynch, A. Lloyd, A.D. McGuire, F. Nelson, W.C. Oechel, T. Osterkamp, C. Racine, V. Romanovsky, D. Stow, M. Sturm, C.E. Tweedie, G. Vourlitis, M. Walker, P.J. Walker, J. Welker, K. Winkler, K. Yoshikawa (2005). Evidence and implications of recent climatic change in terrestrial regions of the Arctic. Climatic Change 72(3): 1-48.

Graves, A., C.E. Tweedie, D. Zaks, S. Serbin, W. Manley, J. Brown, R. Bulger. 2004. Spatial data infrastructure supports long term measurements to detect arctic change. Arctic Coastal Dynamics – Report of the 4th International Workshop. Ber. Polarforsch. Meeresforsch, 482(2004): 29-30.

Serbin, S., A. Graves, D. Zaks, J. Brown, C.E. Tweedie. 2004. The utility of survey grade differential global positioning systems (DGPS) technology for monitoring coastal erosion. Arctic Coastal Dynamics – Report of the 4th International Workshop. Ber. Polarforsch. Meeresforsch, 482(2004): 29-30.

Stow, D., A. Hope, D. McGuire, D. Verbyla, J. Gamon, K. Huemmrich, S. Houston, C. Racine, C. M. Sturm, K. Tape, L. Hinzman, K. Yoshikawa C.E. Tweedie, B. Noyle, Silapaswan, D. D. Douglas, B. Griffith, G, Jia, H. Epstein, D.A. Walker, S. Daeschner, A. Petersen, L. Zhou, and R. Myneni (2004). Remote sensing of vegetation and land cover changes in arctic tundra ecosystems. Remote Sensing of Environment, 89: 281-308.

Tweedie, C.E., R.D. Hollister, P.J. Webber. (2003). Decadal changes in permafrost, land form and land cover near Barrow, Alaska. In: 8th International Conference on Permafrost, Zurich, Switzerland. 20-25 July, 2003.

Tweedie, C.E. (2000). Climate change and the autecology of six plant species along an altitudinal gradient on subantarctic Macquarie Island. Bulletin of the Ecological Society of Australia, 31 (4): 27-28.

Tweedie, C. E & Bergstrom, D. M. (2000). A climate change scenario for surface air temperature at subantarctic Macquarie Island. In: Davison, W (ed). Proceedings of the VII SCAR international biology symposium, Christchurch, New Zealand, 31st August – 4th September. (Invited Chapter).

Erskine, P.D., D. M. Bergstrom, S. Schmidt, G.R. Stewart, C.E. Tweedie, and J.D. Shaw (1998) Subantarctic Macquarie Island – a model ecosystem for studying animal derived nitrogen sources using 15δN natural abundance. Oecologia, 17(1-2): 187-193.

Bergstrom, D. M. & C.E. Tweedie (1998) A conceptual model for integrative studies of epiphytes: nitrogen utilization a case study. Australian Journal of Botany, 46:270-280.

Theses:

Tweedie, C.E. (2000). Climate change and the autecology of six plant species along an altitudinal gradient on subantarctic Macquarie Island. PhD thesis, The University of Queensland, Brisbane, Australia. 334 pages.

Tweedie, C.E. (1994). The ecology of vascular arboreal epiphytes. BSc. Honors thesis, The University of Queensland, Brisbane, Australia. 152 pages.

Non Refereed Publications:

Tweedie, C.E. (2004). CEON initiative gathers support. Witness the arctic, Spring: 22.

Tweedie, C.E. (ed). (2004). Report on the Initial Planning Meeting of the Circum-Arctic Environmental Observatories Network (CEON). Available from March 2004 at http://ceoninfo.org

Tweedie, C.E. and P.J. Webber (2002). A Circum-Arctic Environmental Observatories Network (CEON). Frozen Ground, 26:59-60.

Brown, J, and C.E.Tweedie. (2000). Research site registration is underway at Barrow. Witness the Arctic, Winter 2000/2001, 8(2):18.

Tweedie, C.E. (1994). A vegetation assessment and its application to fire management in

Woodgate and Kinkuna National Parks, part of the proposed Burrum Coast National Park. Queensland Department of Environment and Heritage, Central Coast region, Rockhampton. (173pp).

Melzer, R.I and C.E. Tweedie. (1993). A vegetation survey and fire management plan for Byfield National Park and Byfield coastal management area. Queensland Department of Environment and Heritage, Central Coast region, Rockhampton. (153pp).

Courses Taught at UTEP:

Graduate-level Subjects:

ESE-6404. Environmental Biology: Theory and Application.

Undergraduate Subjects:

BIOL-1306. Organismal Biology (honors level).

Craig’s Research:

The Systems Ecology Laboratory (SEL) is focused on understanding the biocomplexity associated with environmental change and plant and ecosystem structure and function in extreme environments – namely Arctic tundra and the Chihuahuan Desert. We use a variety of plant ecological and physiological methods in combination with aerial and satellite remote sensing and Geographic Information systems (GIS) to examine and model changes in plant and ecosystem structure and function over a range of spatial and temporal scales. The SEL is also committed to maintaining long term environmental observations and improving the capacity for cross disciplinary and international cooperation in monitoring the impacts of environmental change. To facilitate the latter we are partnered to several projects described below that are developing novel internet based portal, mapping and information management systems that facilitate access to distributed information systems.

The SEL has five primary research projects that are currently underway. Most projects are funded by the US National Science Foundation (NSF) and include:

1. **Biocomplexity associated with the response of arctic tundra carbon balance to warming and drying across multiple spatial and temporal scales.** NSF Biocomplexity Program: –September 2004 – August 2007. PI’s: W.C. Oechel, J.S. Kimball and C.E. Tweedie. ($2,000,000 total, $205,121 UTEP).
2. **Rapid assessment of recent changes in land cover and carbon balance in Beringia**. NSF OPP – Arctic Natural Sciences Program: March 2005 – February 2008. PI’s: P.J. Webber and C.E. Tweedie. ($452,263 total, $294,912 UTEP).
3. **Maintenance, development and Innovation of the Barrow Area Information Database and Internet Map Server (BAID-IMS).** NSF OPP – Arctic Research Logistic Support Program: September 2005 – August 2008. PI’s: P.J. Webber, C.E. Tweedie and Allison Gaylord. ($465,914 total, $236,133 UTEP).
4. **Developing and implementing the Circum-arctic Environmental Observatories Network (CEON).** NSF OPP – Arctic Research Logistic Support Program: March 2005 – February 2008. PI’s: P.J. Webber and C.E. Tweedie. ($749,981 total, $365,134 UTEP).
5. **Assessing the impact of land cover change on ecosystem structure and function in the Chihuahuan Desert.** UTEP – Incentive award: June 2005 – June 2006. PI: C.E. Tweedie ($1000).

More descriptions for each of these projects is given below.

1. **Biocomplexity associated with the response of arctic tundra carbon balance to warming and drying across multiple spatial and temporal scales.**

**Intellectual Merit:** *This project is examining how biological and physical processes interact to control carbon uptake, storage and release in Arctic tundra ecosystems and how the self-organizing nature of these interactions varies across multiple spatial and temporal scales*. Approximately 25% of the world’s soil organic carbon reservoir is stored at high northern latitudes in permafrost and seasonally-thawed soils in the Arctic, a region that is currently undergoing unprecedented warming and drying, as well as dramatic changes in human land use. Understanding how changes in annual and inter-annual ecosystem productivity interact and potentially offset the balance and stability of the Arctic soil carbon reservoir is of utmost importance to global climate change science. If there is a net loss of soil carbon to the atmosphere in the form of greenhouse gases (namely CO2 and CH4), greenhouse warming could be enhanced. This non-linear, potentially positive feedback response could very quickly cause Arctic terrestrial ecosystems to function in a manner not known to us from the late Holocene and with globally significant implications.

Project activities benefit from a foundation and wealth of international and national carbon cycle research undertaken in northern Alaska and other Arctic regions over the past three decades. We are initiating a comprehensive study involving an integrated framework of multi-scale aircraft and satellite remote sensing, micrometeorological and CO2 and CH4 flux measurements and hydroecological process model simulations over a 350km North-South transect spanning the dominant Arctic topographic and land cover units of northern Alaska. The study region encompasses many long-term measurement sites that have been in place for 5 to 10 years. We will expand these observations to include an extensive soil moisture manipulation involving a 60 hectare tundra flooding/draining experiment near Barrow Alaska on the Arctic Coastal Plain. The objective of this study is to quantify linkages between soil moisture and carbon uptake, storage and release over multiple spatial (microbial to landscape) and temporal (minutes to decades) scales. Only by increasing the spatial extent of our experimental manipulations and the duration of our observational time series can we better understand and predict the effect of scale on the complex coupling within Arctic ecosystems; namely, how small scale processes participate as components of higher scale phenomenon and how higher scale phenomenon constrain the former lower scale processes. *This knowledge will improve our understanding of the current behavior and potential response of arctic tundra to global change, resulting in better predictions of feedbacks to climate and the global carbon cycle.*

**Broader Impacts:** National and international science are benefiting substantially from this project, as well as local residents in far northern Alaska, who are primarily Native Iñupiat Eskimo. The landscape manipulation site is available to other interested scientists, and provides a regional resource for multi- and interdisciplinary studies of Arctic change. The project is fostering a new collaborative, multidisciplinary team of experts comprised of new and experienced arctic and non-arctic researchers, and students with direct links to NSF, DOE, and NASA projects including Ameriflux, SpecNet, ITEX, SEARCH, CEON and with additional planning, ORION. Northern Alaska residents are benefiting from the symbiotic ties between community, local students, educators, and project investigators. The project’s formal and informal educational outreach is also building on the already highly successful NSF-funded GK-12 PISCES educational activities at Barrow, Atqasuk and other rural villages, the Toolik Lake LTER Schoolyard project and NSF’s REU program. Building on past development, near real-time data from field instrumentation will be included in classroom and mobile displays at the Iñupiat Heritage Center and the Ukpeagvik Iñupiat Corporation Science Center in the near future.

Research findings also will be made available to policymakers and land managers to promote sustainable and minimal impact development in northern Alaska, where cumulative impacts threaten large areas of tundra. Through activities such as IPCC, ACIA and state and local briefings, the research described here will benefit from the BEO’s planned developments (new Global Change Facility, Education Center, wireless backbone, boardwalks, power, etc.) The baseline data from this project and the initiation of a long-term manipulation will benefit future research on the BEO and broader pan-Arctic region.

2. **Rapid assessment of recent changes in land cover and carbon balance in Beringia.**

**Intellectual Merit:** *This project is assessing decadal time scale changes in ecosystem structure and function throughout the Beringia region and supports US involvement in the Swedish Beringia 2005 Expedition.* Recent and persistent changes in climate and human land use in the Beringia region of north eastern Russia and Alaska are amongst most dramatic on the globe. Significant stores of global soil organic carbon exist in this region and understanding how changes in ecosystem productivity interact and potentially offset the balance and stability of the Arctic soil carbon reservoir is of utmost importance to global change science. Net losses of carbon to the atmosphere as carbon dioxide and methane could enhance greenhouse warming.

The close coupling of physical and biological processes in Arctic terrestrial ecosystems is well founded and subtle changes in biodiversity and land cover can cause dramatic shifts in ecosystem function. *Land cover change represents a time-integrated response and shift in the competitive interaction between species responding to an altered biological, chemical and/or physical state.* Thus, given adequate verification and validation; land cover change, shifts in plot based biodiversity and other ecosystem structural components can be used as indicators of change in ecosystem carbon balance. *The key objective of this project is to provide a rapid assessment of the patterns of decadal time scale land cover change at multiple sites throughout the Beringia region and gauge the probable impact these changes have had on ecosystem carbon balance.*

This project is made possible by our participation in the Swedish Beringia 2005 Expedition. Leg 2A of this expedition focuses on research related to the biocomplexity of Beringian terrestrial ecosystems and uses the Swedish icebreaker Oden to transit study sites between Provideniya (Chukotka, Russia) and Barrow (Alaska). Land cover change will be assessed at the plot level in collaboration with a Russian colleague who established marked plots throughout the region between 1984 and 1986. At the landscape level, land cover change will be assessed using modern high-spatial resolution satellite imagery to derive supervised land cover classifications that will be compared to land cover maps derived from newly archived historical air photos and/or recently declassified military spy imagery. Component land-atmosphere fluxes of carbon dioxide and methane will be measured in collaboration with a Swedish colleague in multiple land cover types at each site visited. Component fluxes will be extrapolated to the landscape level for each multi-temporal land cover assessment and the probable changes in carbon balance over time and space will be estimated. Monolith, soil, and vegetation samples will be collected for controlled laboratory experiments and analyses that will enable cross-site comparison of a range of biogeochemical processes.

**Broader Impacts:** This 3-year project will maintain and expand an active field presence by the investigative team and support numerous established and developing national and international programs and collaborations including participation in the International Polar Year of 2007-08. Postdoctoral, graduate and undergraduate students will work directly on project activities and numerous international educational and community outreach activities affiliated with the expedition and ongoing in northern Alaska will be benefited. Research findings will be presented at national and international meetings and documented in peer review journals. Data will be made available to expedition personnel and archived at internationally recognized data centers according to NSF OPP data archiving policy. Spatially oriented data products will be added to our interactive web-based mapping and informational applications that are partnered to the developing ArcticGIS initiative and the terrestrial Circum-arctic Environmental Observatories Network (CEON). These applications can be viewed at [**http://www.baidims.org**](http://www.baidims.org/) and [**http://www.ceoninfo.org**](http://www.ceoninfo.org/). The bi-polar comparison component of an Earth and Antarctic System Science course and an Antarctic field course for undergraduates taught by the PIs will also be enhanced.

3. **Maintenance, development and Innovation of the Barrow Area Information Database and Internet Map Server (BAID-IMS).**

*The key objective of this proposal is to maintain, develop and innovate the prototype Barrow Area Information Database and Internet Map Server (BAID-IMS) that we have developed over the past year.*BAID-IMS is a user-friendly web-based science, logistic and educational informational portal that allows users to access, view and interact with a wide range of spatial data and remotely sensed imagery focused on the Barrow area in northern most Alaska. The area of interest for BAID-IMS spans 280,000 km2 and extends from 100km offshore and north of the city of Barrow, east to Deadhorse, west to the native village of Point Lay and south to the Brooks Range and the village of Anaktuvuk Pass. The application encompasses over 100 data layers in total and includes a range of air-borne and satellite imagery as well as thematic data. Thematic data includes USGS topographic maps, administrative boundaries, infrastructure such as roads, power lines, and native subsistence cabins, nearly 4000 active and historic research sites, vegetation, topographic and hydrographic maps, and distribution/sensitivity maps for select fauna. Users can employ standard Geographic Information System (GIS) tools to zoom, pan, measure distance, identify waypoints for uploading into Global Positioning Systems (GPS), query a range of attribute data layers and make and print their own maps. Federal Geographic Data Committee (FGDC) standard metadata has been compiled for most data layers and provides links to data centers where users can obtain copies of BAID-IMS data for more advanced analysis. A help guide is provided for all tools in the application.

*This award will increase the longevity and the functional and operational capacity of BAID-IMS.* Specifically, we will (1) Continue acquisition of image, thematic and site data to improve the utility of BAID-IMS; (2) Expand the informational technology and server hardware backing BAID-IMS to enhance operational capacity; (3) Continue to train graduate and undergraduate students in the maintenance and development of BAID-IMS, and continue education and outreach activities illustrating the use of BAID-IMS; (4) Publish, present and advertise the functionality and technical underpinning of BAID-IMS and engage community input in the development of BAID-IMS; (5) Encompass new technologies and opportunities as these arise, including the development of wireless technologies for real time access to BAID-IMS in the field, improved cross-browser compatibility, data export capabilities to hand-held GPS’s, and fly-through capabilities to enhance the visualization capacity of BAID-IMS data.

**Intellectual Merit:** *The intellectual merits of this award both exemplify and satisfy needs identified by the international Arctic science community engaged in the Arctic GIS initiative.* Momentum for the implementation of an improved and integrated circum-arctic environmental observatories network is building within the Arctic science community and there will soon be a fundamental need for establishing interactive and web-based regionally focused geospatial information portals and spatial data infrastructures. BAID-IMS provides a template for such a regional and community-driven initiative.

**Broader Impacts:** *The broader impacts of this award include, the career development of two young PI’s, the education and training of undergraduate and graduate students, the rescue of historical data and the creation of a legacy information portal that has the potential to provide advanced and sustained integration of informational data in the Barrow area.* BAID-IMS also provides significant community education and outreach opportunities, especially in local and primarily native villages on the north slope of Alaska. On several instances BAID-IMS has served as a tool for cross-cultural community integration and has assisted in resolving conflicts between traditional native communities and research activities. In addition, BAID-IMS reduces the need for duplication of effort by linking to established, external and specialized informational databases.

4. **Developing and implementing the Circum-arctic Environmental Observatories Network (CEON).**

*The key objective of this three-year proposal is to further the international and multidisciplinary development of the terrestrial Circum-arctic Environmental Observatories Network (CEON,*[***www.ceoninfo.org***](http://www.ceoninfo.org/)*).* CEON is a recently established and rapidly evolving initiative jointly endorsed by the Forum of Arctic Research Operators (FARO) and the International Arctic Science Committee (IASC). CEON’s mission is to strengthen the capacity for emerging monitoring, research and policy needs at high northern latitudes by making data available that is adequate and suitable for addressing a series of well-defined key scientific questions and uncertainties. *CEON has received a high level of international governmental (FARO, Arctic Council), non-governmental (IASC), and peer and stakeholder support (e.g. Study of Environmental Arctic Change – SEARCH and the Scandinavian and north European Network of Terrestrial Field Bases - SCANNET) for such a relatively young and dynamic initiative.* As a priority, this award aims to satisfy the immediate developmental needs identified by the CEON stakeholder community and, where relevant, the Arctic Climate Impact Assessment (ACIA). This award will also support several other initiatives with a strong Arctic and environmental observation focus, including the second International Conference on Arctic Research Planning (ICARP II), the US National Academy of Sciences blue ribbon panel designing an Arctic Observation Network (AON), and the International Polar Year (IPY). Specifically, this award will:
1. *Establish a joint US-Swedish CEON Science Coordination Office (SCO).* This is critical for CEONs transition to becoming a fully implemented and multi-laterally funded international network.
2. *Convene annual CEON stakeholder and working group meetings to foster the community-based decision making necessary for the development of CEON.* Annual stakeholder meetings are likely to attract up to 150 arctic and non-arctic specialists and will encourage CEON partners to convene meetings before or after the CEON meeting and hold and/or participate in workshops that will be used, for example, to offer instruction on standardized sampling protocols and technologies.
3. *Continue the development of novel web-based information portals and visualization tools that improve the capacity for transferring scientific, logistic, and educational knowledge and information both within and outside of CEON.* These include A CEON email list, the CEON-Internet Map Server (CEON-IMS - [**www.ceonims.org**](http://www.ceonims.org/)), the capacity to build regionalized IMS applications centered on focal observatory platforms partnered to CEON, a methodological and standards database, and novel visualization tools that enhance education, outreach and information interactivity.

**Intellectual Merit:** *The proposed activities have significant intellectual merit, namely improving the capacity for circum-arctic scientific synthesis, assessment and decision making by building on the established research and monitoring activities in the Arctic.* Access to data and information on monitoring and logistics will be improved; protocols and standards for environmental measurements will be further developed and made widely and freely available; parameterization and validation of models and remote sensing products using site specific observations will be enhanced; and the capacity to respond rapidly to environmental emergencies, new monitoring needs and opportunities will be fostered.

**Broader Impacts:** *This award will establish the critical framework necessary for CEON to become a long-term scientific endeavor by building from an initial focus that broadens the impacts of ongoing and developing research and monitoring infrastructures and activities in the arctic.* Specifically, this award will benefit international relations and cross-border exchange of knowledge and information; offer unprecedented opportunities to the next generation of terrestrial arctic researchers; and significantly enhance the education and career development of several undergraduate and graduate students, postdocs and a newly appointed faculty member. *With continued international cooperation and multidisciplinary consultation and participation, the successes of CEON will greatly advance understanding of the Arctic system, how it will continue to respond to change, and how humans will need to adapt.*

5. **Assessing the impact of land cover change on ecosystem structure and function in the Chihuahuan Desert.**

Establishing projects that Assess the impact of land cover change on ecosystem structure and function in the Chihuahuan Desert is a short term research priority of the SEL. We are applying similar approaches, techniques and technologies we have developed in the Arctic to locally focused research. Since January 2005 several students have begun projects investigating the following:

1. Claudia Ortega (UTEP NSF REU recipient): Distribution of Invasive Salt Cedar (*Tamarix ramosissma*) in Relation to Native Trees and Shrubs, Hydrology and Soil Type at Rio Bosque Wetland in El Paso, TX. (This project is a component of a larger ecosystem restoration project being lead by Dr Vanessa Lougheed).
2. Paul Hotchkin: Impacts of environmental change on native bee populations in the El Paso area.
3. Rebecca Marin: Impacts of land cover change at the Indio Mountains Research Station (IMRS) on ecosystem structure and function.

Several other lines of research in the Chihuahuan Desert are currently being explored and we anticipate submitting several research proposals in the near future.

Sources:

<http://faculty.utep.edu/Default.aspx?tabid=22769>

<http://www.utep.edu/>

<http://www.science.utep.edu/>