Australian Institute of Alpine Studies

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International Year Of Mountains

Below is the contribution that Dr. Bruno Messerli, made at the launch of the International Year of Mountains at the UN (11 December 2001). One of the original "Godfathers" of the Mountain Agenda, Bruno emphasises important new findings with regard to population and water resources in mountains.

At this official launch of the IYM 2002 it is fascinating indeed to see government leaders, delegates from UN organizations, representatives of mountain people and NGO's, mountaineers and scientists, and to hear their statements about the mountains as "a major ecosystem representing the complex and interrelated ecology of our planet, essential to the survival of the global ecosystem"(Agenda 21, chapter 13). Ten years ago, the situation was very different: During the conference of Rio de Janeiro, the mountains were on a relatively low level of the political agenda, and only a relatively small number of decision makers, development experts and scientists were interested in this topic. This has completely changed during the last ten years.

From all the new knowledge I select only two elements: population size and water resources:

… We should not forget that mountains cover not only around 25% of the land surface, but that also approximately 26% of the global population are living inside or very close to mountain areas. Since the first international mountain conference 1974 in Munich, Germany, we are using the never proved figure that 10% of the world population are living in the mountains. The new figure comes from a data base at 0.5° resolution, derived from a 1 km gridded polygon file, that defined the spatial extent of 242 countries for which 1995 country-level population statistics were available. (Meybeck et al. 2001: Mountain Research and Development, Vol.21, N°1). This means, that mountains cannot be characterized only by remote, poor and disadvantaged people and communities, but also by urban centers inside and immediately outside mountain valleys as in the Alps, around the Pacific or even by mega cities as in Latin America from Mexico City to Santiago de Chile. In this sense, we have to rethink the highland-lowland-interactive system in a new and global perspective.

As perhaps even more important for humanity in the 21st century we have to consider the natural resources of mountain regions like water, biodiversity hotspots, recreation areas for an increasingly urbanized world, mineral resources, hydropower, agriculture, forestry etc. Let's concentrate on the water resources. Just some days before the official Launch of IYM, the Freshwater Conference in Bonn, Germany, ended. Some organizations were calling on world governments, meeting in Bonn, to take urgent action to head off a global water crisis in which two out of every three people in the world will be facing water shortages by 2050, and therefore water needs to be raised much higher on the political agenda. Most significant was the conference statement that 70% of the freshwater available today is used for irrigation and food production, in some areas like North Africa, South Asia etc. even 95%. Such a statement provokes a personal comment: Why did these conference and government members

not mention the mountains as the water towers of these above mentioned areas? In the arid and semi-arid regions of the tropics and subtropics, where possibly more than half of the world population is living, 80 to 100% of the available freshwater is coming from mountain areas. Surface and groundwater in the Aral basin, the Nile, Indus and Euphrates, Jordan, Yellow River etc. are coming from mountains and uplands. The evaporation in the lowlands can be much higher than the rare precipitations. This means, that the water balance in the lowlands can be negative, even without the deviation of water for households, industries and irrigation. A statement from Dutch scientists is astonishing that in the dry summer of 1976, 95% of the Rhine water flowing into the North Sea came from the Alps, from melting snow and ice at high altitude. But also in California, scientists are estimating that two thirds of the available freshwater for this highly industrialized state are coming from the winter and spring snow accumulation in the Sierra Nevada. All this means, the mountains as water towers play a fundamental role for water supply and food security. If the prediction is correct that we shall face a serious water crisis in the middle of the 21st century, then the mountains will play an absolutely central role, not only for the quantity and quality of water, but also for the conflicts about water.

Managing fragile ecosystems - mountain sustainable development - is the title of the mountain chapter in the Agenda 21. it is not sufficient to define sustainability with the environmental, economic and social dimension. In addition, we have to take into consideration specific characteristics of mountain nature and mountain people, like climate variability and natural hazards, highland - lowland - interactions, economic vulnerability, value of mountain resources and products, cultural diversity, demographic problems and migration, policy, law and governance etc. Management of mountain watersheds for sustainable use of mountain ecosystems and resources with the ensuing benefits for the population in the surrounding lowlands is a highly complex and multi-sectoral process.

Now it is our responsibility to create the necessary awareness for the mountains, the mountain resources and the mountain people during the International Year of Mountains 2002 and beyond.

Mountain Glaciers shrinking worldwide

Dr. Ulrich Kamp, Jr., University of Nebraska at Omaha

(http://www.enn.com/news/enn-stories/2001/06/06132001/glaciers_43943.asp)

In this article the author reports on the GLIMS-project (Global and Ice Measurements from Space), and the first results presented by Dr. Wessels from USGS.

"GLIMS is a project designed to monitor the world's glaciers primarily using data from the ASTER (Advanced Spaceborne Thermal Emission and reflection Radiometer) instrument aboard the EOS Terra spacecraft" (http://wwwflag.wr.usgs.gov/GLIMS/glimshome.html).

"The project objectives are to establish a global inventory of land ice including surface topography, to measure the changes in extent of glaciers and, where possible, their surface velocities" (http://wwwflag.wr.usgs.gov/GLIMS/whitepaper.html).

USGS in Flagstaff acts as the worldwide Coordination Center, and several Regional Center all over the world are responsable for a special region. For example, UNOmaha is the regional center for Afghanistan and Pakistan.

So far, our working group under J.F. Shroder, M.P. Bishop and J. Olsenholler at UNOmaha is not able to present reliable results from our region. But we could detect glacier melting at locations not previously expected. Hopefully, the next years will offer results about the conditions of the glaciers in the western Himalaya.

For further information about GLIMS, TERRA, ASTER, EOS Data Center and UNOmaha, please surf the net:

http://wwwflag.wr.usgs.gov/GLIMS/

http://terra.nasa.gov/

http://asterweb.jpl.nasa.gov/

http://edc.usgs.gov/

http://www.unomaha.edu/~glims/

The Biodiversity Blitz Snowy Mountains 2002

Ken Green

The concept of a Biodiversity Blitz is that over a 24 hour period, experts from all fields of biological sciences gather together in one place to make an inventory of all the different types of organisms within a defined boundary. This concept has proven popular in Germany where it is a common event, and in Switzerland, where the results were published in full colour in the German journal 'Geo'. The focus of the 2002 Biodiversity Blitz was the Snowy Mountains with the target area being the variety of ecosystems between the Thredbo Valley Floor and the summit of Mt. Kosciuszko.

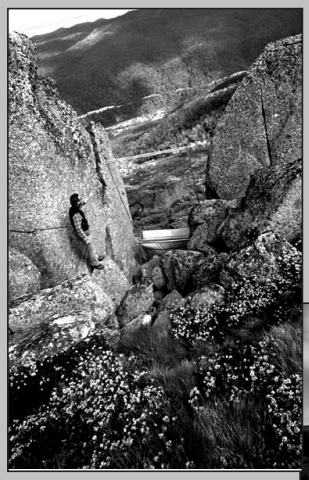
This covers two major life zones: subalpine and alpine and a total of 27 square kilometres.

The idea of holding the Biodiversity Blitz in the mountains in 2002 was aimed at serving a number of purposes. In the International Year of Mountains it highlighted the importance of the mountains in sustaining a unique alpine biota within the generally dry and low-lying Australian landscape. With global warming predicted to have a major impact in the mountains of south-east Australia the survey of the biota over a large altitudinal gradient (about 800m) should also provide a baseline across the whole biotic spectrum for long-term monitoring work. This will be the first attempt to put in place a protocol to examine global warming impacts on the entire mountain biota. Finally the Biodiversity Blitz enabled the networking of a variety of people interested in the mountains from specialist taxonomists to field naturalist to the general public.

So how did it go? 71 people participated, with expertise in everything from birds to mycorrhizal fungi. Already there are some interesting results. Among the moths for example Ted Edwards, who spent ten or so days in the area, collected an estimated 400 moth species including one new species and one last caught in 1922. There will be a report in an upcoming Victorian Naturalist and a report with species lists should be published in time for the International Year of the Mountains Conference in November this year. We got reasonable press coverage making page 3 in *The Age* p5 in The Australian and p3 in *The Sydney Morning Herald*. It must have been a quiet weekend!

Linda Broome releases a Broad-toothed Rat (not a Burramys!) near the summit of Mt. Kosciuszko

Brian Timms leads out with the boat above Lake Cootapatamba



Tony Mitchell with a bat trap in a cleft near the treeline above Thredbo

Brian Timms with David and Meredith Happold who were attending their second such event (after attending the Alp Flix in Switzerland)

Abstracts from the AIAS annual meeting in Hobart

The Effect of Snowmelt Gradients on Snowpatch Plant Community Patterns

Susanna Venn and John W. Morgan, La Trobe University

Snowpatch communities are restricted to high mountain areas where snow persists late in the season. This study, on the environmental determinants of small-scale vegetation patterns at a large, alpine snowpatch on the Bogong High Plains, aimed to determine the role of abiotic factors which drive within-snowpatch plant community patterns. Species richness and patterns of community distribution appear to be dependant on the length of the growing season and soil moisture, but not factors such as soil pH, soil depth or % rock. Shrub communities were more dominant in the early-snowmelt areas, whereas herb and grass communities existed in areas of increasing snow duration and soil moisture. Rapid growth and reproduction of some snowpatch species correspond with snowmelt date and hence, growing season length. Therefore, the role of environmental factors on phenology are well established in some snowpatch species. These findings are discussed in relation to predicted climate change impacts on community composition and dynamics in alpine areas.

Macrofungi from the top of Mt Wellington, Tasmania

Sapphire McMullan-Fisher, University of Tasmania

Fungi traditionally studied by botanists are a little studied group outside of the commercial impact of fungal diseases. Fungi play important roles in ecosystem function; particularly the roles of decomposition, and nutrient acquisition by mycorrhizae (fungal symbionts on the roots of most plants). Despite sceptical predictions macrofungi have been found regularly on the top of Mt Wellington, Hobart's closest alpine area. Pictures, identifications and trends of these macrofungi will be discussed.

Impacts after Four Years of Experimental Trampling on Alpine Environments in Western Tasmania

Jennie Whinam and Nicole M. Chilcott, Nature Conservation Branch, Department of Primary Industries

Experimental trials were undertaken over four years to assess the impact of recreational trampling in four different plant communities in untracked alpine vegetation in the Western Arthur Range, south-west Tasmania. Data on 'pad' formation due to human trampling were collected using vegetation cover estimates, biomass estimates and detailed cross-sectional surface profiles. Shrubs and graminoids appeared to be more vulnerable to sustained trampling damage than other lifeforms and vegetation types; prolonged damage occurs after 200 passes by walkers. In steep buttongrass, flat alpine herbfield, sloping alpine herbfield and steep alpine herbfield prolonged damage may occur after 100 passes by walkers. Shrubs and graminoids are susceptible to breakage from trampling at all sites and treatment levels. Cushions are susceptible to breakage from trampling at high levels. Results from cross-sectional surface profiles indicated significant impact at all sites and treatments (with the exception of the steep alpine herbfield 30 pass treatment) three years after initial trampling, with limited recovery evident at two of the treatments four years after trampling.

Evidence for Biotic Feedbacks on the Pattern and Rate of Encroachment by *Eucalyptus pauciflora* into Subalpine Grasslands

John W. Morgan and Lynise J. Wearne, La Trobe University

One of the important spatial patterns in high mountain areas is the potential for changes in the treeline position. Cases of individual tree encroachment into subalpine grasslands have been recorded in Victoria, and it has been suggested that this is likely the outcome of both small-scale (e.g. regeneration microsite availability) and landscape-scale (e.g. climate change, grazing release) processes. While there is evidence for recent shifts in the position of the ecotone, it remains unclear whether tree encroachment is (a) a random, directional process or (b) a slow, small-scale process dependent on facilitation from surrounding trees. In this study, the groundlayer vegetation, environment and structure of the subalpine forest – grassland ecotone will be described at two sites near Falls Creek. We will quantify the spatial autocorrelation of tree characteristics (density, size and age) from the ecotone to determine Snow Gum (*Eucalyptus pauciflora*) regeneration patterns. Spatial autocorrelation may result from beneficial regeneration near adults (positive autocorrelation, aggregation), from competition (negative autocorrelation, avoidance) or there may be random establishment patterns (no autocorrelation). From these analyses, we can generate hypotheses as to likely causative processes and assess the likely effects of climate change on treeline ecotone shifts.

Arsenic Contamination of Mountain Ecosystems by Migrating Bogong Moths From Agricultural Lowlands

Ken Green, NSW National Parks and Wildlife Service

In spring each year millions, possibly billions, of Bogong Moths *Agrotis infusa* (Lepidoptera: Noctuidae) migrate from the inland plains of eastern Australia to mountains on the Great Dividing Range, covering distances of up to 1000km. They spend the summer aestivating in rock crevices in tors and periglacial blockstreams in the Brindabella Range, Snowy Mountains and Victorian Alps. In these sites the moths may number in the millions. In November 2000, heavy rains washed debris from caves in the Snowy Mountains, onto adjoining grass. Over the next two months large areas of snowgrass (*Poa fawcettiae*) died as a result. Soils were sampled and were assessed for exchangeable cations. Arsenic was detected in soils from the caves and soil and grass from outwash areas where grass was killed, but not in soils and live grass from adjacent areas away from possible drainage. Faeces from mammalian predators of moths (*Burramys parvus, Antechinus swainsonii* and *Rattus fuscipes*) contained varying levels of arsenic whereas faeces from a herbivore from the same region (*Mastacomys fuscus*) contained virtually none. Arsenic levels were higher in moths from caves in the Snowy Mountains where vegetation was killed than in moths from the ACT (where no vegetation was killed) or Victoria. Bioaccumulation of environmental pollutants and their concentration by terrestrial organisms normally occur *in situ*. The results of this study show an unusual case of long distance transport of sublethal quantities of arsenic by individual moths which are then concentrated to damaging levels because of the concentration of millions of contaminated moths at aestivation sites.

The contrasting arsenic content of moths and soils at various mountain locations suggests that there are different sources of these moths. This question may be resolved by genetic or chemical studies matching adults to larvae from known agricultural areas. Collection of material for this study is currently in progress with the primary aim being to narrow the focus of searching for the source of the arsenic.

Threats to the Alps: Biological Invasions and Ecosystem Level Changes

Lynise J. Wearne[1,2] and John W. Morgan[1], [1]La Trobe University, [2]Co-operative Research Centre for Weed Management Systems

On a global scale, invasion by exotic species is considered the most important cause of species diversity loss besides habitat destruction. Although the Australian alpine region is relatively unaffected by invasive species at present, with increasing pressure from tourism and development, the spread and establishment of such species is likely to become a serious threat. The recent invasion by the exotic legume *Cytisus scoparius* (English Broom) within the subalpine region of the Victorian Alpine National Park, represents the first real 'weed' to establish in the area. This species is a nitrogen fixing shrub and, as such, it could potentially effect not only community composition, but also alter the soil nutrient status, particularly nitrogen cycling. This study examined species diversity and environmental changes associated with three different stages of invasion; initial, mature and senescing stands. Results indicate a loss of species richness both above and below ground, and changes to a number of environmental factors as a consequence of invasion. Furthermore preliminary studies of soil nitrogen suggest that N availability is higher in Broom invaded verses native stands at most times of the year. The altered nitrogen cycle appears to result in growth rate changes of some native species, which could potentially lead to permanent ecosystem changes within the subalpine community.

How does being Deciduous Provide *Nothofagus gunnii* with a Competitive Advantage Over *N. cunninghamii* in Montane Tasmania?

Michele Kohout, Monash University

The ecological significance of the winter-deciduous habit of *Nothofagus gunnii* in the Tasmanian highlands was examined by comparing aspects of its ecology to the congeneric evergreen species, *N. cunninghamii*. Carbon gain and biomass allocation was examined by measuring photosynthetic responses to temperature, relative growth rates and biomass allocation patterns of annual shoots. Leaf mechanical protection and the costs of constructing and maintaining leaves provided an indication of how initial investments might influence leaf lifespan and growth at higher altitudes. The results showed that *N. gunnii* leaves had significantly specific leaf area, higher mass- and area-based maximum photosynthetic rates and higher growth rates of annual shoots. *N. gunnii* leaves were cheaper to construct on a mass and area basis, but had higher mass-based maintenance costs and were less mechanically protected than *N. cunninghamii* leaves. The results will be discussed in terms of how both a deciduous and evergreen strategy can provide an advantage in the Tasmanian montane environment.

Plant Regeneration in Tasmania's Central Plateau

Wieslawa M. Misiak, University of Tasmania

The long history of disturbance by human activities on the Central Plateau has resulted in some of the most eroded alpine and subalpine country in Australia. Although the rate of vegetation and soil loss has declined following the introduction of myxomatosis, prohibition of burning and the exclusion of stock grazing within the Tasmanian Wilderness World Heritage Area, recovery has been relatively slow. Work is currently underway to assess the biotic and abiotic limitations to plant regeneration on the Plateau. The availability of seed sources is being determined with the use of seed traps, and the effect of microclimate and soil environment on seedling germination and growth is being monitored. It would appear that some species, such as *Grevillea australis*, play an important role in ameliorating the microenvironment for germination and growth of seedlings.

The Diversity, Evolution and Biology of Snow Scorpionflies (Insecta: Mecoptera: Apteropanorpidae)

Christopher M Palmer [1,2] and David K Yeates [2], [1]Australian National University, [2]CSIRO Entomology

Apteropanorpa Carpenter is a genus of Mecoptera (scorpionflies) endemic to Tasmania, comprising two described species. This genus belongs to the monotypic family Apteropanorpidae. *Apteropanorpa tasmanica* was the first described species, in 1941. Adults were collected at altitudes above 1000m, from Mt Mawson and Mt Wellington. The second species, *A. evansi*, was described very recently from specimens collected on the shores of Lake Augusta, in the Central Plateau Protected Area. Very little is known about the biology and evolution of this fascinating family. Unlike most other Mecoptera, adults are wingless and active in winter. Adults have been most commonly found in heathland at high altitudes, but populations are known to exist in temperate rainforest, and in riparian rainforest at low elevations. A moss-dwelling mecopteran larva from Mt Wellington was described in 1942, most likely belonging to *Apteropanorpa*. Similar habitats in south eastern Australia have not been sampled intensively for members of this genus. Gut contents suggest adults feed on plant or fungal material, but this is incongruent with mandibular structure, which suggests a predaceous feeding strategy. *Apteropanorpa* tolerates such cold environments that effective physiological and behavioural adaptations are indicated. Larvae possess compound eyes and a raised tubercle on the frons, which may be homologous with the median ocellus of other mecopteran families and other endopterygote insects. Ultrastructural studies of the larval eyes and median ocellus of *Apteropanorpa* promise to yield important information regarding the relationships of the Apteropanorpidae to other families of Mecoptera, and will provide insight into the pattern of evolution of all holometabolous insect orders. Preliminary results from field surveys in 2001 have shown that adults are found throughout western Tasmania. Altitudinal pitfall trap sampling from 100m to 1300m on Mt Weld, conducted by Forestry Tasmania and DPIWE, has yielded over 10,000 specimens, with almost all collected in the alpine zone. The sex ratio of this population favours females. Hand collecting has shown that apteropanorpids are not restricted to a single host plant species.

Changes in Alpine Vegetation Relating to Geomorphological Processes on Hill One, Southern Range, Tasmania 1989-2000

Jamie B. Kirkpatrick, Kerry L. Bridle and A.J.J. Lynch, University of Tasmania

Photographs of 96 plots in alpine vegetation, largely consisting of fjaeldmark and bolster heath, on Hill One, Southern Range, Tasmania were taken in both 1989 and 2000. Between these two years vegetation cover declined in the fjaeldmark, largely as a result of erosion, and on the active depositional lobes, through burial of bolster heath. Within the parts of Hill One where vegetation cover was not lost, graminoids decreased and *Pterygopappus lawrencei* increased in the bolster heath, and tall shrubs displaced bolster heath. Thirty-six percent of the rocks visible in the 1989 photographs had moved by 2000, the mean size of the moved rocks being 95 cm^2. Larger rocks were moved on the exposed western slope than the leeward eastern slope. Analyses of climatic data from nearby stations for 1979-2000 indicated a decline in both precipitation and temperatures and an increase in the frequency of the highest wind speeds, all of which are consistent with the nature of the changes that occurred in the mountain. Localised cooling and drying in the two hottest and wettest decades recorded for the globe, emphasises the importance of local data in determining the possible impacts of climatic change on biota.

Environmental Issues Associated with Tourism in the Australian Alps

Catherine Pickering, Griffith University

In the last two years the Mountain Tourism subprogram of the Cooperative Research Centre for Sustainable Tourism has been examining environmental, economic and cultural issues regarding the sustainability of tourism in the Australian Alps. In this talk I will summaries some of results of just three of these projects.

1. Regulation of tourism by park agencies:

A diverse range of summer tourism activities occur in Australian alpine and subalpine parks including; car-touring, bushwalking, horse riding, fishing, backcountry camping, caving, rock climbing and hang-gliding. To manage high impact activities such as horse riding, extensive use is made of zonation, and to a lesser extent, regulations. These strategies function to restrict use by limiting areas and/or numbers. Limited use is made of licenses and concessions. When park entry fees are applied they function to raise revenue, some of which is then used to provide tourist facilities and ameliorate tourism impacts within the parks.

Inconsistencies in the application of rules due to political boundaries and differing attitudes between the managers of the contiguous Australian Alps national parks may be contributing to ineffective management. Park agencies rely on education such as minimum impact codes advocating sustainable behaviour. However, these codes may not be effectively reaching target audiences. More extensive use of permit systems could extend knowledge of codes. However, long-term sustainable management also depends upon determining carrying capacities and thresholds for rapid environmental degradation for areas. At present carrying capacities are not well known for specific areas and visitor monitoring is haphazard.

Therefore key recommendations for Australian managers are: to develop more effective visitor monitoring programs; to determine thresholds to degradation for specific activities in given areas; and through the application of a permit system to restrict use to within these thresholds. Finally, the development of more effective methods for disseminating minimum impact codes to target audiences would enhance the effectiveness of regulatory management.

When the regulatory situation in Australia is compared with overseas countries it is clear that in the Australian Alps national parks and Tasmanian high country parks there is very limited use of regulations to restrict use and minimise impacts. Since summer visitors engage in activities over a wide area and thus have the potential to spread impacts widely, it is vital that planners and managers develop more effective regulatory strategies.

2. Perceptions of parks managers concerning environmental impacts of tourism

The perceptions of staff from park agencies responsible for managing tourism and its environmental impacts in the largest area of snow country in Australia, the Australian Alps National Parks were examined. Park managers consider:

- tourism to have important negative environmental impacts on national parks, around ski resorts and away from resorts.

- the impacts of resorts on adjacent natural areas are often more important than impacts of tourism activities away from resorts.

- the most important impacts were on water quality, with human waste and other contamination such as runoff from ski slopes, oil, grease, salt on roads etc. of most concern in reducing water quality.

- fauna was adversely affected by activities that resulted in increased numbers of feral animals and also by habitat reduction and fragmentation.

- there was a wide range of adverse impacts of tourism on vegetation, the most important of which is disturbance associated often with the provision of tourism infrastructure resulting in increased diversity and abundance of weeds.

- air quality was affected by tourism, particularly around resorts, but it was less important than impacts on water, fauna and flora.

The perceptions of national park managers appear to correspond well with impacts that have been documented in research papers and management reports.

3. Impacts of tourism in the alpine area of Kosciuszko National Park

The alpine area around Australia's highest mountain, Mt Kosciuszko is an increasingly popular summer tourism destination. Estimated numbers of people visiting the area have risen in the last 25 years from 20,000 to 64,000 per year. Tourists in summer principally go on day walks in the area, with the summit of Mt Kosciuszko the major destination. Winter activities principally consist of cross-country skiing, snowboarding and ice-climbing. Tourist are causing a range of impacts on the soils, water quality, flora and fauna through their activities, travel and transport and accommodation near or in the area. Summer tourism and its impacts are likely to increase with increasing promotion of the area as a summer tourism destination, particularly if predicted climatic changes occur in the region reducing the winter ski season. The types of impacts and effectiveness of current management responses are discussed. Further ecological and social research is required if tourism on the roof of Australia is to remain ecologically sustainable.

My thanks to colleagues who have collaborate on various sections of this research including Wendy Hill, Jan Harrington, Stuart Johnston, Ken Green and Graeme Enders.

The Impact of Informal Campsites and Trampling on Soil and Vegetation in the Australian Alps

Andrew Growcock, Griffith University

Impacts of recreation activities in mountain areas can be important as many of the vegetation communities require long periods to recover from even low levels of disturbance. Where overnight camping occurs in backcountry areas, impacts may be great due to the highly concentrated nature of the activity. As backpackers move through the backcountry, damage may also be done through trampling of the vegetation.

The aim of this research is to identify the impacts of backcountry camping and trampling on soils and vegetation within the subalpine areas of the Australian Alps. Two approaches will be taken to describe the impacts of backcountry camping. The first will locate campsites used by major walking groups and identify the extent of impact caused. The second will be a manipulative study identifying how impacts vary within a site according to the type and frequency of use. Vegetation cover, composition and abundance, soil seed bank composition and soil physical properties, compaction levels and hydraulic properties will be compared between paired sites: one used for camping, the other not.

Damage caused by backcountry walking will be determined through controlled trampling trials. These trials will consider the changes to soil and vegetation with increasing amounts of use.

Potential Impacts of Snow Manipulation on Vegetation in the Australian Alps

Wendy Hill and Catherine Pickering, Griffith University

Although direct impacts of tourism on natural systems have been widely documented, the range of secondary impacts is often underestimated or not reported. This study examines potential direct and indirect effects of snow manipulation (slope grooming, snow grooming, snow making, snow harvesting and snow fences) on vegetation in the Australian Alps. In order to maintain economic viability, ski resorts have substantially increased snow manipulation. There has been little research in Australia on the resulting environmental impacts. This is despite the high conservation value of the region with resorts located either in or adjacent to national parks.

Based on overseas work, it appears that snow manipulation results in a cascade of changes that can negatively affect native flora. Slope grooming can involve extensive modification of the environment including removal of native vegetation and reformation of slope topography, resulting in changes to hydrological patterns. Snow grooming not only physically damages plants through direct contact, but compacts the snowpack increasing density, and reducing porosity and permeability. This retards spring snowmelt and limits the ability of the snowpack to slow water runoff, thus increasing the risk of erosion. Snow compaction directly affects plants by increasing risk of physical damage from freezing, however the range of secondary impacts are extensive and include lower soil temperatures, greater depth of soil freezing, depleted soil nutrients and higher pH. Secondary biological effects of snow compaction and other snow manipulation techniques are less studied but include changes in the composition of plant communities, soil biota, herbivory, animal activity, predation, insect activity and seed dispersal. The study highlights the need for research into secondary environmental impacts of tourism to ensure that winter ski tourism in Australia is not just economically sustainable, but also environmentally sustainable.

Aeolian landforms in the Lake Sada - Augusta area of the Central Plateau, Tasmania

Jason Bradbury, Department of Primary Industries, Water and Environment Tasmania

In 1994 a brief project was conducted to compile an inventory of aeolian landforms, assess their significance and suggest a conservation management strategy. Aeolian landforms include a variety of dune forms within generally crescentic fields, concentrated on the eastern (downwind) margins of the many water bodies and inferred to be lunettes (lake bordering dunes). This implies that they formed under a relatively arid climate with greater lake bed exposure. The presence of similar landforms downwind of the Augusta impoundment (Eastern Central Plateau) indicates that formation may have occurred rapidly (within tens of years) once appropriate conditions prevailed. All but one of the lunettes are composed of sand-sized particles of dolerite, making them unique in Australia and of very high geoconservation significance. The doleritic sand largely consists of feldspars and pyroxene minerals that are very susceptible to weathering. Given the unweathered condition of the upper units a Holocene age is strongly implied. Edaphic properties, particularly drainage, are substantially different to those of the more widespread ground moraine or dolerite bedrock, thereby providing a distinct environment for flora and fauna. From a geomorphological perspective this is most obvious in the stabilisation of sand by relatively abundant woody vegetation and preferential use of the lunettes by burrowing animals. Most of the aeolian landforms have been subject to anthropogenic degradation, which is often significant. The principle causes include fire, excavation, artificially raised water levels and trampling. Degradation is manifested by reactivation of the processes of sand transport, including wave erosion, blowouts and drawdown-induced sapping.

Circumpolar Warming Effects of Tree-Line Reproduction in Canada and Siberia

Harvey Nichols, University of Colorado, Boulder

The arctic tree-line is sensitive to climatic changes as indicated by paleo-ecological studies, and it is predicted by global circulation models to respond strongly to greenhouse warming. Northern Canadian studies of tree-line reproduction in black and white spruce (*Picea mariana* and *P. glauca*) spanning two decades demonstrate a widespread switch from infertility due to cold summers (1960s-1970s) to pollen and cone production (1990s), in line with climatic warming predictions. Ecotonal cone formation is usually sporadic and localized, but this large scale reproductive shift, along a 1500 km transect, suggests widespread climatic warming since the 1970s across much of the Northwest Territories. Labrador, not included in the original study, has experienced a delayed response.

In 1995 I tested the hypothesis by examining a transect of arctic tree-line sites in western Siberia. At all these sites ecotonal larch trees (*Larix sibirica*) were reproducing sexually, and greenhouse [glasshouse] studies confirm that enough seeds are viable to allow seedling colonization of the tundra. Siberian colleagues noted that the age structure of these "tree-islands" based on tree-ring studies suggested that a recent warming response was identifiable.

In 1996 I examined a series of "tree-islands" in the tundra of northern Yakutia in northeast Siberia. All the larch trees (*Larix kajendera*) bore cones, but greenhouse studies show that seed viability was very low (<1%), possibly due to a persistent cold trough in the upper Westerlies.

These Siberian studies (at 27 sites) represented only a modest fraction of the Eurasian tree-line, but the widespread fertility at so many locations, plus the extensive Canadian evidence, and Fenno-Scandinavian findings, suggest that the predicted polar warming may be responsible, with Labrador and Yakutia showing lagging responses. Whether this is due to natural or anthropogenic climatic change, or some combination, and whether it will be short or long-term, is unclear, and merits further study and long-term monitoring.

Managing the Impacts of Recreational Walking in the Tasmanian Wilderness World Heritage Area

Grant Dixon, Parks and Wildlife Service, Tasmania

Recreational bushwalking has taken place in the area now encompassed by the 1.3 million hectare Tasmanian Wilderness World Heritage Area (WHA) for the best part of a century. However, during the last three decades or so a major increase in visitor numbers, and perhaps a greater focus on alpine destinations, has resulted in both more extensive and intensive impacts from this activity.

Physical impacts include extensive eroded, muddy and braided tracks; the development of pads and new tracks in previously trackless areas, the expansion and proliferation of campsites, and issues regarding sanitation and the impacts of human excrement on the environment.

Increased appreciation of the values of the WHA, both natural and recreational, together with increased resources available to the managing agency for tracks during the last 10 years, have facilitated a more comprehensive and coordinated approach to attempting to manage these problems.

The drafting of track management plans for particular tracks or recreational areas in the late 1980s was an attempt to provide a more consistent approach to track works. However it was soon recognised that a broader and more strategic approach, encompassing more than just works planning, was required.

An inventory documenting the extent and condition of all 1000+km of walking tracks in the WHA was undertaken in 1990-91 The Walking Track Management Strategy (1994) was drafted based on the findings of the inventory and a comprehensive international literature review. Key components of the Strategy were a seven-tier track classification system, a comprehensive, prioritised works program, the development of an ongoing monitoring system, an expanded user education program and a proposed walker regulation (permit) system.

Works priorities were set across the WHA based on track condition and estimated rates of change in the context of the track's classification prescriptions. The works program initially focussed on Priority Erosion Control (PEC), rather than walker comfort issues. Ongoing (so far) funding, most recently through the Natural Heritage Trust, has allowed many of the very high priority works to be completed. New techniques have been developed for alpine areas in particular, notably the use of rock, cost-effective minimal width planking and the construction of camping platforms. Already, concerns have been expressed regarding changes in recreational opportunities as a result of such works.

The monitoring program involves track, campsite and aerial components. More than 500 track monitoring sites across the WHA are regularly revisited. Condition data on more than 700 campsites is also regularly updated. Large scale (1:5000) aerial photographs are used to delineate the extent of pads and tracks in selected, often-remote areas where the terrain is sufficiently open. Overall, the monitoring findings indicate continued track and campsite deterioration, especially in alpine areas, although rates vary across the WHA.

Not surprisingly, the proposal for a walker regulation or "permit" system has been the most controversial component of the Strategy. Various public forums, seminars, consultation and political manoeuvring have taken place without any effective progress on the issue. The most recent phase of the debate is to involve the development of an approach to walker management of areas, in consultation with a group of stakeholders (Bushwalking and Track Review panel). This is intended to involve a debate over what is acceptable – including impacts, social, regulatory issues. In the meantime, we continue to apply more traditional bandaids to an escalating problem.

An overview of patterns and trends in the alpine invertebrates

Peter B. McQuillan , University of Tasmania

Alpine Australia has a rich and highly endemic fauna of invertebrates representing a unique experiment in living in a stressful environment. Differences in the insect communities among Australian alpine mountains and habitats reflect historical and biological features of the environment, as well as resource limitations.

Endemism at genus and family level is highest in western Tasmania and lowest in Victoria for both terrestrial and cold freshwater groups. The greater degree of woodiness of Tasmania's alpine flora creates opportunities for diverse internal feeders.

Many insects associated with herbaceous foodplants tend to be geographically widespread, e.g. xanthorhoine moths (40+ species) with larvae on forbs, whereas shrub dependent taxa include a high proportion of local and regional endemics, exemplified by archiearine moths on Tasmanian conifers. Important browsers on shrubs include weevils (*Merimnetes* and allies), grasshoppers, and moth larvae. Probable remnants of Gondwanan-origin plant-insect associations are apparent in all regions, attesting to a long history of montane environments in Australia.

Numerically abundant species include some that are altitudinal migrants, which disperse to the highlands in late spring, but may not breed locally. Some are functionally important: Rutherglen bugs *Nysius vinitor* consume vast amounts of herbaceous seeds in the late summer in Victoria and New South Wales. The Bogong moth *Agrotis infusa*, supports mammalian predators but also visits many

flowers at night, and syrphid flies follow the spring flowering sequence up the mountainsides to visit a wide range of alpine flowers.

Habitats such as alpine grasslands have characteristic insects, some of which are important agents in plant dynamics. In the Snowy Mountains and Tasmania, hepialid moths, *Oncopera* spp., locally defoliate *Poa* swards creating germination niches for many dicots. Amycterine weevil larvae bore in the crown of tussocks The most conspicuous of the few alpine butterflies are *Poa*-feeding *Oreixenica* species, some variable phenotype between mountains, shown to be clinal in at least one case.

Much remains to be learned about the pollination ecology of the alpine flora. In Tasmania at least, the proportion of white flowers increases along altitudinal gradients, suggesting an appeal to less specialised pollinators. Indeed, pollination of many alpine dicots is mediated by flies (Syrphidae, Calliphoridae, Tachinidae) and beetles (*Chauliognathus, Sessinia*) and the few native bees mainly visit *Euphrasia* and *Wahlenbergia*. There is also a suggestion of sequential flowering in sympatric cushion plant species on Mount Field, perhaps as a strategy to share, rather than compete for, scarce pollinators.

The Impacts of Human Waste Disposal on the Ecosystems of the Back country of Tasmania.

Kerry Bridle and Jamie Kirkpatrick, University of Tasmania

This project uses replicated field experiments to determine the impacts on vegetation and soils of human waste disposal in the ecosystems most used by back country tourists in Tasmania. The results of these experiments will be used to develop ecosystem-specific guidelines for human waste disposal that will minimise deleterious impacts on conservation values, while minimising inconvenience to users. This paper presents the results of breakdown rates of toilet paper, tampons and tissues that were buried for 6 months and 1 year. We will also present results from a parallel study to determine whether the burial of faeces involves any public health risk.

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

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Call for Papers :

Special session at the 98th Annual Meeting of the Association of American Geographers (AAG), Los Angeles, CA, March 19-23, 2002. This session is sponsored by the Cryosphere Specialty Group in conjunction with the Climate Specialty Group and the Mountain Specialty Group

The proposed session title is: 'The changing cryosphere: Implications for recent climate and environmental changes'

Human activities are changing the chemistry of the atmosphere, modifying the landscape, and placing stresses on critical resources including soils, water and biota. Atmospheric concentrations of CO-2 are above any levels experienced in millions of years and this is generating concern that the Earth system will warm in coming centuries. Indeed, 20th century warming is well documented and the cryosphere, consisting of ice in all its forms, may serve as a bellwether for the increasing human impact on the climate system. One of the most evident changes is the accelerating retreat of mid-latitude and tropical ice fields. In fact, cryospheric observations alone provide nearly unequivocal evidence of 20th Century warming. Research reveals that Arctic sea ice is thinning, permafrost thicknesses are diminishing, some Antarctic ice shelves are disintegrating, many lake and river ice covers are freezing later and breaking up earlier, and the southeastern part of the Greenland ice sheet may be thinning. In some regions the amount and distribution of seasonal snow fall have become more variable. Another consequence of the retreat of glaciers and ice caps is the likely loss of critical archives of the Earth's climate history.

Papers are solicited to examine the nature of these cryospheric changes and their potential linkages to 20th Century warming. Papers exploring the climatological controls on the cryosphere and exploiting data from the National Snow and Ice Data Center (NSIDC) are also encouraged. We invite submissions covering all aspects of the cryosphere including polar ice sheets and ice shelves, alpine glaciers and ice caps, sea ice, permafrost, river and lake ice, and seasonal snow cover.

Please contact Ellen Mosley-Thompson (contact information below) if you plan to submit a paper.

Details on the Los Angeles Meeting can be found at the AAG web site: http://www.aag.org/ (clicking on the "Annual Meeting" link)

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Money in environmental science

In the Canadian Rocky Mountains, the Bow Valley cuts east- west through the north-south trending mountains. The valley is a life-sustaining artery that runs from the Alberta plains to the heart of the Rockies. The valley has high value as both a year-round wildlife refuge and a desirable setting for human habitation and recreation. As with many other mountain communities, the region is struggling with effects of tourism and trying to diversify its economy.

Often tourism and other commercial industries are seen as the only economic "industries", especially in mountain communities. A recent study by the Biosphere Institute of the Bow Valley shows that ecosystem research can also have a positive impact on the economies of surrounding communities. The study focuses on the Town of Canmore, located in the Bow Valley, just outside the gates of Banff National Park. Once a small mining Town, it is now facing rapid growth, partially due to its rapidly growing tourism industry. The study shows the amount of money spent on ecosystem research in the region (over $2.24 million in 2000), the number of jobs created in the region, the location and types of employment and the housing requirements of the researchers. It also shows the percentage of local, provincial, national and international funds that are spent on such research in the region. For the Executive Summary or for the full report go to http://www.biosphereinstitute.org/.

AIAS Annual Meeting – Hobart 5-7 December 2001, Kerry Bridle

Well we wondered what we'd got ourselves into – an invasion from the North Island – and weird alpine researchers at that. But it happened and I think it all went well. We haven't had any negative feedback – well not from any of the Australian contingent anyway, either they're too polite (ha ha) or very laid back – until you show them some plant or invertebrate –in fact anything will excite them except a sod (of soil that is).

The talks went to time (who was that man asking all those questions?). Powerpoint behaved, and the tea-person (Janet Smith) did an excellent job. Jamie – the pied piper of Hobart led the Mastacomys to the nearest pub and then on to the restaurant. At the restaurant we split the raucous duo (Ken and Jamie) up for the sake of all other diners. Not that the volume was much reduced – they just shouted one-liners to each other across the table.

So day one of the field trips – we turned up at Uni for an 8.30 am departure and people were there! Off to Mt Field National Park with local knowledge provided by Jenny Mudge (ranger at Mt Field), Jennie Whinam, Mike Comfort, Sib Corbett (Nature Conservation Branch NCB of DPIWE), Grant Dixon and Phil Wyatt (Parks and Wildlife Service), Peter McQuillan (UTAS) and led by Jamie and the tartan brolly. It wasn't windy so we didn't have a Mary Poppins re-enactment but still the weather held out and I think people had an enjoyable day on Mt Mawson and Tarn Shelf. And that guy turned up again – the one who asked lots of questions! Someone else will have to fill in the details of the evening's entertainment because I went home.

Day 2 – the Eastern Central Plateau – the coldest place in Tasmania. Well it rained so we took our time in getting there. And when we got there we picked up the local ranger Dave Geoghegan, who likes the idea of management burning. Needless to say the alpine ecologists set upon him with great gusto. However, being good-humoured, Dave took it all on board and disarmed his drip-torch for the day. A new troop of informants was on hand to dish out information and answer questions: Mike Pemberton (Chief Earth Scientist with NCB), Jennie Whinam, Mike Comfort, (NCB), Wieslawa Misiak (Plant Science UTAS) and again led by Jamie, and the tartan brolly. Peter McQ decided that no sensible invertebrate would be seen out on Liawenee Moor in bad weather and opted to stay in his lab. But obviously he is no meteorologist because after an early lunch the rain went away and we had a fine (ish) afternoon. We visited grazing trials, alpine sand dunes and went in search of a Tasmanian Alpine Humus soil (with a Reject Shop spade much to the disgust of the Earth Scientists). And again there he was, the ever-questioning man!

Of course the ever-questioning man was Alec Costin. His enthusiasm was tiring for the rest of us mere mortals!. I think Alec's daughter sent him on the trip for some respite from the brain that never stops. It was a fantastic opportunity to spend some time with an amazing alpine ecologist. Thank you Alec for coming and thanks to CP from the CRC for Nature Tourism, for a substantial contribution to the meeting.

Thanks to everyone for bothering to travel to God's own country and we hope that we made it worth your while!

I think that these meetings are a great way to get to know other alpine researchers and to chat about how we do what we do. I like the fact that they are more informal than a 'conference', and that we have plenty of opportunity to interact with foreigners (read as mainlanders). Having a bunch of enthusiastic people together creates more enthusiasm and gives you extra contacts to bounce ideas (or jokes) off.

Monarch of the mountains: reflection on some conservation issues

Frank Ingwersen

Last year, I had the opportunity to visit some high, forested mountains in Mexico at about 3,400 m altitude. There, the *Sierra de Chincua Reserva Ecologica*, a *Special Biosphere Reserve* (BR) was created in 1986 to preserve the southern habitat of the migratory Monarch Butterfly (*Danaus plexippus*). Monarchs migrate annually in two streams, one from the Canadian - U.S border, across the USA to Monterey on the West Coast, the other, through the eastern USA to Mexico, where it arrives within a few days of the same date annually. There they overwinter in the high ranges on the border of the states of Mexico and Michoacán. It migrates some 5,000 km, flying up to 130 km a day at up to 50 km/hr.

When the weather warms, the surviving Monarchs will begin migrating northwards in stages. The males are by then dead. The forest floor is littered with their bright orange coloured wings and spent carcasses. The females, already fertilised by them, begin the return journey to the far north but they will last only a month. Four or five new generations bred along the way will take over the migration. The last to reach southern Canada will begin their return south before reaching sexual maturity. It is an epic biological story. No Monarch that reaches the *Sierra de Chincua* has ever experienced the navigational cues and migratory drives before. How is it done? A suggestion is that they position themselves so that the sun angle is 20° throughout the migration. These mountains provide a place to see and wonder at the phenomenom of migratory species as a whole and in particular, the Monarch butterfly.

While the high mountains of central Mexico are critical habitat for this species, they are only one link in a chain of shared responsibilities. As well as Mexico, Canada, and the USA are involved in maintaining the habitat requirements of this migratory species; ultimately, the responsibility for the survival of the Monarchs, famous for their prodigious migratory feats, rests with all three countries. The range of issues related to Monarch survival across such a huge ecological and geographic range includes; maintenance of lowland food plant species in the family Asclepiadaceae (and some Asteraceae), hazards from cropland insecticides, and herbicides that reduce “weeds” that are their food plants. Recently, in the USA, the use of genetically modified (Bt) corn that produces endogenous insecticidal chemicals, has been criticised because of the possibility of affecting non-target Monarchs through pollen spread onto their food plants.

The tall coniferous “Oyamel” forest of the fir species, *Abies religiosa*, in which overwintering occurs in the high mountains of central Mexico is critical to the maintenance of the migratory cycle. is The Biosphere Reserve (BR) created in 1986 with core and buffer zones as is usual for a BR, was expanded in 2000. The *Sierra de Chincua* range has traditionally been available for logging and cleared areas form the basis of small farm fields used by local people. Mexican people live within the broad area around the reserve and come into it for various purposes. Logging is limited and further restriction is under consideration but logging both legal and illegal continues. In the nearby town of Angangeo, tourism related to the Monarch sites, and copper mining are part of the local economy.

The issues of conserving a species of word-wide interest but which depends on three nations (one of which is not wealthy) to guarantee its survival, all arise in the *Sierra de Chincua* reserve. International cooperation and pressures from relatively wealthy nations led to the formation of the BR. The reserve’s integrity depends mainly on Mexico where its governments, at various levels, have to resolve many issues; how to preserve the Oyamel forest, how to limit logging, attract tourism, control visitors who can threaten the overwintering colonies; and how to enable the multi purpose function of human utilisation of some zones in a balanced way, as is envisaged for BR’s.

The subtleties of habitat management are revealed in the research of Alonso-Mejía *et al* (*Biol. Cons.* 1998. 85: 151-159). They measured a significant increase in the rate of predation on Monarchs by native birds in old logged (“cleared”) areas compared with less disturbed forest (“uncleared”). They recommend that further logging be prohibited in the forest habitat areas.

My guide at the reserve headquarters at *Llano de las papas* (“Potato Flats”) was, as part of his honours project, investigating how the presence of Monarchs encourages the several bird predators into the forest. His work and

therefore also, the concept of fixed zoning of the forest for conservation and utilisation, is complicated by the fact that the colonies of butterflies may shift during the season. Birds do prey on the Monarchs although the latter ingest alkaloid toxins from their food plants and render themselves unpalatable and toxic to the birds, squirrels and the one mouse predator that is known. Nevertheless several factors can reduce their toxicity. The last available food plants encountered near the mountains before overwintering, contain relatively little toxin. The mouse and the birds have learned to avoid the wings that contain more toxin, and to intermittently, feed on butterflies. The sun also reduces the toxin's activity and Monarch colonies nearer the less shaded open areas may therefore be more susceptible to predation.

Because a Biosphere Reserve has international status, it seems reasonable that there should also be international recognition that the costs of preserving part of the range of an international migratory species cannot reasonably be borne by only one country (particularly one with a large disparity in socio-economic conditions compared with other partners). An arrangement that reflects the relative GDP's of the three countries that own the Monarch would be seem desirable. The scope of a BR allows for multi-purpose utilisation zones to benefit a broad range of people, in particular, local populations. If the management of the reserve, (*viz.* logging issues) is intrinsically in conflict with their needs and reasonable aspirations, it must be asked if BR status is realistic. Having adopted BR status as a result of international aspirations to preserve such a biological wonder, both national and international visitation to the reserve might be expected to provide an economic benefit to the local people who would be affected by restrictions on land use.

Clearly many local people do benefit by selling services to visitors. The sprawling temporary market camp of food stalls, souvenirs shops, horse stable, corrals and guides provides dusty, smoky tangible evidence of natural market forces at work. (All timber for this seasonal construction of course comes from the forest). As the BR has international status, an estimate of the international economic component of tourism could be valuable in arguing cases for various utilisation scenarios. The reserve staff however, were not aware of any attempts to survey or measure the economic benefit that accrues either from Mexican tourists or international tourists who come to the area. This seemed regrettable as such information could be valuable in gaining support for conservation strategies that carry a cost or penalty for local people. The need for this has recently been recognised through the donation of $US5 mil. to the World Wildlife Fund by the private, U.S. based Packard Foundation to enable further forest to be reserved and compensation for logging foregone to be paid to landholders.

The quiet beauty of the high Oyamel forest where you can actually hear butterflies because of their density in clusters, is managed by local people working as guides. They try to keep visitors from going too close to the colonies which have a group response alarm reaction and move if disturbed. The viewing places are well known, tracks are everywhere and you can walk or ride a horse to reach the Monarchs.

The issues of the conservation of iconic species in countries with limited resources are all here, with the magnificent butterflies. The world's high mountains are often in similar situations. The achievement of international aspirations in locally achievable and acceptable terms will usually require consideration of the issues raised here: biological range across national boundaries, critical habitat in one that is not a wealthy nation, conservation interest in wealthy countries driving reservation, tourism, local requirements for resources and income.

But go to the *Sierra de Chincua* Biosphere Reserve, if you can, and ponder on the marvels of Lepidopteran migration, not forgetting Australia's own Bogong Moth migration and its relationship to aboriginal culture. Wildlife and humanity are linked in both. The *Otomí* people of Mexico once consumed limited amounts of the lipid-rich Monarchs, tolerating the unpleasant toxins and avoiding consuming excessive numbers to do so. In the Mexican cult of the day of the dead, Monarchs were regarded as the returning spirits of ancestors.

The Monarchs are now dependent on human wisdom for their survival in a world of modern hazards that toxins cannot protect against. Preservation of their international migratory habitat is essential in each of three countries. In the relatively underesourced country that Mexico is, while it does what it can, who else should contribute and how?