Australian Institute of Alpine Studies

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AIAS Annual Meeting

December 12-14 saw the 5th meeting of the AIAS at Howman's Gap in Victoria. The format differed from previous meetings with field trips interspersed among the talks. Informality was the key with many students giving impromptu five minute talks, thus continuing the main aim of the AIAS: communication of what's going on, where and by whom. Talks were given by:

Paul Mitrovski - Conservation genetics in the Australian Alps.
Andrea White - Climate change effects on vegetation patterns.
Tobi Edmonds - Effects of variation in snow persistence on vegetation diversity.
Susanna Venn - Recruitment processes over an altitudinal gradient.
James Shannon - Sphagnum bogs and wet heathlands in the central highlands.
Sam Grover - Peat hydrology and carbon cycling.
Ian Mansergh - Simulation of the spread of the January 2003 fires.
Dean Heinze - Recovery of *Burramys parvus* post-fire.
Ruth Lawrence - Bushfire history and streamflow responses to fire on the Bogong High Plains.
Ken Green - Monitoring programs for global change in Kosciuszko National Park.
Roger Good - Erosion mapping and the impact on the distribution of plant communities on the Main Range – Kosciuszko National Park.
Jennie Whinam - Post-fire monitoring and recovery strategy testing of sub-alpine Sphagnum –shrub bogs in Kosciuszko National Park & the Australian Capital Territory.
Keith McDougall - Classification of the treeless vegetation of the Australian Alps.
Glenn Sanecki - The distribution of small mammals in relation to snow cover in Kosciuszko National Park: a landscape approach.
Andrew Growcock - Walking on ashes: is tourism affecting soil loss after bushfire damage?

ABSTRACTS of AIAS talks

Conservation genetics in the Australian Alps

Paul Mitrovski

Involves 2 components: 1) Population genetics study of *Burramys* using microsatellites. Aims to investigate genetic variability, migration, and the mating system of *Burramys* as well as characterising fire recovery. 2) Examining plant response (adaptation or plasticity or both) to a changing environment using an altitudinal transplant experimental approach.

Modeling the Potential Impacts of Climate Change on Vegetation Patterns on the Bogong High Plains

Andrea White

I'll be using field observations, meta-data analyses and simulation modeling to study the impact of global warming on alpine vegetation, with a particular emphasis on bog communities. I'll also attempt to assess the state of bogs on the Bogong High Plains, by developing an index of bog condition. The wider application of this work is to aid in the development of tools by which land managers can recognise and assess change, and adapt management practices accordingly.

Effects of variation in snow persistence on vegetation diversity

Tobi Edmonds

There are three main steps to the project. 1. Mapping snow drifts that are present on the Snowy Mountains Main Range in mid-January following different size snowpack in the preceding snow season. Results: 1992 Deep snowpack = many snow drifts in the landscape in January 1993. 2000 Medium snowpack = fewer snowdrifts in the landscape in January 2001. 1999 Shallow snowpack = almost no snowdrifts in the landscape in January 2000. 2. Linking these snow drift maps back to the Spencers Creek snow records (Snowy Hydro) to estimate the regularity with which each snowdrift appears in the landscape in January. Results: Snow drifts present in January 1993 should occur 1/10 years. Snow drifts present in January 2001 should occur 3/10 years. Snow drifts present in January 1996 should occur 7/10 years. 3. Sampling the vegetation in areas that experience persistent snow drifts with differing regularity. Hypothesis: That there will be a difference in vegetation cover and composition between areas covered by snow in January 7/10 years and those covered by snow in January 1/10 years. Or somewhere in between.

Recruitment processes over altitudinal gradients

Susanna Venn

Differences in mountain top vegetation patterns in the Victorian Alps are a result of historical interactions with soils, climate, pollinators, and other plants. I'm aiming to answer the following questions: Are differences in some species abundances and location because seed simply cannot get to certain places? Or if it can, why can't seedlings establish? Are the current environmental parameters the main force driving the success of germination and establishment? Are some species which don't appear to follow the patterns of environmental parameters simply remnants of past vegetation communities that have managed to "hang on"? Can patterns in recruitment be linked to similarities or differences in environmental factors?

Sphagnum bogs and wet heathlands in the central highlands

James Shannon and John Morgan

The Central Highlands region is perhaps best known for its tall wet sclerophyll forests and areas of cool temperate rainforest. Wet heathlands containing *Sphagnum* communities are also present in the headwater streams that drain the region. Gentle slopes, impeded drainage, high annual precipitation (1500 mm), and cold-air drainage inverted tree-lines create conditions appropriate for *Sphagnum*-dominated plant communities and peat formation.

This study examined the floristic variability apparent in these communities across the region and also focussed in more detail on the patterns within several representative sites. Altitude related factors, aspect affects, slope and basin size appear to explain variation in structure and composition across the region. Subalpine sites are similar to those found in the higher regions of eastern Victoria and exhibit general similarities among site composition and affinities. Montane sites range from broad wet heaths dominated by epacrid shrubs, to narrower closed canopy rainforest and riparian systems, characterised by *Carex appressa*, *Leptospermum grandifolium* and *Nothofagus cunninghamii*. The last mentioned group is in varying stages of post-fire succession regulated by site specific microclimate. Several nominally montane sites in larger basins contain subalpine species; occurring below their usual altitude range.

Vegetation patterns within three sites were examined in detail and these are driven by variability in several factors: surface proximity of the water table, substrate depth, slope, frost exposure and snow cover duration.

The condition of *Sphagnum* peatland systems in the Central Highlands is generally better than elsewhere in south-eastern Australia. Anthropogenic impact has been in the surrounding forests and minimal within actual wet heathlands. Introduced species are rare and erosion minimal. Palaeoecological studies show they have a long history and have functioned as peatlands in some cases for more than 30,000 years, despite dramatic fluctuations in climate and the composition of the surrounding vegetation.

Peat hydrology and carbon cycling

Sam Grover

Sam Grover is half way through a PhD investigating the hydrologic properties of peat soil beneath bogs in the Australian Alps, and the carbon cycling occurring in bogs and dried peats. Stay tuned for exciting results at next year's AIAS.

Bushfire history and environmental responses to fire on the Bogong High Plains

Ruth Lawrence

The history of the Bogong High Plains is strongly intertwined with its fire history. The area was 'discovered' by Europeans immediately after the 1851 fires when stockmen sought relief pastures. Although not burnt at that time, the area was subject to fires in 1854, during the mining era of the 1870s and '80s, in 1890, 1901, 1914, 1919, 1923, 1926, 1927, 1932, 1933, 1939, 1944, 1952, 1959, 1965, 1978, 1985 and 2003. Most of those fires burned small areas of less than 20 square kilometres, but the 1926, 1939 and 2003 fires burned large tracts of land. The results of the fires on the environment of the Bogong High Plains are numerous. The ages of most Snow Gum communities on and around the Bogong High Plains can be traced to one or several of those fires. The proportional cover of shrubland communities compared to grassland communities has been elevated in response to perpetual disturbance from fire (and grazing). As a result of the 1926 and 1939 fires, landscape deflation in valley environments occurred when several Sphagnum mossbeds were burnt. For the 1939 bushfire, hydrographs from severely burnt catchments demonstrated the following modifications compared to their pre-fire hydrological regimes: a drop in runoff as the fire burnt the catchment, an elimination of the pre-fire diurnal streamflow pattern, and a modest increase in low and medium runoff values for the first year following the fire. The effects of the 2003 fire on the hydrological regime of the Bogong High Plains are currently being analysed.

Monitoring programs for global change in Kosciuszko National Park

Ken Green

To avoid repetition, rather than print the abstract, a report on the establishment of the plots is reported below.

Erosion mapping and the impact on the distribution of plant communities on the Main Range – Kosciuszko National Park

Roger Good, Stuart Johnston and Jane Burkitt

At the time of the removal of grazing from the Kosciuszko summit area in the 1950s, an erosion survey and mapping program was undertaken by the Soil Conservation Service. Approximately 470 hectares of erosion along the Main Range between Mt Kosciuszko and Mt Gungartan/ Bulls Peaks were mapped as moderate to severe sheet erosion and noted as requiring some erosion control measures to be put in place. Between 1959 and 1974, some 440 hectares were treated and stabilised by the SCS but due to the extent and impact of erosion, the distribution and extent of several plant communities changed. The most notable change in the occurrence of the alpine plant communities has been that of the short alpine herbfield which occurred extensively below snowpatch areas but due to grazing and erosion of the snowpatches, has now all but disappeared. Large areas of original snowpatch vegetation have, since stabilisation, been colonised by snow grasses (Poa spp.) and several tall alpine herbfield species, giving them an alpine herbfield like appearance . Notable amongst these has been the increasing population of *Ranunculus anemoneus*, considered for many years, to occur only in moist, protected tall alpine herbfields. The shift in community and species occurrence has been assisted by the decline in the duration and depth of the snowdrifts on the snowpatch areas over the past 40 to 50 years. In other communities the changes in soil conditions as a result of erosion have contributed to different plant species occurrences e.g. erosion feldmarks and hummock shrublands. With the predicted changes in alpine climatic conditions as a result of global warming, further changes in plant community distribution can similarly be predicted for these previously disturbed and eroded lands.

Classification of the Treeless Vegetation of the Australian Alps

Keith McDougall

We are currently producing a quadrat based classification of the treeless vegetation of the Australian Alps using available data from Victoria, NSW and the ACT (currently 1320 quadrats). Parts of the Main Range between Mt Kosciuszko and Mt Jagungal will be completed in early 2004.Analysis is being performed using Bray-Curtis similarity with no transformation, and hierarchical agglomerative clustering using group average to produce quadrat groups (in the Primer software package).A preliminary analysis was made using 1088 quadrats and a cut in the dendrogram at about 30% group similarity. The analysis is constrained to some extent by taxonomic changes since the first surveys in the early 1980s. For this reason *Craspedia* spp and *Celmisia* spp (and a few others) were aggregated (except for local endemics).

A total of 588 native taxa was recorded in the quadrats. The most common were *Carex breviculmis* (55% of quadrats); *Asperula gunnii* (54%); *Poa costiniana* (36%); *Microseris lanceolata* (33%), *Poa fawcettiae* (33%). There were 65 weed taxa recorded, the most common being *Acetosella vulgaris* (45%), *Hypochaeris radicata* (30%), *Trifolium repens* (17%), *Taraxacum officinale* (10%), *Cerastium glomeratum* (8%).

Of the plant communities identified, most were very localised, and most sample relationships were geographic (especially for the drier communities). A few communities, however, appear to span State and regional boundaries (eg. a snowpatch – 45 quadrats at Thredbo, Charlottes Pass, Perisher, Carruthers Peak (NSW), Bogong High Plains (VIC); a tall shrubby bog – 11 quadrats at Wellington, North Bryce, Reynard, Lost Plain, Sentinels, Snowy Range (VIC), Scabby Plateau, Bimberi (ACT); a grassland – 95 quadrats at Big Boggy Plain, Happy Jacks Plain, Emu Plain, Kiandra (NSW), Dargo High Plains, Mt Stirling & Mt Buller, Bluff, Wellington, Howitt, Bennison Plains (VIC); dry (fen) pools – 10 quadrats at Mt Howitt, Dargo High Plains, Dinner Plain, Mt Jim (VIC), Seventeen Flat, Broadway Plain, McPhersons Plain (NSW); a damp grassland – 25 quadrats at Upper Geehi, Upper Tumut, Rennix Plain, Big Boggy Plain, Happy Jacks Plain, Perisher (NSW), Bennison Plain, Bryces Plain, Dinner Plains, Mt Jim (VIC); *Sphagnum* Bogs – everywhere (111 quadrats)).

Report on post-fire monitoring and recovery strategy testing of sub-alpine *Sphagnum* –shrub bogs in Kosciuszko National Park & the Australian Capital Territory

Geoffrey Hope, Jennie Whinam & Roger Good

Sphagnum moss-shrub mires in the ACT and Kosciuszko National Park occur on the higher ranges on stream sources and along streams and in a few places on valley floors down to 1100m. This community is of importance as habitat for Corroboree Frogs and other taxa and in its hydrological properties. Almost all the ACT mires and the montane and sub-alpine Kosciuszko mires have been affected by the January 2003 fires, with the burnt area varying from 55-100% of the mire surface. In general the vegetation in the burnt swamp areas has been reduced to ash or charred remnants with the exception of *Sphagnum* moss hummocks which have in most cases remained, even though the moss has been killed. The fibrous root mat has mostly survived as the peat soils have not caught fire except in isolated patches. Some regeneration of sedges, grasses and other monocots is taking place. Epacrid shrubs (*Richea continentis*, *Epacris paludosa*, *E. brevifolia*) have mostly been killed but some myrtaceous species (*Baeckia* spp., *Callistemon sieberii*) are resprouting from the base.

We have established trial plots to a) monitor post-fire recovery of burnt *Sphagnum*-epacrid bog to provide trajectories for peatland management and b) assess whether re-colonisation of dead *Sphagnum* hummocks and recovery of *Sphagnum* can be enhanced by simple intervention suitable for broad scale application.We have established fixed quadrats which cover a range of fire damage on Ginini, Snowy Flat, Tom Gregory and Rotten Swamps in the ACT and at Pengilley's Bog at Kosciuszko. The quadrats have been scored for fire damage and growth by each species recorded, together with photography. Return monitoring at least twice per year for five years is envisaged, and at each visit, general bog regeneration status around the quadrats will be assessed, with standard photographs being taken.

One problem for *Sphagnum* colonisation is that it is sensitive to excessive sunlight and the loss of shrub cover may result in desiccation, overheating and bleaching. We have established trial plots at sites in both Kosciuszko National Park and in the ACT to establish whether recovery can be assisted. The plots have the following treatments: fertiliser; transplanted moss; fertiliser and transplanted moss; shade; shade and fertiliser; shade, transplanted moss and fertiliser; and control (no treatment). Fertiliser is 80g of Osmocote "native" low PKN pellets. Transplant consists of placing living *Sphagnum* into the hummock quadrat area. Shade cloth (vertical and horizontal) and sterilised mulch have been applied at Pengilley's Bog. The relative rate of colonisation and recovery will be assessed by re-measuring the quadrats.

Walking on ashes: is tourism affecting soil loss after bushfire damage?

Andrew J. Growcock, Catherine M. Pickering and Stuart W. Johnston

Recent fires in the Australian Alps provide an opportunity to compare the relative impacts of large-scale natural disturbance such as fires, with the impacts of tourism, specifically trampling by walkers, on subalpine vegetation. Soon after the January-February 2003 fires, areas such as Kosciuszko National Park were being promoted as a 'once in a lifetime opportunity' for tourists to view burnt areas as vegetation began to flourish from the ashes of the fire. However, the ecological impacts caused by visitors to these burnt areas may be significant. Understanding the relationship between the intensity of use by tourists and the new environmental conditions and their degradation thresholds will be valuable for land managers.

Different intensities of trampling (control, 30, 100 and 200 passes) were applied using a replicated block design to five extensively burnt sites in the subalpine area of Kosciuszko National Park six weeks after the fire occurred. Vegetation and soil conditions were examined before trampling, immediately after trampling and six weeks later. Preliminary results indicate that trampling, even at low levels, initially caused an increase in soil exposure and some soil loss. Six weeks later however, only minor differences remained among the treatments. Land management agencies responsible for these fragile areas should still encourage walkers to spread out when walking off track in burnt areas or remain on hardened tracks

The distribution of small mammals in relation to snow cover in Kosciuszko National Park: a landscape approach

Glenn Sanecki

Kosciuszko National Park contains a large area of unique alpine and subalpine ecosystems and is one of 20 of the 440 UNESCO Biosphere Reserves that have been included in a pilot program to monitor the effects of global warming. With this threat and increasing pressure from winter recreation activities, it is important that we better understand the role of snow in these ecosystems. Small mammals including the common bush rat, Rattus fuscipes, the dusky antechinus, Antechinus swainsonii, and the threatened broad-toothed rat, Mastacomys fuscus, remain active beneath the snow throughout the winter. A few studies have attempted to consider the role of snow in their ecology, but have been limited to small scales or have used indirect methods. In this paper I present part of my PhD research in which I investigated the distribution of small mammals using a newly developed hair tube technique. This technique permitted sampling beneath the snow at a scale that considered the range of snow conditions occurring in the subalpine zone and across a number of different habitats and topographic positions. Small mammal presence is negatively correlated with snow cover, but where they do occur, habitat structure, in particular, shrubs and boulders, play an important role in the development of the subnivean space in which they over-winter. Subnivean space development is also influenced by other factors both human induced and natural. Comment will be made about the immediate and likely longer term effects of the 2003 fires on subnivean space development and the implications this may have for small mammals.

Report on the IUCN WCPA Mountains Field Workshop, Ukhahlamba-Drakensberg World Heritage Site, South Africa; September 2003 by Graeme Worboys, Deputy Vice Chair Mountains, IUCN WCPA

This workshop, based at Didima within the World Heritage park formed part of the IUCN World Parks Congress, was conducted immediately prior to the Congress. It was orchestrated by IUCN WCPA Vice Chair Mountains Larry Hamilton, and hosted professionally and brilliantly by Ezemvelo KwaZulu-Natal Wildlife. Some 60 mountain protected area practitioners from around the world convened to help discuss mountain management matters including updating and improving the 1991 IUCN WCPA Mountain Protected Area Management Guidelines; as well as reviewing, and internationalising the principles of management of the Australian Oxford University Press (2001) book "Protected Area Management, Principles and Practice". Each participant also submitted a paper. An enormously useful collection of current mountain management papers has been generated and this collection will be published as a single volume in early 2004. It will be an immensely valuable reference for Mountain managers and scientists. Part of the workshop contributed to the concept of "Mountain Peace Parks", and a peace climb of the highest peak in the Drakensbergs led to the development of the "Didima Declaration".

WEED ALERT!

Keith McDougall, DEC

Orange Hawkweed (*Hieracium aurantiacum*) was found in Kosciuszko National Park (Jagungal Wilderness) in December, the first record for NSW. This species was previously only known on the mainland at Falls Creek and Mt Buller in Victoria. Hawkweeds are proclaimed W1 weeds in NSW. This means that they must be continuously suppressed and destroyed, and cannot be sold or distributed. They are also proclaimed weeds in VIC, WA and TAS and are classed as prohibited imports by the Australian Quarantine and Inspection Service.

The concern about Orange Hawkweed arises from its extraordinary weedy properties and its behavior elsewhere. Plants can produce large quantities of viable seed without fertilization, seed is wind dispersed and plants are stoloniferous. Orange Hawkweed originates from Europe. It is a major environmental weed in montane areas in NZ, USA and Canada. In New Zealand, it is the dominant species in some high mountain grasslands. Although first recorded at Falls Creek in the late 1990s, Orange Hawkweed has already spread with the prevailing wind towards Rocky Valley Dam (about 2 km away), and was found this summer in undisturbed and unburnt treeless vegetation at Basalt Hill about 5 km from Falls Creek.

The Kosciuszko infestation is in snow gum woodland with a grassy understorey (burnt in 2003), and covers about 1 ha. The infestation has been sprayed with herbicide but considerable vigilance will be required in future years. Despite a control program at Falls Creek, new infestations are found each year and sprayed infestations commonly tend to recover to some extent.

Orange Hawkweed can be distinguished from native species with basal leaves (eg. *Craspedia* and *Podolepis*) by its covering of hairs (long simple hairs on leaves and stiff and black glandular hairs on stems), milky stem sap, and by its bright orange flowers in mid summer (mostly Dec and Jan).

Of equal concern is the discovery this summer of a second Hawkweed species on mainland Australia, found just outside Falls Creek village - *Hieracium praealtum subsp. bauhinii*. This one is yellow-flowered but looks very much like the native *Picris* (and from a distance like *Hypochaeris*), which will make it very hard to detect and control should it spread further. The scary thing about this species is that it covers almost 100% of the ground surface in open disturbed areas but also under 100% cover of *Bossiaea foliosa*.

Brochures and posters are currently being produced to alert visitors to the Alps about Orange Hawkweed.

International Mountain Day

The United Nations General Assembly has designated 11 December, from 2003 onwards, as 'International Mountain Day'.

This decision to name 11 December as International Mountain Day results from the successful observance of the UN International Year of Mountains in 2002, which increased global awareness of the importance of mountains, stimulated the establishment of national committees in 78 countries, and strengthened alliances through promoting the creation of the International Partnership for Sustainable Development in Mountain Regions, otherwise known as the 'Mountain Partnership'. FAO was the designated lead coordinating agency for the International Year of Mountains and the Organisation is mandated to lead observance of International Mountain Day.

The theme for the first ever International Mountain Day in 2003 is 'Mountains - Source of Freshwater'. This theme complements the messages of the International Year of Mountains, and also links to this year's UN International Year of Freshwater. More than half the world's people rely on mountain water to grow food, to produce electricity, to sustain industries and, most importantly, to drink. Careful management of mountain ecosystems and the water resources they support has never been more important to our long-term security and survival.

The Mountain Group has prepared a toolkit of resource, communication and promotional materials to create awareness about the importance of mountains to life and to celebrate International Mountain Day. A CD-ROM of this toolkit has recently been sent to partners, including the International Year of Mountains national committees (or similar mechanisms at the country level) and members of the Mountain Partnership. Copies of this CD-Rom are available on request. However, an electronic version of the complete toolkit is available for free downloading at the official *International Mountain Day Web* site at: www.mountains2002.org/imd/imd.html.

January 2004 in the alpine zone of the Snowy

Ken Green

GLORIA

The major work of January in the Snowy Mountains was finally getting GLORIA (Global Observation Research Initiative in Alpine Environments) off the ground (on the ground?). Harold Pauli, one of the GLORIA principals and the senior editor of the GLORIA field manual, visited early in the month and spent almost a week here looking at the GLORIA sites and general alpine vegetation. The GLORIA sites are set up according to a strict protocol in a number of mountain ranges in the world on an altitudinal transect from the treeline to the nival zone. They are set up on "summits" so that: a) they are not shaded by higher land and b) they are easy to find. Vegetation is analysed at 16 quadrats at each of the cardinal points, 5m below the summit (or within 50m horizontally if the summit is relatively flat) with percentage cover of all species being recorded down to the 10m contour (or 100m horizontally) in eight segments (0-5m and 5-10m below the summit at NSE & W). Temperature is measured at a depth of 10cm in the soil at either the summit itself, or in the middle of each cluster of four vegetation quadrats at the 5 metre contour (we are currently measuring both = 5 data loggers per site). The sites were set up last year but the bushfires interrupted the work. People swarmed over Mt Clarke spur: myself and one student setting up (requiring about 800m of string on some summits), Catherine Pickering, Wendy Hill and Tanya Fountain from Griffith University did the vegetation analysis, one full time photographer Jeremy Carrington recorded all points, plus various people at various times lending a hand, Michael Campbell, Brian Smith, Zarni Bear, Kristy Barry, Susanna Venn, Gen Wright, Dane Wimbush, Tim Greville, Roger Good and Jane Burkitt, with Mary Green as General Dogsbody. Apart from memories of repeat ascents of Mt. Clarke Spur and "Heartbreak Hill" the most memorable event was the hailstorm on Wednesday 21 January with two parties caught out on the spur. Two hail stones were measured at 50mm and 60mm in diameter – and these were by no means unusual – three storms took up most of the hour it took to descend to the Snowy River. In the absence of a rock shelf to get under the recommended tactic (remembering to try and avoid lightning strike) was to sit against a rock, holding your pack over your head (trying not to expose knuckles) and being prepared to take a few bruises from ricochets. Anyone doing vegetation or soil studies in the next short while should be aware of the cause of the fringe of broken vegetation lying around many alpine shrubs, the thumbnail sized sections where bark was removed and the deep golf to cricket ball sized pockmarks on bare ground, in bogs and in short alpine herbfield.

Multi-summit Invertebrate Study

The aim of the Multi-summit Invertebrate Study is to use the established GLORIA sites as long-term monitoring sites for invertebrates. A permanent altitudinal transect examining pitfall traps and invertebrates from soil samples was set up on Mt Clarke spur in January. Pitfalls (plastic cups) are placed in 150mm lengths of 75mm storm water pipe fixed permanently in position at the 5m and 10m contour below each summit at each of the four cardinal points = 8 pitfalls per summit, over the five summits used for the GLORIA project. These are capped when not is use. Soil samples were taken within the 5-metre contour. Five samples were collected per summit with each sample being split into the top 5cm of the soil and the next 5-10cm. To ensure that the soil invertebrate transect reflects altitudinal rather than vegetation differences, each sample was taken at the interface of *Poa-Celmisia* patches at all altitudes, regardless of the predominant vegetation (which is dense heath at the bottom of the transect but open *Poa-Celmisia* herbfield higher up).

Snowpatch studies

The snowpatch studies finished off a month of alpine work. Because of the fires last year, the sites were not set up until well after the last snowpatches disappeared and so were located by memory. Five snowpatches were chosen in: Twynam Cirque, back-Blue Lake Cirque (two snowpatches), Mawson Cirque and on Mt. Kosciuszko – the Cootapatamba Cornice snowpatch. Each snowpatch was divided into (a) bare area – presumed to be under longest lasting snow, (b) interface between bare area and short alpine herbfield, (c) short alpine herbfield, (d) interface between short alpine herbfield and tall alpine herbfield, (e) tall alpine herbfield. A temperature logger recording at 90 minute intervals was located in each area and was buried beneath approximately 75mm of soil. Permanent receptacles for pitfall traps were located, where possible, in areas c, d and e of each snowpatch. Receptacles were 150mm lengths of PVC stormwater pipe as for GLORIA. All points were located from a star picket sunk into the ground. The first task in January was to visit the sites to determine how all the infrastructure (pitfall pipes etc. put in last year) held up over the winter. As Alec Costin found, the mechanical forces generated under snowpatches in Australia are almost glacial in their impact. So we had a lot of loose star pickets and one beautifully compressed stormwater pipe (I will try and get ANU to measure the force required to replicate the effect). One advantage, I found, of these lengths of stormwater pipe in a habitat characterised by ground water was that the pipes could be used to measure the depth of groundwater (currently close to the top of the pipes in snowpatch vegetation communities but below the bottom in tall alpine herbfield). All sites were visited, the edges of the snowbank were located with a GPS and water table depth was measured. At four snowbanks, the profile of the snow was measured using a laser theodolite which will be used again in March to survey the ground beneath thus giving us the January depth of snow. At five snowbanks (in Twynam Cirque, back-Blue Lake Cirque and Mawson Cirque) golf tees were pushed in at 2 metre intervals around the bottom of the snowbank and 4 metre intervals around the top. This will be repeated in February and again in March (then surveyed) to determine the 'growing season' or time free of snow at various points in the snowpatch. Two additional snowpatches, on the NE flank of Mt. Kosciuszko (Muellers snowpatch) and in Club Lake cirque have been provisionally added to the study depending on their position at the end of the season on the league of top 20 snowbanks. As we go to press there are still 20 snowbanks on the Main Range. Two honours students Tobi Edmonds (Charles Sturt University) – see abstract above -and Michael Campbell (Griffith University) are working on various aspects of snowbanks this summer.

STOP PRESS:

Sapphire McMullan-Fisher reports that the special issue of the Australasian Mycologist, first talked about in the 2001 meeting has finally been published!

Below is the list of papers:

Special issue on Australasian alpine fungi: introduction
Root survey and isolation of fungi from alpine epacrids (Ericaceae)
A new species of Lanzia (Ruststroemiaceae) from Mt Kosciusko, Australia
A new species of Aleurodiscus (Stereaceae) from Mt Kosciusko, Australia
Myxomycetes and fungi associated with alpine snowbank habitats in New Zealand
Australasian sequestrate (truffle-like) fungi 15. New species from the tree line in the Australian alps
Some agarics of the Kosciuszko National Park
Some macrofungi from alpine Tasmania

Abstracts can be found at

bugs.bio.usyd.edu.au/AustMycolSoc/Home/ams.html

IMPACTS OF CLIMATE CHANGE

'Extreme Weather Prompts Unprecedented Global Warming Alert' The Independent July 3, 2003

In an astonishing announcement on global warming and extreme weather, the World Meteorological Organisation signalled last night that the world's weather is going haywire.

In a startling report, the WMO, which normally produces detailed scientific reports and staid statistics at the year's end, highlighted record extremes in weather and climate occurring all over the world in recent weeks, from Switzerland's hottest-ever June to a record month for tornadoes in the United States - and linked them to climate change.

The unprecedented warning takes its force and significance from the fact that it is not coming from Greenpeace or Friends of the Earth, but from an impeccably respected UN organisation that is not given to hyperbole (though environmentalists will seize on it to claim that the direst warnings of climate change are being borne out).

The Geneva-based body, to which the weather services of 185 countries contribute, takes the view that events this year in Europe, America and Asia are so remarkable that the world needs to be made aware of it immediately.

The extreme weather it documents, such as record high and low temperatures, record rainfall and record storms in different parts of the world, is consistent with predictions of global warming. Supercomputer models show that, as the atmosphere warms, the climate not only becomes hotter but much more unstable. "Recent scientific assessments indicate that, as the global temperatures continue to warm due to climate change, the number and intensity of extreme events might increase," the WMO said, giving a striking series of examples.

In southern France, record temperatures were recorded in June, rising above 4 places - temperatures of 5C to 7C above the average.

In Switzerland, it was the hottest June in at least 250 years, environmental historians said. In Geneva, since 29 May, daytime temperatures have not fallen below 25C, making it the hottest June recorded.

In the United States, there were 562 May tornadoes, which caused 41 deaths. This set a record for any month. The previous record was 399 in June 1992.

In India, this year's pre-monsoon heatwave brought peak temperatures of 45C - 2C to 5C above the norm. At least 1,400 people died in India due to the hot weather. In Sri Lanka, heavy rainfall from Tropical Cyclone 01B exacerbated wet conditions, resulting in flooding and landslides and killing at least 300 people. The infrastructure and economy of south-west Sri Lanka was heavily damaged. A reduction of 20-30 per cent is expected in the output of low-grown tea in the next three months.

Last month was also the hottest in England and Wales since 1976, with average temperatures of 16C. The WMO said: "These record extreme events (high temperatures, low temperatures and high rainfall amounts and droughts) all go into calculating the monthly and annual averages, which, for temperatures, have been gradually increasing over the past 100 years.

"New record extreme events occur every year somewhere in the globe, but in recent years the number of such extremes have been increasing.

"According to recent climate-change scientific assessment reports of the joint WMO/United Nations Environmental Programme Intergovernmental Panel on Climate Change, the global average surface temperature has increased since 1861. Over the 20th century the increase has been around 0.6C.

"New analyses of proxy data for the northern hemisphere indicate that the increase in temperature in the 20th century is likely to have been the largest in any century during the past 1,000 years."

While the trend towards higher temperatures has been uneven over the past century, the trend since 1976 is roughly three times that for the whole period.

Global average land and sea surface temperatures in May 2003 were the second highest since records began in 1880. Considering land temperatures only, last May was the warmest on record.

It is possible that 2003 will be the hottest year ever recorded. The 10 hottest years in the 143-year-old global temperature record have now all been since 1990, with the three hottest being 1998, 2002 and 2001.

The unstable world of climate change has long been a prediction. Now, the WMO says, it is a reality.

UNEP News Release 2003/68 Climate change in the Australian Alps

Climate change is likely to reduce snow cover in the Australian Alps, according to a study by CSIRO Atmospheric Research. However, the research – sponsored by Government and Industry bodies – shows that with adaptation measures such as snowmaking, ski resorts could manage the impacts and remain viable at least to 2020.

Measurements from southeast Australian alpine sites over the past few decades show temperatures have risen, with alpine precipitation increasing slightly in NSW and decreasing slightly in Victoria, and snow depths showing a small decline at some sites.

The study examined future changes in snow cover based on climate change projections from nine climate models. Two scenarios were considered: low impact where warming was slight and precipitation increased, and high impact where warming was large and precipitation decreased.

By 2020, the average annual duration of snow-cover decreases by between five and 40 days; maximum snow depths are reduced and tend to occur earlier in the season; and the snowline rises – for example at Mt Kosciuszko the snowline on 1 September is predicted to rise from the present average of 1460 metres to between 1490 and 1625 metres. The total area covered in snow shrinks by 10-40%.

By 2050, season durations are reduced by between 15 and 100 days. The low impact scenario leaves low elevation sites like Baw Baw with seasons of around 50 days, while the high impact scenario leaves only the highest sites like Falls Creek with seasons of more than 10 days. Maximum snow depths drop by 10% to 90% and the total area covered in snow shrinks by 20 to 85%.

One option to adapt to these changes is increased use of snow-making. Allowing for the decline in natural snow depths and the reduction in temperatures low enough for snow-making, the increase in the number of snow guns required by 2020 is between 11 and 200%. A middle estimate is a doubling of snow guns. Hence with sufficient investment the Australian ski industry may be able to manage the impact of projected climate change until at least 2020. Note that this does not take into account positive influences on snow-making, such as likely improvements in snow-making technology, nor negative influences such as limited water supply.

More information: www.dar.csiro.au/publications/hennessy_2003a.pd

Climate change good for the birds? by Dr L Jenni and Dr M Kery

Research from a team at the Swiss Ornithological Institute reveals complex effects of global warming on migratory habits of birds. These effects may constitute a serious threat to some species - in particular those with longer migratory flights.

Over the past two decades spring temperatures in temperate regions have increased. This change has advanced the start of the reproductive season for many species. However, until now there has been hardly any information about the effects of global warming on other aspects of the annual cycle of migratory birds, such as autumn migration.

Using the records of almost 350,000 captures of 64 different species in an Alpine pass in Switzerland dating from 1958-1999, Drs. Jenni and Kery at the Swiss Ornithological Institute were surprised to find no uniform shifts in the timing of autumn migration but a complex adaptation that benefits some species over others. The birds were caught in mist nets arranged in the pass during both day and night. After recording their details, Dr. Jenni released the birds to continue their migration.

"The Col de Bretolet site in Switzerland is 1920m above sea level and is a pure passage site for species migrating from a wide areas of Scandinavia, central and eastern Europe," says Dr. Jenni. "This means that all birds recorded here are in transit and the data generated is not complicated by non-migratory movements of locally breeding birds."

"The data show that long-distance migrants, those that winter south of the Sahara, appear to be leaving earlier," says Dr. Jenni. "For instance the Pied Flycatcher, Willow Warbler and Garden Warbler now fly south almost a week earlier."

In contrast, short distance migrants that winter in Southern Europe and Northen Africa have delayed their autumn migration. For example the Skylark now migrates seven days later and the European Starling nine days later.

An additional complicating factor is that species with a variable number of broods migrate later than species with only one annual brood, probably because they

have extended their breeding season. This increases their reproductive rate.

This long-term study suggests that the effects of global warming are complex. "We believe that short distance migrants may benefit from global warming through higher reproduction and shorter migration," explains Dr. Jenni. "In contrast, trans-Saharan migrants may not gain the same benefits. Global warming could thus be a serious threat to some long-distance migrants and one reason for the recent decline of such species in Europe."

The timing of autumn migration is governed by three main factors: the end of the reproductive season; conditions in the breeding area after the breeding season is over; and expected conditions in the passage and wintering grounds.

"For long distance migrants crossing the Sahara the migration could be constrained by the onset of the dry season in the Sahel region," concludes Dr. Jenni. "This region suffers serious drought conditions. Migrant species would want to cross the region before the drought had started. The spring arrival of these species and the start of their breeding season is also constrained so they are losing out to species with shorter migration patterns."

(www.pubs.royalsoc.ac.uk/proc_bio/news/jenni.html)

Many Ski Resorts Heading Downhill as a Result of Global Warming

World Conference on Sport and the Environment in Turin 2 to 3 December 2003. Turin/Nairobi, 2 December 2003- Many low altitude ski resorts face economic hardship and even ruin as a result of global warming, a new study launched today by the United Nations Environment Programme (UNEP) concludes.

Experts at the University of Zurich say that the levels of snow falling in lower lying mountain areas will become increasingly unpredictable and unreliable over the coming decades. Currently an estimated 15 per cent of Switzerland's ski resorts are deemed to have unreliable levels of snowfall. In the future, between 37 percent and 56 per cent could have such low levels of snow that many, including the Swiss resorts of Wildhaus and Unterwasser, will be facing acute difficulties in attracting overseas tourists and local winter sports enthusiasts.

"The impacts of climate change on winter tourism may be even more severe in countries such as Germany or Austria due to the lower altitudes of their ski resorts," say the researchers. The internationally celebrated winter sports town of Kitzbuehl, popular among the rich and famous, faces extinction as a top ski resort. Kitzbuehl is an example of a resort lying at the low altitude of 760 metres, a height that will make it acutely vulnerable to declining and less frequent snow. The study says that ski resorts in North America and Australia will be impacted too. Indeed, none of Australia's ski resorts will be economically viable by 2070 under a worst case scenario.

The findings have come from Rolf Burki and colleagues at the University of Zurich. They are being presented today at the V World Conference on Sport and the Environment taking place in Turin, Italy, which is the host city for the 2006 Winter Games. The conference has been organized by the International Olympic Committee in cooperation with the Organizing Committee for the winter games in Turin and UNEP. The news also comes as nations meet in nearby Milan for the latest round of climate change talks known as the 9th Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change.

Klaus Toepfer, UNEP's Executive Director, said: "Winter sports and tourism are big business in many of the world's mountain areas. They offer important sources of revenue and employment for sometimes remote communities as well as healthy, pleasurable recreation for millions. In many communities, downhill and cross-country skiing, tobogganing, snow boarding and other winter sports are also important cultural and family activities."

"Climate change in the form of extreme weather events such as hurricanes, floods and droughts, is the greatest challenge facing the world. Clearly it is the poorest of the poor on continents like Africa, Asia and Latin America who are at the greatest risk, who are the most vulnerable. The United Nations Millennium Development Goals, covering such issues as water and sanitation, are all going to be harder to deliver, if global warming is not tackled. But this study on winter sports shows that it is not just the developing world that will suffer. Even rich nations are

facing potentially massive upheavals with significant economic, social and cultural implications," he said.

Dr Burki, who is Lecturer and Senior Research Associate at the University of Higher Education, St Gallen, as well as Lecturer at the International School of Tourism Management, Zurich, said: " Climate change will have the effect of pushing more and more winter sports, higher and higher up mountains, concentrating impacts in ever decreasing, high altitude, areas. As ski resorts in lower altitudes face bankruptcy, so the pressure in highly, environmentally sensitive, upper altitude areas rises along with the pressures to build new ski lifts and other infrastructure."

"The extent to which countries, regions and communities can adapt will depend on how the costs and technology of snow making equipment develops, how the economics of building extra, higher altitude infrastructure such as cable cars develops, and the location of existing resorts," he added.

"However, it appears clear that many resorts particularly in the traditional, lower altitude resorts of Europe will be either unable to operate as a result of lack of snow or will face additional costs, including artificial snow making, that may render them uneconomic," said Dr Burki, whose research has been carried out in collaboration with Hans Elsasser, professor for Economic Geography at the University of Zurich, and Dr Bruno Abegg, a travel journalist. Indeed, the team suggests that higher temperatures will make artificial snow making increasingly inefficient and expensive, if not impossible.

The research has used temperature forecasts produced by the Intergovernmental Panel on Climate Change (IPCC), a body of some 2,000 scientists. The IPCC was established by UNEP and the World Meteorological Organization to model the impact of rising levels of carbon dioxide and other greenhouse gases in the atmosphere and to offer advice to governments on how to deal with the threats. The IPCC estimates that temperatures will rise by between 1.4 degrees C and 5.8 degrees C by 2100 unless action is taken to significantly reduce emissions from sources such as vehicles, industry, offices and homes.

Global warming is expected to be stronger on land areas in the northern hemisphere during the winter months, making mountain-based winter tourism acutely vulnerable.

Austria, Italy and Germany

In Austria, the present snow line is likely to rise 200 to 300 metres higher over the next 30 to 50 years. "Many mountain villages, above all in the central and eastern parts of Austria, will lose their winter industry because of climate change," says the study. In Italy, half of the winter sport villages are below 1,300 metres. "Some of these are already facing major problems with snow cover. In future, there will only be a few winters with a winter atmosphere -- that means snow -- in these ski resorts," it says.

"If the altitude for snow reliability rises to 1,500 metres because of climate change, winter sports would only be possible [in Italy] in the higher zones of the ski areas and many resorts would have no economic viability in the future," the scientists conclude. Many of Germany's ski resorts are also at relatively low altitudes. Resorts in the Black Forest area and in Allgaeu could be severely affected by climate change.

Switzerland

The study has focused on Switzerland to assess the likely future impacts of climate change on a typical winter sports country. The researchers considered a ski resort "snow reliable" if, in seven out of 10 winters, it receives at least 30 to 50 centimetres of snow on at least 100 days between December 1 and April 15. Currently 85 per cent of Switzerland's 230 ski resorts are classed as "snow reliable". These are in areas where the snow line is at 1,200 metres or above.

Under one scenario, snow in ski resorts becomes unreliable at 1,500 metres in 30 to 50 years as a result of global warming. "The number of snow reliable ski resorts would drop to 63 percent. The Jura, Eastern and Central Switzerland, Ticino and the Alps in the cantons of Vaud and Fribourg will be particularly jeopardized by global warming," they say. If snow reliability rises to 1,800 metres, under a more acute warming scenario, only 44 percent of skiing regions would be snow reliable. Even in the higher altitude cantons of Grisons and Valais, an estimated 25 percent of resorts face threats. The precise economic losses facing a country like Switzerland are uncertain. But some experts have suggested that tourism losses in that country, as a result of climate change, could eventually be as high as $1.2 to $1.6 billion annually.

Australia and North America

The report suggests that, for nine Australian ski resorts, a rise of 0.3 degrees C would, by 2030,

only bring into question the viability of the Mount Baw Baw site. However, if temperatures climb by 0.6 degrees C by the same date, only five resorts are likely to be unaffected. Under a worst case scenario, in which temperatures climb by 3.4 degrees C by 2070, none of Australia's existing ski resorts would be operating at a profit. In the Lakelands areas of Canada the current ski season could, if current snowmaking technology is in use, decline by between seven and 32 per cent by 2050 as a result of global warming. Resorts may have to make between 48 per cent and 187 percent more artificial snow by the same date. "The ability of individual ski areas to absorb additional snowmaking costs may be the crucial factor in remaining economically viable," says the report.

Permafrost and Glaciers

The researchers say that impacts are already being felt in mountain areas. Glaciers, used for both winter and summer skiing, have been retreating over the past century and a half. For example Swiss glaciers have lost more than a quarter of their surface. By 2030, 20 percent to 70 percent of Swiss glaciers may have disappeared the scientists say.

Rising temperatures will also have other economic and safety impacts. Permafrost, essentially frozen soil, is likely to be more vulnerable to melting, increasing the risks of landslides and raising the costs associated with anchoring and bracing cable car stations, lift masts and other structures.

The researchers, who also included precipitation models in their calculations, suggest that avalanches may become more common above 2,000 metres, which may increase risks to skiers and other sports people as well as damage to infrastructure.

The researchers argue that, while winter sports tourism is clearly a potential victim of climate change, it also has a responsibility towards reducing carbon dioxide and the other emissions linked with global warming. These can arise from traffic travelling to the resorts and the energy-intensive equipment used to make artificial snow and ice.

The report, "Climate Change and Winter Sports: Environmental and Economical Threats", is available at www.unep.org.

publications

Advances in Global Change Research (15) -- Climate Variability and Change in High Elevation Regions: Past, Present & Future -- edited by Henry F. Diaz

The world's mountain systems, including the people in them, have gained international attention in the last few decades. The United Nations' International Year of Mountains-2002 can be regarded as the culmination of a long process involving research, development of research networks, a greater awareness by various sectors of society of the critical importance of mountain regions for a sustainable future, and recognition of that fact by policy makers.

This volume reviews recent climatic trends in high elevation regions of the world, assessing the reliability of various environmental indicators that can be used for monitoring climatic change, and assessing whether physical impacts of climatic change in high elevation areas are becoming evident, and to discuss a range of monitoring strategies needed to observe and to understand the nature of such changes.

Contents and Contributors:
1. Climate Variability and Change in High Elevation Regions: Past, Present and Future; H.F. Diaz, et al.; 2. Climatic Change in Mountain Regions: A Review of Possible Impacts; Beniston, Martin.; 3. Variability of Freezing Levels, Melting Season Indicators, and Snow Cover for Selected High-Elevation and Continental Regions in the Last 50 Years; H.F. Diaz, et al.; 4. Comparison of Radiosonde Temperature Climatologies and Trends at High and Low Elevation Sites; D. Seidel, M. Free.; 5. 20th Century Climate Change in the Tropical Andes; M. Vuille, et al.; 6. The Impact that Elevation Has on ENSO-Related Signal in Precipitation Records from the Gulf of Alaska Region; G.W.K. Moore, et al.; 7. The Health of Glaciers: Recent Changes in Glacier Regimes; M.F. Meier, et al.; 8. Tropical Glacier and Ice Core Evidence of Climatic Change on Annual to Millennial Time Scales; L.G. Thompson, et al.; 9. Climate Variability and Environmental Changes as Recorded in Glaciers from the Central Andes; U.M. Schotterer, et al.; 10. Large-Scale Temperature Changes across the Southern Andes: 20th Century Variations in the Context of the Past 400 Years; R.A. Villalba, et al.; 11. Frequency-Dependent Climate Signal in Upper and Lower Forest Border Trees in the Mountains of the Great Basin; M.K. Hughes, G. Funkhouser.; 12. Multi-Decadal Variability of Precipitation in the Greater Yellowstone Region as Inferred from Tree Rings; L.Graumlich, J. Littell.; 13. Taking the Pulse of Mountains: Ecosystem Responses to Climatic Variability; D.B. Fagre, et al.

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Higher Degree Abstracts

Just started

Nathan Ning (Honours student), Department of Environmental Management and Ecology, La Trobe University, Supervisor: Dr Phil Suter

The 2003 eastern Victoria fires present an excellent opportunity to investigate the short-term (and potentially long-term) post-fire response patterns of the aquatic fauna of alpine Sphagnum peatlands. The rarity of landscape fire, and the slowness of post-fire regeneration in alpine communities warrant intensive ecological studies when events like the 2003 eastern Victoria fires occur. These studies are the principal means of gaining an understanding of ecological response patterns following major but rare disturbances such as landscape-scale fire.

The short-term (< 1 year) impacts of fire on aquatic macroinvertebrate assemblages and water physico-chemistry of Sphagnum peatlands on the Bogong High Plains, Victoria, will be studied between November 2003 and February 2004. Both lotic and lentic habitats will be examined at three burnt and three control sites to evaluate any post-fire habitat variation in macroinvertebrate community composition and structure, and water physico-chemistry. Macroinvertebrate community attributes will be assessed at six weekly intervals using artificial substrata, and water physico-chemistry will be evaluated at three-weekly intervals during the same three-month study period.

Just finished

Tristan Armstrong Hybridization and adaptive radiation in Australian alpine Ranunculus, PhD thesis abstract. School of Botany and Zoology, Australian National University

This thesis focuses on the nature of interspecific hybridization, and on the factors responsible for restricting introgression among the five species of Ranunculus (sect. Acris) largely confined to the alpine zone of the Kosciuszko plateau: R. muelleri Benth., R. dissectifolius F. Muell., R. graniticola Melville, R. millanii F. Muell. and R. niphophilus B. Briggs. The species exhibit strikingly divergent morphological features maintained consistently despite frequent local hybridization. Interspecific hybrids are morphologically intermediate and restricted to ecotonal areas between microhabitats occupied by each parental species. In such situations, narrow (< 4m wide) hybrid zones frequently form.

The species are entirely interfertile, as revealed by artificial crossing and seed germination experiments. F1 and F2 interspecific hybrids and backcrosses are viable and fully fertile. Glasshouse growth trials demonstrated that hybrids show no sign of reduced vigour or intrinsic disadvantage relative to parental species. F1 hybrids and some backcross combinations showed slight heterosis. The performance of some F2 combinations involving R. graniticola suggested a degree of genomic incompatibility. Quantitative genetic analysis of inheritance of morphological traits demonstrated that key aspects of parental morphology have a strong genetic basis and are under independent polygenic control.

Natural interspecific pollen transfer was analysed using direct and indirect methods and found to be widespread relative to the width of hybrid zones. Further, it was demonstrated that natural interspecific pollination leads to substantial hybrid seed set within parental populations, where hybrid plants are absent.

Analyses of soil chemistry, hydrology and floristic association among parental habitats and across hybrid zones suggest that each species occupies a distinct ecological niche strongly determined by edaphic factors. These niches differ markedly in hydrology, including bogs, fens, snow bank drainage

lines as well as wet and dry herbfield. Spatial proximity of these contrasting niches locally favours the creation and establishment of hybrids.

These results suggest hybridization is restricted purely by habitat specialisation and intense selection against hybrids within parental habitats. The performance, over a three-year period, of parental and artificially generated F1 hybrid seedlings planted into parental habitats and across hybrid zones strongly supports this hypothesis. Parental species were most successful (in terms of survival, and growth) in their own habitat, with hybrid performance generally intermediate to that of the two parental species in parental habitats. Hybrids out-performed parental species in most hybrid zones, in accordance with the bounded hybrid superiority model proposed by Moore (1977). These findings accord with Briggs' earlier suggestion (1962) that exogenous selection, rather than isolation arising from the mating system maintains the integrity of these species despite the potential for complete introgression.

Phylogenetic analysis of nuclear (ITS 1&2) and chloroplast (matK) DNA sequences from Australasian and Eurasian Ranunculus sect. Acris species indicates a pattern of recent dispersal from a northern origin, followed by a period of rapid adaptive diversification within Australia. Low levels of sequence divergence, and a molecular clock test based on two independent calibrations support a model of early Pleistocene dispersal of Ranunculus (sect Acris) into Australia and New Zealand from alpine New Guinea, followed by a period of rapid adaptive radiation during the Pleistocene, particularly in alpine areas. The five species that are the subject of this thesis are closely allied, although appear to have separate origins within Australia (except for the Kosciuszko endemics). Sequence comparisons among individuals collected at Kosciuszko and in other alpine areas suggest that the low level of divergence among alpine species (and Australian species generally) is the result of recent evolution rather than reticulation.

It likely that these interfertile lineages have coexisted in sympatry, or at least close proximity for much of their evolutionary history. The intensity of ecological selection suggests that speciation in this group may have been facilitated by the development of specific adaptations to exploit new alpine micro-habitats, affording lineages sufficient genetic isolation to diverge independently.

Hugh Smith An investigation of sediment movement on a burnt and unburnt hillslope in a sub-alpine environment, Kosciuszko National Park, Honours thesis abstract, School of Geosciences, University of Sydney

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In January 2003 widespread bushfires occurred throughout the Australian Alps, burning approximately 1.73 million hectares. This study investigated sediment movement on a burnt and an unburnt hillslope in a sub-alpine environment in Kosciuszko National Park. Measurements involved the use of grids of erosion pins located at upper, mid and lower slope positions on both nearby hillslopes, monitored for a period of 18 weeks. The effects of wombat bioturbation, soil properties (including soil hydrophobicity) and vegetation regrowth on sediment movement were also examined. Increased sediment movement was found on burnt compared to unburnt sites largely as a result of the loss of protective ground vegetation cover (with almost no regrowth during the study period). Wombat bioturbative activities also increased sediment movement, but were spatially limited; and soil hydrophobicity had a limited effect on sediment movement. High levels of surface soil organic matter (20.7% to 89.4%) greatly increased soil cohesiveness thereby reducing considerably the extent of increased sediment movement on the burnt hillslope. The low to moderate fire intensity was insufficient to reduce this surface soil organic matter. SOILOSS modelling of soil erosion was conducted and compared to field results, with the limitations of SOILOSS for the study environment discussed.

cont. on p.19

MOUNTAINS AS WATER TOWERS E-DISCUSSION The Quantity and Quality of Water in - and from - Mountain Areas TOPIC 2: DISCUSSION SUMMARY Impacts of Climate Change

Sincere thanks to everyone who contributed to the second topic of discussion. It was a pleasure to read your messages. Like the first summary, this second summary is categorized by discussion thread, however recommended resources are noted at the end of the summary.

Climate System Complexity

Both Shawn Marshall and Chris Landry noted that the climate system is highly complex - being both temporally and spatially variable - and is not subject to simple rules. It is therefore unpredictable and more comparable to a human brain than a complex machine. Because of this, most of the signs of climate change are difficult to extract from temporal weather patterns or specific geographic data. This is particularly true for mountain places, which as Chris notes, also exhibit a host of complex and, on occasion, "emergent" behaviors.

Chris also noted that the alpine snow system may be a particularly responsive "earth surface system" because it is a "solid" system that exists at temperatures very near it's "triple point" where solid, liquid, and vapor phases exist simultaneously. According to Chris, the mountain snowpack yields a 'wealth' of system behavior data directly linked to weather and climate behavior each winter.

What do we know?

Shawn Marshall lamented the "steady stream of information and misinformation" about climate change presented by traditional media sources, and attempted to summarize the conclusions he believes are now generally accepted by most of the scientific community:

1) Greenhouse gases make the Earth warmer; 2) Greenhouse gases are increasing as a direct consequence of human activity and are now at concentrations unprecedented in human history; 3) The Earth is warming; 4) The observed 20th century warming is consistent with what is expected from the increased greenhouse gas concentrations.

Chris Landry described the effects of these changes as they appear on the ground. According to Chris, the San Juan Mountains and surrounding regions, are experiencing a water crisis due to several relatively dry winters followed by hot summers. This is a significant problem for regions in other parts of the western U.S. because mountain snowpacks provide between 50% and 80% of the water supply required by residents in what is already a semi-arid/arid region.

Shawn suggested that changing temperature and precipitation regimes cannot help but impact alpine ecosystems, geomorphological processes, and hydrological systems. According to Shawn, available observations from the Canadian Rockies suggest warmer, drier winters, with an increasing frequency of winter rainfall at the expense of snowfall.

Developing Mountain Specific Information

Shawn Marshall also suggested that it is difficult to quantify climate change in alpine regions because there are few weather stations in most of the world's mountain environments. Long-term monitoring sites are concentrated in valley bottoms, and understanding alpine regions requires that data from, for example, a 1500 m altitude site must be extrapolated upward to ~2500-3500 m, which is very difficult.

Chris Landry noted that the western United States is fortunate to have a network of ski areas scattered throughout the western ranges, many of which have collected climate and snowpack observations for extended periods of time. Data have been archived with the WWAN (Westwide Avalanche Network), a subscription based, industry service. The U.S. also has an extensive network of "Snotel" sites monitoring mountain snowpack snow-water equivalents (SWE). Snotel is operated by the U.S Dept. of Agriculture's Natural Resources Conservation Service (www.wcc.nrcs.usda.gov/snotel).

Furthermore, Chris's organization, the Center for Snow and Avalanche Studies, hopes to help create a "North American Snow System Observation Network" (NASSON) specifically organized and operated to collect observations documenting the multiplicity of snow-related processes that mountain snowpacks 'drive', including the storage and release of water.

Resources

Westwide Avalanche Network (WWAN) (www.avalanche.org)
Snotel (SWE) (www.wcc.nrcs.usda.gov/snotel)
Center for Snow and Avalanche Studies (CSAS) (www.snowstudies.org)
Mountain Forum Online Library - Climate Change Resources (www.mountainforum.org/resources/library/liblevels/lib308a.htm#change)
US Climate Change Science Program (www.climatescience.gov/default.htm)
Government of Canada Climate Change Web Site (www.climatechange.gc.ca)
UNEP.Net (www.unep.net)
UNEP Mountains and Climate Change Site (mountains.unep.net/cc.htm)
Northern Climate ExChange (www.taiga.net/nce/index.html)
GRID/Arendal: Climate Change (www.grida.no/climate)
GRID/Arendal: Impacts of Climate Change on Mountain Areas (www.grida.no/climate/vital/28.htm) (graphic)
The Intergovernmental Panel on Climate Change (www.ipcc.ch/index.html)

Center for Snow and Avalanche Studies

Greetings from the Center for Snow and Avalanche Studies, located at 9,300 feet (2,835 m) in Silverton, Colorado, in the heart of the San Juan Mountains range of the Southern Rocky Mountains. The San Juan Mountains contain the headwaters of the Rio Grande River as well as several significant tributaries to the mighty Colorado River. Although this 'water year' (October through September) has shown some improvement over last year's unprecedented drought, this range and our region are continuing to experience a significant water crisis. In fact, the entire state of Colorado is suffering from the effects of several 'dry' winters and very hot summers, only partially mitigated by last spring's '100 year' winter storm on the Front Range. Coloradans have come to expect and anticipate daily reports and analyses of the state of the mountain snowpack in their newspaper and television media. Even our national nightly news broadcasts have gained a new angle on the standby theme of climate change, running news items featuring a field worker on snowshoes deploying his 'federal sampler' and describing how unusually 'dry' the snowpack is. Here in the Western U.S., mountain snowpacks are variously attributed with providing 50-80% of the water supply we rely upon to occupy this semi-arid/arid region.

Dr. Marshall, in his discussion of climate change in mountains (submitted 7/21/03) commented on the scarcity of high-quality alpine climate data, and the challenges of extrapolating low-elevation observations upward. Here in the United States, we are fortunate to have a network of ski areas scattered (albeit rather unevenly) throughout our Western mountain ranges. Many of those ski areas have collected climate and snowpack observations for extended periods. Those data have been archived with the WWAN (Westwide Avalanche Network), a subscription based, industry service. WWAN data has been used by Mock and Birkeland (see http://www.avalanche.org/~nac/NAC/techPages/techPap.html) to describe 'snow climates' in the Western U.S., and those or similar typologies have been applied to Western Canada as well. WWAN does not generally collect snow hydrology data but the U.S. also has an extensive network of 'Snotel' sites monitoring mountain snowpack snow-water equivalents (SWE). Snotel is operated by the U.S Dept. of Agriculture's Natural Resources Conservation Service (see their website at http://www.wcc.nrcs.usda.gov/snotel) and these sites are the source of the snowpack data frequently cited by our media (as are some similar State-operated networks, such as in California).

Dr. Marshall also alluded to the non-linearity of climate, climate change, and climate-induced processes in mountain systems. Spatial and temporal variability is, clearly, confounding our understanding of most, if not all, mountain processes. In addition to observed variability, the embedded behaviors of mountain systems, not the least of which are the hydrologic behaviors of mountain systems, may also exhibit a host of complex and, on occasion, 'emergent' behaviors.

Avalanches represent just such a complex 'system response' to mountain weather and climate. The alpine snow system may, in fact, be a particularly responsive 'earth surface system', given that it is a 'solid' system existing at temperatures very near it's 'triple point' where solid, liquid, and vapor phases exist simultaneously (as opposed to the rock structure of the mountains, for instance). The mountain snowpack, under constant forcing by gravity, and occasionally 'critical' disturbances by weather (and/or humans), yields a 'wealth' of system behavior data directly linked to weather and climate behavior each winter.

Here at the Center for Snow and Avalanche Studies, we are particularly interested in exploring those complex behaviors, and in generating appropriate data for such studies. To that latter end, we hope to help create a "North American Snow System Observation Network" (NASSON) specifically organized and operated to collect observations documenting the multiplicity of snow-related processes that mountain snowpacks 'drive', including the storage and release of water. Historically, observations of mountain snowpacks have been driven by data protocols designed to yield 'operational' (ski area, or highway safety) or 'resource management' data (water yield). We propose to undertake, with an interdisciplinary team of mountain system scientists, the development of a system-oriented, behaviorally-based observational protocol designed to reveal snow-system behaviors over the short (seasonal to decadal) and long (50-100 year) terms. Given an extensive and thoughtfully distributed network of such snow-system observation sites, it is our sense

cont. from p.16

Just published

Ken Green Altitudinal and temporal differences in the food of foxes (Vulpes vulpes) at alpine and subalpine altitudes in the Snowy Mountains., Wildlife Research (2003) 30:245-253.

The diet of foxes over three years at alpine and subalpine altitudes in the Snowy Mountains followed a cyclical change determined by seasonal climatic events that were very marked and predictable and did not allow for great variation in timing of prey availability. The diet was dominated by mammals in winter with a change in the snow-free months to insects, mainly comprising bogong moths, with grasshoppers becoming important later in the season. Mammals preyed upon at both altitudes were mainly broad-toothed rats Mastacomys fuscus, bush rats Rattus fuscipes and dusky antechinus Antechinus swainsonii. In the alpine zone, foxes were less dependent upon the food chain deriving from in situ primary productivity than were foxes in the subalpine zone and were more reliant on other energy sources, particularly immigrant bogong moths.

that these data would go a long way toward filling the gap in alpine climate data that Dr. Marshall has described.

In the meantime, our attentions will also go toward near- term efforts to understand the release of water stored in mountain snowpacks. For example, we have joined an interdisciplinary research team interested in investigating the influence of aerosols (dusts and other contaminants) on the rate and duration of snowmelt processes. Anecdotally (our project proposal is under review by NASA), we observed an unusally rapid and 'peaky' runoff here in the San Juans this spring, coincident (?) with an unusal number of major 'dust storms' leaving several layers of dark red dust in our snowpack. Both our proposed NASSON and this latter project are described on our CSAS website (http://www.snowstudies.org).

Coloradans and most Westerners have made, or heard made, a connection between mountain snowpacks, water supplies, climate change, fire, and drought. Mountain snowpacks as water storage vessels have received unprecedented attention in our media, and those with a commercial or governmental interest in water (rights) are, to be sure, contemplating all of their options in the face of a perceived 'drying' trend, including weather modification. The Denver Water Board funded cloud seeding operations last winter but, paradoxically, quickly denied 'enhancing' the monster spring blizzard, presumably in hopes of being held harmless for the property damage wrought by that storm. Although water law currently begins at the moment of precipitation with the ground, it is not far-fetched to contemplate lawsuits claiming that 'downwind' water rights, extended to clouds in the sky, are being 'poached' by upwind cloudseeding operations (even though no definitive studies have demonstrated any 'enhancement' effect on snowfalls from cloudseeding). Since some 50-80% of Western water supplies begin as mountain snowfalls, our snowpacks are increasingly understood, I believe, as a resource commodity as valuable as any other in the west.

Thanks to the Mountain Forum for undertaking this e- discussion, and we'll look forward to subsequent submissions on a theme that lies at the heart of our efforts here at the Center for Snow and Avalanche Studies.

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Your comments on the content or contributions for future issues are most welcome.

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