Southern Connection Congress, Chile, January 1997

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1. Introduction

The primary purpose of my visit was to attend and present a paper at the Southern Connection Congress in Valdivia, Chile. However, I took advantage of being in southern South America to visit a number of National Parks in Chile and Argentina (on annual leave) and to participate in some field work above tree line at Ushuaia, Argentina.

2. Southern Connection Congress

The Congress was held in Valdivia, 6-11 January 1997. There were five days of paper and poster presentations and one day in the field. The major symposia covered a wide range of topics including systematics, biogeography, ecology, conservation and sustainable development. There were two special sessions to discuss: conservation and sustainable use of forest ecosystems, and progress in the southern hemisphere countries in implementing the Convention on Biological Diversity.

2.1 PARTICIPATION

Southern Connection is an organisation of individuals who study all aspects of the biology of the countries derived from Gondwana. The organisation was formed because fragmentation of the ancient Gondwanan land mass has dispersed a common biota and ecosystems, and the scientists who study them are in many far-flung lands with little chance for interchange and discussion of scientific findings. There were 330 participants from 18 different countries, with the greatest representation coming from: Chile 115; Australia 62; Argentina 46; USA 41; and New Zealand 32. South Africa had 7 participants and, with the exception of 2 from Brazil and 1 from Uruguay, the remainder of the participants were from Northern Hemisphere countries. Most of the New Zealand participants were from Landcare Research (10) and universities (16) with other Crown Research Institutes (Forest Research Institute, National Institute of Water and Atmospheric Research, Crop & Food Research, and Hort Research) being represented by one or two people each. I was the only participant from the Department of Conservation.

Whereas some valuable information and insights were gained from listening to presented papers, as always the greatest value of attending this meeting came from the opportunity to interact with participants during the breaks, at social events and on the field trip. Most of my conversations dealt with weed issues in southern hemisphere countries and I benefited from the experience of the

South Africans, who are more advanced in the effective control of woody invasive weeds, especially pines, than we are. I was able to assist Chileans and Argentinians with some of their approaches to weed control. They are at a point that we were at 10-15 years ago where the authorities have not yet grasped the severity of the problems that they face. Also, there was a considerable amount of interest in the Department of Conservation and how we manage our protected lands. Interestingly, I had a greater opportunity to catch up with New Zealanders than I normally do in New Zealand. At home, they are often busy and distracted by work pressure but away from that, in a foreign land, there was more opportunity to discuss their research and the management problems that DoC faces.

2.2 PAPERS

A list of the papers that I heard, with brief notes for some of them, is appended as Section 7.1. I will elaborate on four of them here. The best paper, in my view, was given by Francois Vuilleumier from the American Museum of Natural History, entitled "What biological considerations are relevant to bird conservation in south-temperate South America and how can they be implemented?". Francois introduced the concept of "ghost biomes" in which biomes (biological zones) are so degraded that existing maps depict former vegetation rather than today's vegetation. He investigated the 15 biomes in South America south of 30°S and found that the continued survival of avifaunas associated with the original vegetation of these ghost biomes is considerable. Although the few remaining unmodified patches of vegetation are crucial to conserving the diversity of bird species in any biome, a more productive strategy is to preserve large samples of ghost biomes that will include all species reflecting the avifauna of former vegetation.

Francois illustrated how all biomes are modified in different ways, with an example of Patagonian steppe managed by adjacent farmers in different ways; the contrast on either side of the fence was striking. Exactly the same situation exists in New Zealand, where all of our biomes are ghost biomes and we have suffered great losses of avifauna from them. In contrast with South America, though, many of our valuable ghost biomes are protected and managed as public lands. Most are on private land in South America and the challenge is to establish conservation reserves. A start has been made with one of the largest protected areas, the Rio Negro Reserva Natural in Argentina, being established by a sheep farming landowner who hired a team of people to investigate the natural values of the native vegetation remnants on his estancia and advise how best to retain them in perpetuity.

In addition to the message imparted in Francois' talk he illustrated many of the species he mentioned with his own charming colour drawings. He also described how much more one can learn by getting out and observing nature rather than reading about it in other people's manuscripts and reports. He was speaking from experience.

Gene Likens from the Institute of Ecosystem Studies, Millbrook, New York, presented a salient paper on "Discovering long-term changes in ecosystem structure and function". The key point from this paper was that collecting data over the long term (>10 years) provides an opportunity to interpret ecosystem changes more accurately than if data are collected over the short term (3-5 years). Short-term data can be very misleading. At Millbrook the elemental composition of rainwater has been analysed annually since 1963. There has been a significant decrease in H^+ concentration in that time, but it took 18 years for a significant relationship to become apparent and over that time there have been sharp and gentle increases in H^+ concentration. Other declining ions were SO_4, Ca and Mg, but NO_3 has increased. The drop in Ca and Mg appeared to be related to changes in regulations on emissions from cement factories. As a result of these studies and other studies which show that forest growth at Hubbard Brook is slowing down, the scientists plan to investigate whether Ca is limiting forest growth.

Gene outlined the basic requirements of long-term monitoring in a series of points (Likens 1997):

1. Continuous data sets must be constantly updated, scrutinised for errors and rigorously reviewed.
2. Methods and procedures should be standardised to the extent possible, and intercalibrated with other organisations or individuals doing similar studies. Calibration of analytical results should be done by comparison against standardised samples.
3. Full data sets should be stored in at least TWO separate locations to avoid accidental loss.
4. Analytical methods or collection procedures should not be changed without fully testing the effect of the new procedure on the long-term record.
5. Methods or procedures developed for one location or study should not be adopted for another area or study without careful testing and justification.
6. The best frequency for sampling in a time series should be determined on the basis of the questions addressed and from analysis of results.
7. Plots and other study sites should be marked and identified permanently. Detailed descriptions of the area and the methodology should be on file in more than one location. Sufficient detail should be provided so that other investigators could reproduce calculations, methods, etc., at some later date.
8. Appropriate and adequate controls must be established at the beginning of the study.
9. Provision should be made for the long-term storage of samples.
10. Stability, interest and dedication of responsible individuals, institutions or agencies are critical to success of long-term studies.
11. Funding should be sustained and reliable.
12. Long-term data sets should be used to answer questions.

All of these points are relevant to the core business of DoC. Some of us do some of the above but as an organisation we do not do all of them. In New Zealand it is possible to fulfil point 3, for some data, in a sensible fashion: for example, the National Vegetation Survey (NVS) database is maintained by Landcare Research.

This is the primary repository for all permanent plot vegetation data collected in New Zealand. Copies of data should be sent and held there and originals retained by the collection agency. Also, the National Bird Banding Office is maintained by Science & Research Division of DoC. Here records of all band details and sightings of banded birds are maintained, with original records kept by the observer. There are many other examples of national databases which we are or should be contributing to.

Other relevant points that Gene made were:

- long term data are essential for policy development;
- there are no simple answers to complex environmental questions;
- the most important component of successful sustained long-term monitoring is the dedication of one or two people to the programme;
- monitoring should be relevant to ecosystem processes;
- a catchment or ecosystem scale is appropriate for most long-term studies.

DoC is in the business of long-term monitoring, and the recent advent of "mainland islands" has focused attention much more on monitoring methods and data collection. We should learn from the experience of those who have been in the business for more than 30 years, especially in terms of the requirements for long-term monitoring.

Another paper relevant to DoC's work was presented by Jerry Franklin, University of Washington, Seattle, about "Conservation in the matrix". Jerry defined the matrix as the unreserved or managed part of the landscape which provides habitat, connectivity, and goods and services. The matrix generally dominates the landscape, and water is one of the most important services/goods of the matrix. Like Francois Vuilleumier, Jerry stated that conditions in the unreserved portion of the landscape matrix are critical to successful conservation strategy because most populations and their habitats occur in the matrix. There is a need for buffers along streams and around wetlands, and reserves have to include some of the most productive forest lands. I am reminded here of Geoff Park's book "Nga Uruora" and Philip Simpson's draft restoration strategy for Wellington Conservancy. It would be fair to say that, in DoC, the basic principles of restoration ecology are well understood, and through the PNA programme we are attempting to describe and make best conservation use of the matrix. In New Zealand, the matrix, as defined, is chiefly a feature of lowland areas.

My own paper (see summary appended as Section 7.2) was entitled "The impact of invasive plants on plant communities in New Zealand". I began my talk by asking three questions which the audience answered with a show of hands:

1. Who came to Chile from another country?
2. Who went on the field trip on Wednesday?
3. Who cleaned their boots thoroughly before entering Chile?

Equal numbers of people put up their hands in answer to the first two questions (c. $^2/_3$ to ¾ of the people in the room) but less than half of the people in the room raised a hand in answer to my third question. My comment at this stage was that this sample of people (who should know better!) had just supported one of my concluding statements: that "people are a problem". In my 15 minute talk I developed two themes:

1. The responsibility of humans for creating opportunities for invasions to occur and for mitigating against those invasions.
2. The loss of biodiversity which is the inevitable result of invasions.

I used the DoC weed database developed by Susan Jane Owen and others as the basis for my talk. My talk was well received but, unfortunately, it was scheduled for the last session of the last day so the opportunity for feedback was severely limited.

2.3 FIELD TRIP

The one-day field trip was to Puyehue National Park in the Lake District, featuring two dominant volcanoes - Volcan Puyehue (2236 m) and Volcan Casablanca (1990 m). This location was chosen because of the altitudinal sequence from mixed broadleaved forests (Valdivian rainforest) to tree line and alpine shrublands. Three stops to examine the vegetation associations were organised, and the four busloads were rotated about those stops.

My bus proceeded to halfway up the road to the *Pilgerodendron* bog at 700 m. Here, the park rangers had cut a track from the road edge through dense bamboo beneath towering podocarps and broadleaved trees to an open bog fringed by *Pilgerodendron uviferum*, a conifer very reminiscent of our *Libocedrus bidwillii* in its growth form. What we took to be seedlings of this species growing on hummocks in the bog were, apparently, sprouts from rhizomes of the trees around the bog edge. Other species fringing the bog were *Nothofagus antarctica* and *N. betuloides*, *Embothrium coccineum* and *Drimys winteri.* The bamboo (*Chusquea*) present in the bog was a different species from that in the adjacent forest understorey.

Our visit to the Park was on a wet day, with passing heavy showers, and the ground beneath the forest was saturated. The passage of 30-40 people over the recently cut track created numerous bare slippery patches. However, I gained the impression that the ground cover and understorey would repair itself quickly once the human onslaught of the day had passed.

Our next stop was at the top of the road at Antillanca ski resort, a very impressive facility in a Scandinavian style. We walked up a ski run, now devoid of snow, through the *Nothofagus antarctica* and *N. pumilio* forests to tree line. In the middle of open scoria fans, near tree line we observed *Gunnera magellanica* and *Embothrium coccineum*. *Rhacomitrium lanuginosum* is a coloniser of open areas there, as it is in New Zealand. We got a lift on the back of a ranger's truck to the edge of a crater on Volcan Casablanca, at c. 1400 m. Here the wind was blowing strongly and the mist swirled across the crater, lifting occasionally to reveal the herbaceous vegetation which has colonised the area extensively. *Pernettya pumila* was one species that we recognised, but the rest were interesting blue-, red- or yellow-flowered herbs unfamiliar to us.

Back down at the ski resort we observed *Hieracium praealtum* beginning to colonise the edge of an artificial pond. However, this was the only potentially invasive weed that we were aware of during the field trip.

Our final stop was down near the entrance to the park at c. 450 m. We took Los Pioneros trail through the Valdivian rainforest to c. 600 m and a lookout over the valley. One of the most impressive species was *Dasyphyllum diacanthoides* (trevo), a huge tree in the daisy family, which has a trunk up to 2 m diameter and height of c. 40 m. Many specimens were perched on top of huge boulders (which are assumed to be glacial erratics) with huge clasping roots going down into the soil. It was not clear whether the trevos germinate and grow on top of boulders or whether the trees we saw were of such an age that soil erosion had left the boulders with the trees perched on top.

A number of plant genera were very familiar although the species were different, e.g., *Uncinia*, *Luzuriaga*, *Aristotelia*, *Weinmannia*. Again bamboos were dominant in the understorey, in patches. Where bamboo is present it forms a dense monoculture, but where it is absent there is a diverse understorey of herbs and shrubs, many with bright red flowers.

At the end of the day, we had seen many new plant species and different vegetation associations but the vegetation zonations and many of the plant genera and families were very familiar too, as would be expected given the common origin of the New Zealand and Chilean floras and vegetation.

2.4 WEEDS OF VALDIVIA

During the week in Valdivia, Peter Johnson (Landcare Research, Dunedin) and I took the opportunity to observe and note down the plants cultivated in gardens as well as the urban weeds along roadsides, waterways, and in parks. In the garden at our hospedaje we recorded 106 cultivated ornamentals, and only three of those species were not common in gardens in New Zealand at comparable latitude/altitude. A number of New Zealand natives were among the ornamentals - species of *Leptospermum*, *Pittosporum*, and *Hebe*, as well as *Phormium tenax* and *Cordyline australis*. It was unusual to see the latter two species without the characteristic leaf edge damage caused by their own suite of associated herbivorous invertebrates. *Cordyline* was used, invariably, as specimen tree, planted in pride of place at the front of the property.

The similarity of the weed flora with that of middle New Zealand was striking - gorse, broom, willows, buttercups, annual poa, Yorkshire fog, cotoneasters, etc. We recorded c. 90 species and only seven of those were species which we do not recognise as naturalised in New Zealand (yet). We had to remember where we were while compiling this list because there are a few South American species which are weedy here but, of course, are native to Chile, e.g., Darwin's barberry (*Berberis darwinii*).

2.5 NEXT SOUTHERN CONNECTION CONGRESS

The next congress will be held at Lincoln University in January 2000. It will provide a valuable opportunity for more DoC staff to interact with scientists and science advisers to managers from other southern hemisphere countries. It was agreed at the congress in Valdivia that the meeting would be held in South America every second time to give the South Americans greater opportunities to interact with and learn from scientists from countries who are better supported financially and legislatively. The programme as it is now set is: Lincoln, New Zealand 2000, Argentina 2003, South Africa 2006, Chile 2009, Australia 2012, Argentina 2015, New Zealand 2018, Chile 2021, etc.

3. Tour of National Parks

From 11 to 25 January I visited National Parks in Chile and Argentina in the company of Alan and Pat Mark, Kath Dickinson, Jan Allen, and Rob Smith. Alan organised the itinerary to cover the best of the National Parks in southern South America.

Our first visit was to Volcan Osorno, a massive volcanic cone with fine scoria slopes gradually being colonised by *Nothofagus.* Normally the sun beats down on to the black scoria screes, and a thousand biting tabanid flies (like horse flies) come out to persecute hapless warm-blooded mammals. But, as we stepped off the bus at Petrohue, it began to rain and proceeded to pour as we made our way up the mountain slopes. When we were out on the scoria fans the rain was torrential and so heavy that it couldn't soak into the scoria fast enough and created a white sheet of water flowing down the slope. We were all soaked by this stage and headed down for some shelter in which to eat our lunch. Through the deluge, though, we were able to observe the classic colonisation of open volcanic slopes, as exemplified on Rangitoto Island but involving a different range of species except for the cosmopolitan *Rhacomitrium lanuginosum*.

From Puerto Montt we headed for Alerce Andino National Park via Lago Chapo, a hydro lake, and then back through the small settlement of Corrientosa to a camping ground with just a few other people in it. Next day we walked from the park headquarters into some stands of alerce among the rainforest. Alerce is *Fitzroya cupressoides*, a South American endemic cypress which is the largest and longest-living conifer in Chile and Argentina. Some trees have been recorded as over 3600 years old. In the rainforest, the alerce grows in stands on the poorer soils, surrounded by other tree species such as the red-flowered *Crinodendron hookerianum*, *Podocarpus nubigena, Caldcluvia paniculata* and *Amomyrtus luma.*

The track in this park was very reminiscent of Stewart Island substrates, without the boardwalk - very soft and lots of muddy puddles. We went along this track the same day as one busload of people who were on the post-congress tour, but we didn't see or hear them all day, although we could see where they had been on the way out. It was interesting to see *Gunnera chilensis* (Chilean rhubarb) colonising stony debris fans, within the forest, formed by landslides. Apparently this species, like the *Coriaria* it associates with, is capable of fixing nitrogen via bacteria in root nodules.

After another night camping by the park we headed for the airport at Puerto Montt (lat. 42°S) and flew south to Punta Arenas (lat. 53°S). In New Zealand terms this is the equivalent of flying from Reefton to south of Campbell Island. We took a bus north to Puerto Natales and spent the next day on a bus tour of Torres del Paine National Park. The vegetation here is mainly pampas, a lot of it fire-induced, and *Nothofagus* woodlands or forest, principally *N. antarctica* and *N. pumilio.* A characteristic feature of some of the beech stands was the pale green strands of a mistletoe, *Missodendron*, hanging from the branches. The pampas was very low fescue-like grasses with low shrublands of often spiny, dense shrubs including a range of *Berberis* and *Escallonia* species. From the bus window we saw several groups of guanaco (related to llama) and rheas. Occasionally we would spot a condor circling high on the thermals, and the odd fox (introduced) could be seen slinking behind a bush. The countryside offered vast panoramic views, somewhat reminiscent of the South Island high country.

The following day we went by boat up the Seno Ultima Esperanza to view the Balmaceda Glacier, which comes down from the Patagonian ice cap to the sea right at the southern end of the mainland Andes. Evidence of clearance of the beech forests was abundant at the southern end of the sound, but towards the head of the sound it was more natural There were estancias all the way up, on both sides of the sound, and the northernmost one that we saw had a magnificent view across the sound to Torres del Paine, c. 45 km distant.

We got off the boat at the Serrano Glacier, a small tongue of ice east of the Balmaceda, which flows into a small lake. The track from the jetty went over the terminal moraine and along the edge of the lateral moraine to the head of the lake. The lake was fringed with *Nothofagus betuloides.* We saw *Gunnera magellanica* fruiting, as well as a *Leucopogon* and *Berberis.* There were nodding yellow flowers on a *Calceolaria* by the track, and a *Poa* which germinated its seeds while they were still on the plant (viviparous). It was a delightful walk amongst vegetation which was different from others we had seen.

Next day we crossed the border into Argentina and found a camping ground in El Calafate (Spanish for barberry) on the southern shore of Lago Argentino. The following day we took a bus to the Perito Moreno Glacier, a vast wall of ice that calves into an arm of Lago Argentino called Canal de los Tempanos. The glacier often advances on to the point of land where we were standing, cutting off the arm of the lake and causing the water level on the south side to rise. Eventually the pressure of water becomes too great and the ice gives way, causing a great rush of water down the rest of the arm and into the lake proper. A bare zone c. 12-15 m above the current water level indicates the height to which the water rises in the cut-off arm.

The Perito Moreno Glacier is at the southern end of Parque Nacional Los Glaciares and we headed next for a camping ground in El Chalten at the northern end of the park. The impressive towering columns of Cerro Fitzroy and Cerro Torre are here on the edge of the Andes. The track to Cerro Fitzroy goes through mainly *Nothofagus pumilio* forest of different stature - some very tall

(c. 18 m) and others short and shrubby. Many plants were flowering, including a yellow *Viola*, a *Calceolaria*, *Geum*, pink *Geranium*, *Escallonia rubrum*, and several species of *Missodendron.* As we returned to the campground we passed several groups of climbers heading in, with pack horses carrying most of their supplies.

We had two full days at El Chalten, experiencing the local foehn wind, which swept down from the mountains and gusted through the branches of the beech trees in the campground (just like a Canterbury nor'wester, strangely enough).

From there we returned to El Calafate and the next day took the bus to Rio Gallegos near the Atlantic coast. From there we flew across the Magellan Strait to Ushuaia, on the southern side of the island of Tierra del Fuego. The northern part of Tierra del Fuego is flat Patagonian pampas, as it is around Rio Gallegos. But as the land becomes more hilly, south of Rio Grande, the beech forest becomes dominant. Near Ushuaia the beech forest goes from sea level, on the Beagle Channel, to c. 600 m.

Parque Nacional Tierra del Fuego is the southernmost National Park in the world. It is west of Ushuaia and abuts the border with Chile. We visited a bog by the Rio Pipo which was full of different species of *Sphagnum*, including the red *S. magellanica. Nothofagus antarctica* grew on hummocks with *Empetrum rubrum*. (Outside the National Park, sphagnum is harvested from bogs, but not in an obviously sustainable fashion.) Further on towards the Chilean border we pulled up at a lake edge just as a rain shower began. With the beech forest around the lake edge and the rain falling across the lake, it looked just like Fiordland. However, a number of beech trees by the lake shore had been felled by beavers. These mammals have been introduced to Tierra del Fuego, and, while the park staff undertake some control, there is no programme to eradicate them.

The most consistent feature of the National Parks we visited in Chile and Argentina was the inconsistency in the manner in which they were run. The entry fees varied from free to c. US$20.00. At some parks there was one Guarda Parque and in others there were many. Most of the "management" seemed directed at processing the visitors - getting passport numbers and fees, and occasionally providing toilet facilities. The few tracks that we went on seemed fairly well maintained. Interpretation material was usually in the Guarda Parque headquarters and in a fairly old-fashioned style. The most popular park that we visited was Parque Nacional Los Glaciares, both at the Perito Moreno glacier and at El Chalten.

4. Ushuaia fieldwork

The purpose of this work was to document the vegetation from tree line (*Nothofagus pumilio*) to the ridge tops on either side of the valley below the Martial Glacier. This Glacier has receded substantially and is behind Ushuaia at the end of a road leading to a ski field. The walk up to tree line from the road end takes c. 1 hr. It is a popular walk with locals and visitors who take the chairlift to tree line, once it starts operating at 10 a.m.

The first stage of the work was to become familiar with the vegetation, which we did by taking small samples of the plants that we saw and sellotaping them into a notebook so that we could refer to them and use them for identification. Each plant had a tag name until we were able to obtain the true name. This was not too difficult an exercise, as many of the genera were familiar to us, and Alan Mark already had some experience of the flora.

Sampling consisted of one 10 x 20 m quadrat randomly located within each 50 m altitudinal band on each side of the valley, starting at tree line and finishing at the ridge crest (some 800 m of altitude). Within each quadrat we estimated the percentage cover of each species present, as well as bare ground or rock. There was great diversity among the cushion plant species, including *Bolax* spp., *Empetrum rubrum*, *Saxifraga* spp., *Phyllachne*, *Gaultheria.* There were small shrubby herbs belonging to *Senecio* and a spiky-flowered plant called *Nassauvia,* as well as a tiny *Viola.* We found three genera of ferns - *Grammitis poepigiana*, a *Polystichum* and two tiny *Hymenophyllum* spp. which lived amongst the cushion plants.

There were some interesting lichens, too, including some, like *Thamnolia vermicularis*, which grow in New Zealand as well. The most abundant lichen was a species of *Neuropogon* which covered the stones of the scree slopes, indicating by its abundance just how quickly the stones in the scree were moving. Amongst the cushion vegetation there were species of *Peltigera*, *Pseudocyphellaria*, and *Cladia*. In the stream and seepages were mosses and liverworts of all shades of green and red.

The first part of the week was spent doing the field sampling and the last two days were devoted to gaining access to and using the herbarium at CADIC (the scientific organisation that we were staying at) and the private herbarium of Natalie Goodall which was in her house in town. Those two herbaria plus the "Flora of Tierra del Fuego" by Moore (which is very out of date) were our tools for identification of the c. 90 plant species that we had come across. We were able to make good progress though and had identified c. 90% of the species in the time we had. I suspect the the two little *Hymenophyllum* species have not been collected from this location before and, as they were not fertile, they will not be able to be identified.

5. Acknowledgements

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Thanks to Eduardo Villouta who was in Chile before and during this conference for his help with internal travel arrangements and tips on how to survive in

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7. Appendices

7.1 PAPERS ATTENDED AT SOUTHERN CONNECTION CONGRESS, VALDIVIA

On most days there were three concurrent sessions, but at one stage there were four, and sometimes there was just one. Therefore, not all papers are recorded. The pepers are presented in the order in which I attended them. I have made brief notes where they might be of interest to DoC staff.

Peter Bannister et al., Otago University. "The water relations of *Ileostylus micranthus* (Loranthaceae), a New Zealand mistletoe." *Ileostylus* obtains water and nitrogen from the host xylem. Water use efficiency of the mistletoe tends to be less than that of its host on N-rich hosts. The mistletoe shows a more limited range of responses than its host to changes in water availability.

Kathy Weathers, Institute of Ecosystem Studies, Millbrook, USA. "Cloud water in southern Chile: is it an important source of nutrients?" Cloud water is more acid and nutrients are more concentrated than in rain water.

Francesco Squeo, Universidad de La Serena, Chile. "Plant water relations of coastal desert shrub species from north-central Chile". There are three potential water sources in the coastal desert: rain, deep water, and fog. The average annual rainfall for La Serena has dropped from c. 160 mm to 80 mm during the course of this century. Shallow-rooting shrubs are likely to be more affected by this trend than deep-rooting ones.

Chris Lusk, Universidad de Talca, Chile. "Foliage and nitrogen dynamics in juvenile temperate rainforest trees of differing shade tolerance." Shade tolerant species do not appear to require more nitrogen than other species but, taking their crown leaf area into account, there is more nitrogen in the canopy of shade tolerant species. The life span of leaves of shade tolerant species is longer than other species and leaf life span is strongly correlated with soil fertility: long life spans on poor soils.

Kath Dickinson, Victoria University. "Epiphytes in a southern temperate rainforest, South Westland, New Zealand." Branch angle and diameter are strongly correlated with epiphyte community type.

Stephan Halloy, Crop & Food Research, Invermay. "Cloud epiphyte communities in the Amboro National Park, Bolivia." Epiphyte communities differed between two tree species and the epiphyte community is distinct from the forest tree community in terms of leaf morphology.

Carlos Rapela, Universidad Nacional de La Plata, Argentina. "Geological Evolution of Patagonia during the 'Gondwana Supercontinent Stage'."

E. Romero, Universidad de Buenos Aires, Argentina. "Fossil terrestrial flora and biogeographic history of southern South America."

Peter Weston, Royal Botanic Gardens, Sydney. "Cladistics of a key woody group: Proteaceae." The genera or tribes of Proteaceae have strongly disjunct distributions suggestive of Gondwanic origin of the family.

R. Pascual, Universidad Nacional de La Plata, Argentina. "Fossil land mammals and the geobiotic history of southern South America." South American mammals have passed through three main stages, represented by geological changes undergone in the South American continent: Stage 1 - Cretaceous; Stage 2 - Sth American; Stage 3 - neotropical.

B. Santelices, Pontifica Universidad Catolica de Chile. "Reevaluating the individuality in multicellular organisms."

C. Heuser, Tuxedo, USA. "Vegetation and paleoenvironments of southern Chile over the past 50,000 years." There is a large amount of cycling of vegetation types over time in southern Chile. Main study site on Chiloe.

Peter Kershaw, Monash University, Melbourne. "Regional patterns of climate and vegetation in the late Quaternary of mainland southeastern Australia." The maximum extent of forest was during the climatic optimum 6000 yr BP.

Mike Macphail, Australian National University, Canberra. "Late Quaternary vegetation of Tasmania: spatio-temporal changes and their relation to climatic changes."

C. Villagran, Universidad de Chile. "Historical biogeography of southern South American forests." 90% of vascular plants are endemic to South America.

Vera Markgraf, University of Colorado, USA. "Character, timing and forcing of late Quaternary climate change in southern South America." Investigations reveal similar patterns in South America, New Zealand and eastern Australia where there is continuity of species presence as long as climate changes are not too great or abrupt. Different mechanisms of climate change may have operated at different times.

R. Villalba, Columbia University, USA. "Dendroclimatology: a southern hemisphere perspective."

E. Ezcurra, Universidad Nacional Autonoma de Mexico. "Amphitropical disjunctions in American deserts: the genus *Larrea* (Zygophyllaceae) and the Cactaceae as case studies." Tribes of Cactaceae have evolved separately in North and South America. Columnar species are very sensitive to frost whereas the other groups (pereskioid, opuntioid, and globose) are more sensitive to rainfall, particularly the % of summer rainfall.

John Hickey, Forestry Tasmania. "Fire ecology of wet temperate forest ecosystems of south-eastern Australia." The general tenet is that, when fire comes in, the Gondwanan conifers go out, e.g., *Lagarostrobos* and *Athrotaxis*. Rainforest may be more fire-resistant than previously realised. Burnt rainforest can recover.

John Ogden, University of Auckland. "A review of the incidence and significance of fire in the control of vegetation patterns in New Zealand." Fire has been a feature of the forests of both islands since the last glacial maximum. There is a natural oscillation with climate between forest domination and other types of vegetation. In the last glacial, grasslands, heathlands and shrublands dominated, whereas in the last interglacial, beech, kauri and podocarp/hardwood forests dominated. There have been regional fires at intervals of centuries.

Antonio Lara, Universidad Austral de Chile." Fire and the dynamics of Alerce (*Fitzroya cupressoides*) forests in the Cordillera Pelada, Chile." Fire events have been dated using the fire scars of this long-lived conifer.

Dave Kelly, Canterbury University. "Ecological and biogeographical implications of explosive flowering in New Zealand Loranthaceae mistletoes." So far three species of native bee have been recorded opening *Peraxilla tetrapetala* flowers (but not *P. colensoi*). Also, a native caterpillar eats the insides of the flowers, which darkens them so the birds don't open them.

Alan Watson-Featherstone, Trees for Life, Scotland. "Ecological restoration of the Caledonian forest in Scotland, and its relevance for the forests of the southern hemisphere region." Opening line: "Forests precede civilisation, deserts follow them". The Caledonian forests are reduced to 1.1% of their original area. All natural predators have been exterminated, so browsing pressure from deer and sheep is too severe to allow regeneration of Scots pine seedlings. Restoration includes setting up exclosures near seed sources and planting and protecting seedlings in areas where there are no seed sources.

Wendy Sysouphat, University of South Australia, Adelaide. "Ethnobotanical aspects of conservation." Education is a key component of the South Australian ethnobotany programme, working in partnership with local indigenous people.

David Aagesen, University of Minnesota, USA. "Effects of human activity on the distribution and conservation of *Araucaria araucana.* "

Antonio Lara, Universidad Austral de Chile. "Mapping and monitoring of vegetation in Chile as a tool for adequate resource management." GIS layers include land use, elevation, slope, aspect, hydrology, National Parks, roads. The smallest unit for mapping is 6.25 ha.

Mary Arroyo, Universidad de Chile. "Maintaining biodiversity and ecological sustainability in the Rio Condor forestry project, Tierra del Fuego: concepts and concrete actions." Described how some areas will be reserved while others are logged. Areas for reservation are relatively large and represent the range of diversity on the site. Omitted to mention that the whole forest in Chile is adjacent to Parque Nacional de Tierra del Fuego, across the border in Argentina.

Jan Williams, Charles Sturt University, Australia. "Certification of forest management: a review of policy and practice." Certification has potential as a tool to promote sustainable forest management.

Peter Wardle, Landcare Research. "Alpine timberlines in New Zealand and the southern Andes." Comparison of climate records for stations in New Zealand and S. America with comparable altitude, latitude, distance from the coast, etc., shows that temperatures in S. America are consistently lower by 1-2°C, yet timberline in S. America is higher than in New Zealand.

Alistair Robertson, Massey University. "*Myosotis* and *Ranunculus* and the age and origins of New Zealand." *Myosotis* has limited dispersal ability - the nutlets fall out of the calyx.

Peter Williams, Landcare Research. "The relationship between subalpine to alpine flora and environment in western Nelson, New Zealand." Species distribution is most closely linked to geology, with most species on the richer rocks. Most species would not be present without high fertility and diverse sites.

John Carter, Victoria University of Wellington. " Phytoliths and the use of phytolith analysis in paleoenvironmental reconstruction." Phytoliths are aggregations of silica which are formed in plant foliage and stems and are resistant to decomposition in many environments over a wide time period. They have recently been extracted from 400 million year old soils. Phytolith analysis is now at the stage that pollen analysis was in the 1930s.

Geoff Hope, Australian National University, Canberra. "Human impact and natural vegetation stability in the tropical south-west Pacific". Gondwanan floras extend into tropical regions, e.g., *Nothofagus* forest in Irian Jaya. In some tropical areas, such as Papua New Guinea, fires have been lit almost since the last glacial period. Sites with >8000 mm of rain are most likely not to have a fire history.

Eddie Rapoport, Universidad Nacional de Comahue, Argentina. "Are animals better colonisers than plants?" With increasing area, the number of exotic plant species increases arithmetically, whereas the number of native plant species increases geometrically. Generic pollution is usually greater than specific pollution. In Britain, London has the highest degree of weed invasion, with 78.2% of the flora being exotic. Elsewhere the maximum concentrations of exotics are in cities and ports. Eurasian weeds are so successful because they are adapted to disturbed agricultural environments. A comparative analysis of strategies concludes that animals are better colonisers of stable, low-disturbance habitats, while plants are better colonisers of disturbed, especially anthropic, habitats.

Barry Fox, University of New South Wales. "The impacts of animal invasions in temperate regions of Australia." Has derived a six-point scale to record abundance and distribution for exotic mammals: 5 = widespread and abundant; 4 = localised and abundant; 3 = widespread and in small colonies; 2 = localised and in small colonies; 1 = present in small numbers; 0 = not present. Rabbits occupy >800 islands around the world. They are absent from South Africa because of active efforts to keep them out.

Marilyn Fox, University of New South Wales. "Ongoing biological invasions of Southern Australia - consequences of late colonisation of a Mediterranean type ecosystem." A Mediterranean climate is winter rainfall and summer drought. Fabaceae, Asteraceae, Chenopodiaceae and Brassicaceae are the major dicotyledon weed families and Poaceae and Iridaceae the major monocotyledon weed families in Mediterranean South Australia.

John McLennan, Landcare Research, Havelock North. "Impact of mammalian predators on kiwi (*Apteryx* spp.) in New Zealand forests." Nest protection by males has evolved to avoid predation by birds, e.g., weka. Predation of eggs is low - most egg deaths are caused by pathogens. Predation plus other causes result in 95% mortality of kiwi chicks. At this low rate of recruitment, populations are declining. Modelling indicates that 19% chick survival is required to maintain populations. Mustelids and cats are the main predators, and effective methods of stoat control are a high priority.

Doris Soto, Universidad Austral de Chile. "Introduced salmon in southern South America: present and future effects." Introduced salmonids include brown and rainbow trout and Pacific, Atlantic and chinook salmon. More than six million salmon have escaped from farms, especially during storms in 1989. In Chile there is probably no single lake without trout. As lakes eutrophy (measured by chlorophyll content) piscivory by trout increases. Chilean rivers and lakes are beginning to resemble northern hemisphere lakes and rivers in the preindustrial era. Spawning salmon deliver significant amounts of marine-derived nitrogen and carbon as nutrients to rivers and streams.

Dave Richardson, University of Cape Town, South Africa. "Pines as invasive aliens in the Southern Hemisphere: why some species have invaded some habitats and what can be done to deal with the problem." In their natural range, pines dominate on sites with poor soils. Pines were introduced to South Africa c. 1680, Australia c. 1780 and New Zealand c. 1830. Pine planting in the southern hemisphere has increased since WW II. *Pinus radiata* is one of the 10 most important species in plantations. Others are *P. elliotii*, *P. patula* and *P. oocarpa*. In New Zealand, the following species have been planted widely: *P. banksiana, contorta, halepensis, mugo, muricata, nigra, patula, pinaster, ponderosa, radiata, strobus, sylvestris, taeda*. Those which have naturalised extensively are underlined. In the southern hemisphere 19 species of pine are substantial invaders. The species that cause the greatest problems are generally those that have been most widely planted and for the longest time, and the most impacted areas have the longest histories of intensive planting. Predictive models have been developed for "pioneer pine" species, e.g., *P. halepensis* and for "late-seral pine" species, e.g., *P. sylvestris*.

Steward Pickett, Institute of Ecosystem Studies, Millbrook, USA. "The flux of nature: changing views of ecology and resource management." Went through some old paradigms, e.g., systems are closed, systems are self-regulating, succession is deterministic, disturbance is an exception, humans are not part of nature, and suggested that these old assumptions be thought of as one end of a continuum. He calls this set of assumptions the "equilibrium" paradigm and promotes a new paradigm called the "nonequilibrium" paradigm. This contemporary paradigm is captured in the metaphor of "flux of nature", and requires management that takes spatial and temporal heterogeneity and probability in ecological systems as fundamental and crucial to success. Natural flux takes time and money. In today's world, time is money and space is rare. Natural flux has limits, e.g., evolutionary history, malleability of systems, genetic variability, rates of change. However, human-induced changes are now extreme.

Mary Willson, Forestry Sciences Laboratory, Juneau, USA. "Endemic birds of south-temperate rainforests in Chile." Investigated forest patch size and bird species diversity. Found that 5 m wide corridors of forest will work on Chiloe providing they are very dense.

Pablo Marquet, Pontificia Universidad Catolica de Chile. "Conservation ecology of small mammals in temperate ecosystems: local to regional scales." Many of the small South American mammals are specialists with narrow ranges and are, therefore, vulnerable. Species assemblages of rodents are unique combinations, most combinations being observed only once.

Stephen Hopper, Kings Park and Botanic Garden, Perth. "A Gondwanan perspective on the conservation of southern western Australian biota." In Western Australia the diversity of vascular plants is far greater than for nonvascular plants, e.g., 194 lichen species cf. Acacia 560 spp. and *Caladenia* 91 spp. Of 12,000 species of vascular plants, 1100 are exotic weeds introduced since 1826. Locally sourced material is essential for restoration work, or it will fail.

John Hickey, Forestry Tasmania. "Testing sustainability in Tasmanian commercial forests." Tasmania has high levels of forest reservation but sustainability indicators need to be developed. The Tasmanian Forest Agreement supports investigations for reservation. Some *Dicksonia antarctica* have been aged up to 1000 years old.

Hal Mooney, Stanford University, USA. "Responses to global change: north versus south." When plants get more carbon dioxide they use less water. Thus, with global warming, water regimes could change. Fire climates will become more severe. Continuing invasions will lead to changing biota. Economic patterns may be more important than population pressures on ecosystems.

Peter Meserve, Northern Illinois University, USA. "The interplay of biotic and abiotic factors in a semiarid Chilean community: results of a long-term ecological experiment."

Colin Bale, University of New England, Australia. "Floristic dynamics of *Nothofagus moorei*-dominated forests." Seedling recruitment of *N. moorei* is poor throughout its altitudinal range and appears to be associated with site disturbance.

John Turner, Newcastle, Australia. "Trees associated with *Nothofagus moorei* at the southern end of its range, Barrington Tops, New South Wales." Some Gondwanan species and some of tropical origin are associated with *N. moorei*.

H. Jimenez, Universidad de Chile. "Floristic patterns in forests on the Rio Condor property, 54°S, Tierra del Fuego, Chile." The three beech species at this latitude are: *Nothofagus pumilio* - lenga, *N. antarctica* - nirre, and *N. betuloides* - coigue.

Mario Rajchenberg, Centro de Investigacion y Extension Forestal Andino Patagonico, Argentina. "A synopsis of polypores (Fungi, Basidiomycotina, Aphyllophorales) from the subantarctic forests of Argentina." Fungal spores germinate to form primary mycelium. These mycelia can mate if they are sexually and genetically compatible. A secondary mycelium is formed and can be recognised by the clamp connections on the hyphal threads. Spores from different fungi can be germinated together, and the degree of compatibility assessed. This is a useful way of checking the species status of fungi from different countries. In Argentina there is a high proportion of brown rotting species.

Gabriella Hassel de Menendez, CONICET - Museo Argentino de ciencias Naturales "Bernadino Rivadavia", Argentina. "Life strategies and distribution of southern South American hepatics." In evergreen forests there is not much litter, so hepatics are abundant on the forest floor. But in summer-green forests there is much more litter and far fewer hepatics: evergreen, hepatics 225, mosses 70; summer-green, hepatics 41, mosses 92. Shuttle species of hepatics grow on trees which change their bark. In southern South America there are 518 species of hepatics of which 418 are endemic and most are dioecious.

Renata Hildebrand-Vogel, Institut fur Landschafts-oekologie Munster, Germany. "*Notbofagus pumilio* forests - vegetation and ecological differentiation." There is a set of c. 14 species common to lenga forest from north to south (35° 35' - 55°S).

Jenny Chappill, University of Western Australia. "Systematics of *Jacksonia* (Leguminosae)."

Steve Wagstaff, Landcare Research, Lincoln. "Evolution and biogeography of the *Hebe* complex (Scrophulariaceae) inferred from its rDNA sequences." Members of the *Hebe* complex comprise a putatively monophyletic group of 6 genera that are distributed from eastern Australia and New Guinea to the Falkland Islands. Indications are that the *Hebe* complex evolved in the mountains and later radiated into the surrounding lowlands.

Ilse Breitwieser, Landcare Research, Lincoln. "The genera of the New Zealand gnaphalioid Compositae." Most genera in this group have been incorrectly placed in northern hemisphere genera, but detailed study of plant characters and DNA sequence analysis is beginning to unravel the relationships of the taxa. Genera currently included in this group, and key characters, are: *Anaphalis* - capitula in dense clusters; *Ewartia* - shrub; bracts and clustered heads; *Helichrysum* - solitary, sessile, terminal heads; *Cassinia* - heads in clusters; *Craspedia* - multicapitula in dense ball; *Gnaphalium* - mainly stoloniferous; *Pseudognaphalium*; *Leucogenes* - pseudoray surrounds several capitula; *Raoulia* - mat form and cushion form with terminal, sessile, solitary capitula and small leaves; *Haastia* - same flowers as *Raoulia* and hairs on leaves.

Martin Foggo, Central Institute of Technology, Wellington. " New Zealand's southern islands vegetation and the subantarctic question." Species and vegetation variation between the islands in the New Zealand region represents differences in location with respect to seed source and prevailing winds, their latitudinal thermal zone, their isolation, age of the islands and the influence of the recent ice ages. Other islands around similar latitudes in the southern ocean show a broad similarity in vegetation (structure and circum-polar floristics) to those of the New Zealand region, with differentiation in composition being influenced by the same discriminating environmental factors: soil nutrient status, altitude, temperature, and exposure.

Allan Fife, Landcare Research, Lincoln. "Some evidence of long-distance dispersal in the New Zealand and South American moss floras." About 38% of moss species recorded in New Zealand occur also in temperate South America. *Entostbodon laxus* has characters indicating that it is a species of relatively recent origin. It usually colonises bare humic soil in alpine environments and its presence throughout the Andean cordillera, on relatively recently derived islands (such as Campbell and Kerguelen) and in mountainous regions of New Zealand of Tertiary origin indicates the ability of this species to disperse over long distances in recent times via the prevailing westerly winds.

B. Jonsell, Royal Swedish Academy of Sciences, Sweden. "The problem of bipolar plant distributions revisited." Bog and fen habitats are well represented in bipolar areas. Long-distance dispersal in the Pleistocene seem the most likely explanation for these disjunct distributions of a wide range of plant forms including lichens, mosses, and some vascular plant species (particularly *Carex* species and some grasses).

Stephan Halloy, Crop & Food Research, Invermay. "Comparative biodiversity situation and management in New Zealand and Bolivia." Issues outlined included present estimates and uncertainties, research, policy, and conservation actions with respect to species richness, endemism, diversity, structure, habitat destruction, threats, exotic species, gene banks, protected natural areas and other conservation management, property of genetic resources, as well as political and social trends. There is limited information on species diversity in Bolivia but the vascular flora is mega-diverse. Seed bank accessions in Bolivia and New Zealand are largely of exotic species. In Bolivia, the Indians harvest mammals according to their population dynamics but the colonists do not, and therefore some species are being driven to extinction. Also, the Indians have zero population growth, but the population of colonists is expanding. There is high uncertainty in the data used for biodiversity assessment.

Jan Williams, Charles Sturt University, Australia. "Implementing the convention on biological diversity: the Australian domestic experience." In Australia, taxonomic knowledge is good except for fungi and invertebrates. There are c. 890 vascular plants endangered and 79 extinct. There is a need to anticipate, prevent and attack causes of biodiversity decline. Planning is under way for a national weed strategy and a national feral animal strategy. Although Australia is responding well to the Convention on Biological Diversity, past policy improvisation and amnesia should not, and need not, be repeated.

Maria Menvielle, Administracion de Parques Nacionales, Argentina. "Effect of planned fires on the sexual and vegetative reproduction of *Melia azedarach*, an exotic tree invading the temperate savannas in "El Palmar" National Park, Argentina." Seedling emergence and survival of *M. azedarach* varies in relation to fires and climate. Adult trees resprout from the base after fire. Fire plays an important role in reducing the fruit bank but cannot be used as the sole method of control. Chemical control is being investigated. In Australia, where *M. azedarach* is native (but not endemic) the species appears to be spreading. It is tolerant of a wide range of climate, and there may be confusion between the native ecotype and invasive ones.

Steve Higgins, University of Cape Town, South Africa. "Modelling tree and shrub invasions in the fynbos shrublands of South Africa." The major concern of the managers of fynbos natural areas is the invasion of woody trees and shrubs. Little is known about the rates, patterns and potential impacts of the invasions. In the model, matrix layers include plant age, no. of seeds produced, fire return interval, vegetation age. The most important factors required for the model are fecundity, dispersal, reproductive maturity, age and fire return interval. The ability to survive fire is not important. Modelling at the landscape scale takes into account vegetation types and management options. Spending 1 million rand is effective. Spending 100 thousand rand has no effect, and spending 0 rand leads to mass invasion quickly.

8.2 ABSTRACT AND OVERHEAD TRANSPARENCES OF PAPER BY CAROL WEST ON IMPACT OF INVASIVE PLANTS ON PLANT COMMUNITIES IN NEW ZEALAND

Almost all plant communities in New Zealand are severely affected by invasive exotic plants in some part of their range. The communities range in altitude from estuaries to high-country tussocklands.

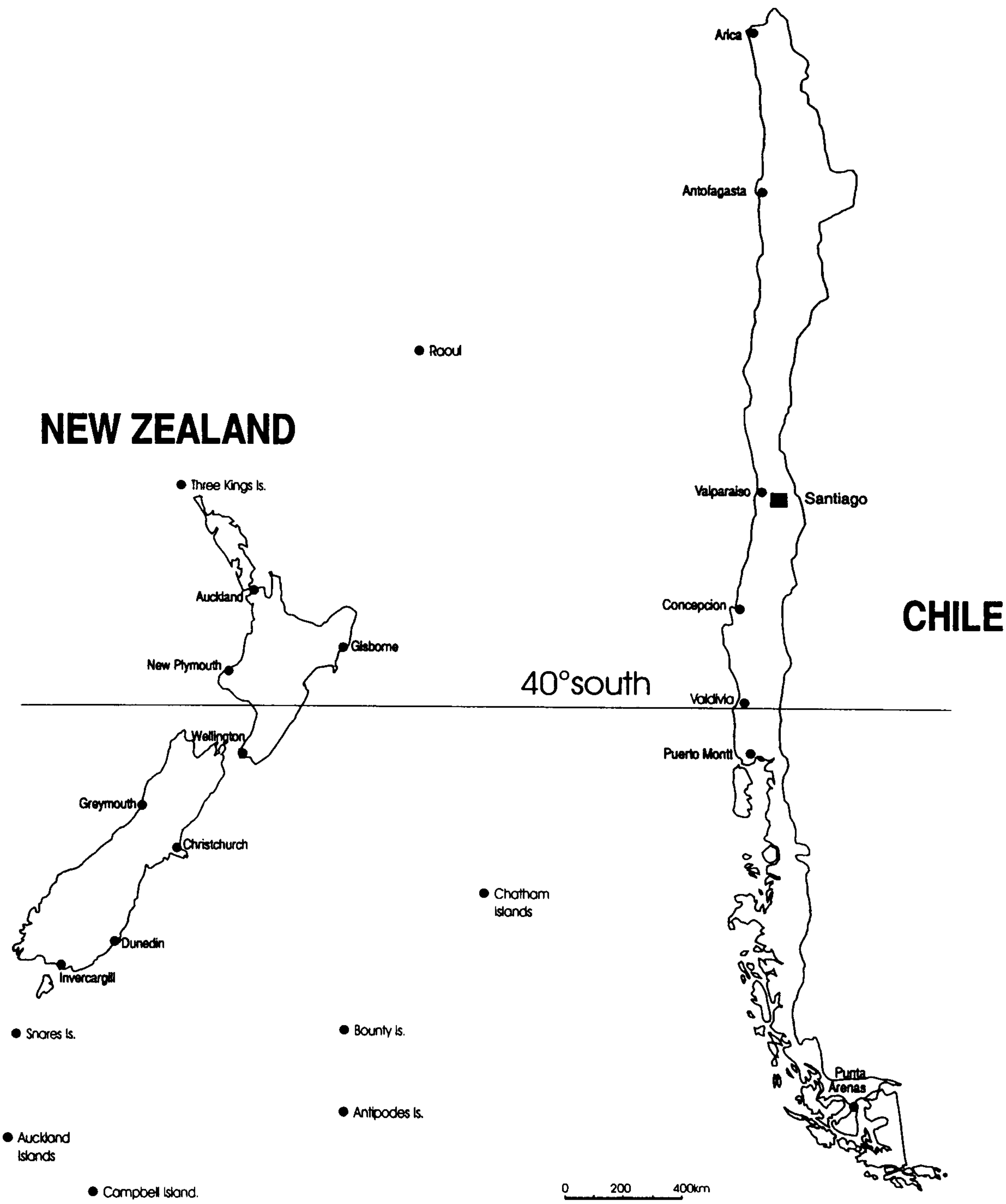

Figure 1. Comparison of latitudes of New Zealand and Chile.

Only two major plant communities are largely unaffected by invasive plants to date: beech forest (*Nothofagus*) and subalpine herbfields. The plant communities affected reflect, in part, the origins of the exotic species which have been brought into New Zealand, as well as the degree of disturbance which they have suffered.

Currently the Department of Conservation has control or eradication programmes targeting c. 250 species throughout the country. Some species are widespread, and controlled only where they impinge on sites of high ecological value. Other species are in their earliest phases of invasion and are targeted for eradication on a national or regional basis. The impact of these invasive species is assessed using a scoring system designed to evaluate the biological success of each species, as well as its effect on a plant community. The behaviour of invading species in other countries has a major bearing on our ability to evaluate any potential effect in New Zealand.

Keywords: invasive plants; plant communities; weed control.

Explanation of Figures 2-4

1. Figures 2-4 are based on two lists of plant species in the document "Ecological weeds on conservation land in New Zealand: a database", compiled by S. J. Owen, January 1997 working draft (Department of Conservation, Wellington). List 1 comprises 162 taxa that are well recognised as ecological weeds, and many have been present for decades and come from the temperate zone of the northern hemisphere. List 2 comprises 72 taxa that have only recently been recognised as ecological weeds and have not been included in the main database yet. They are generally more recently naturalised, tend to have tropical affinities and are more likely to be from other southern hemisphere countries.

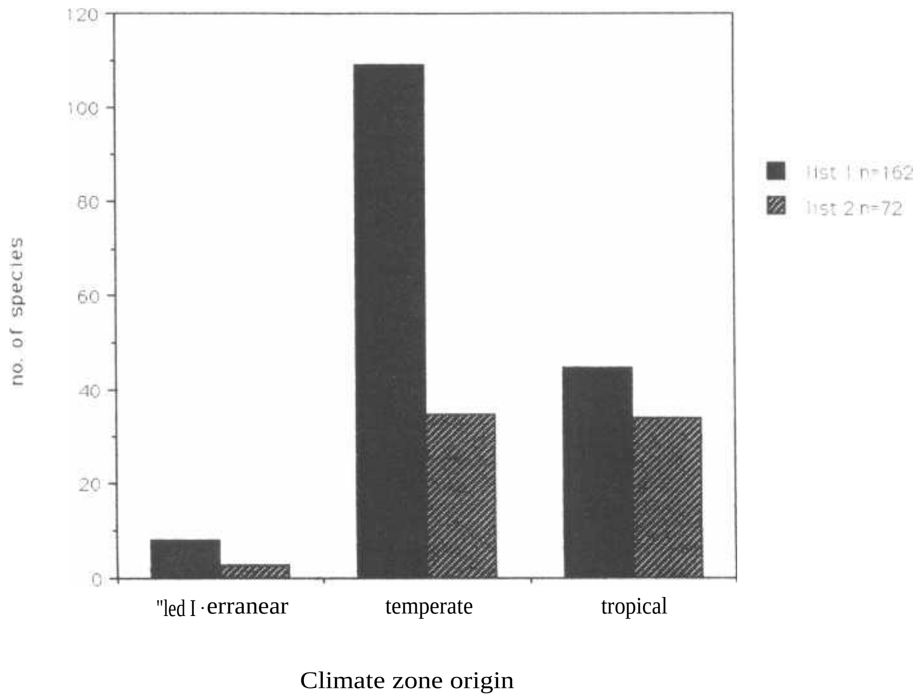

Figure 2. Climate zone of origin of naturalised weeds in New Zealand.

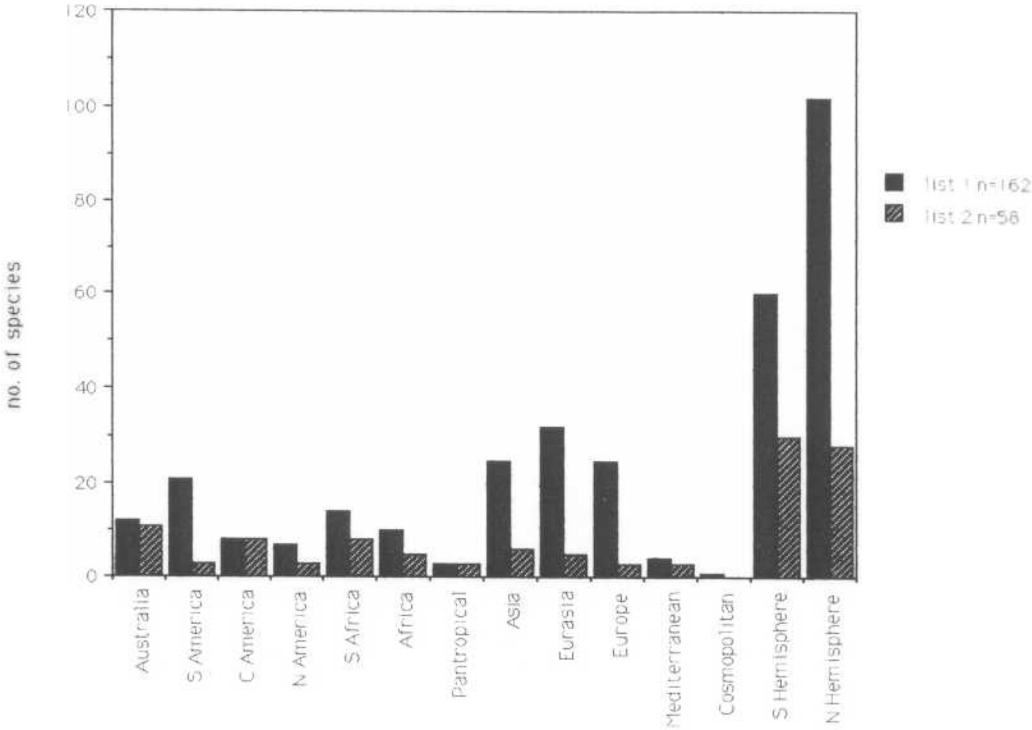

Figure 3. Country of origin of naturalised species in New Zealand.

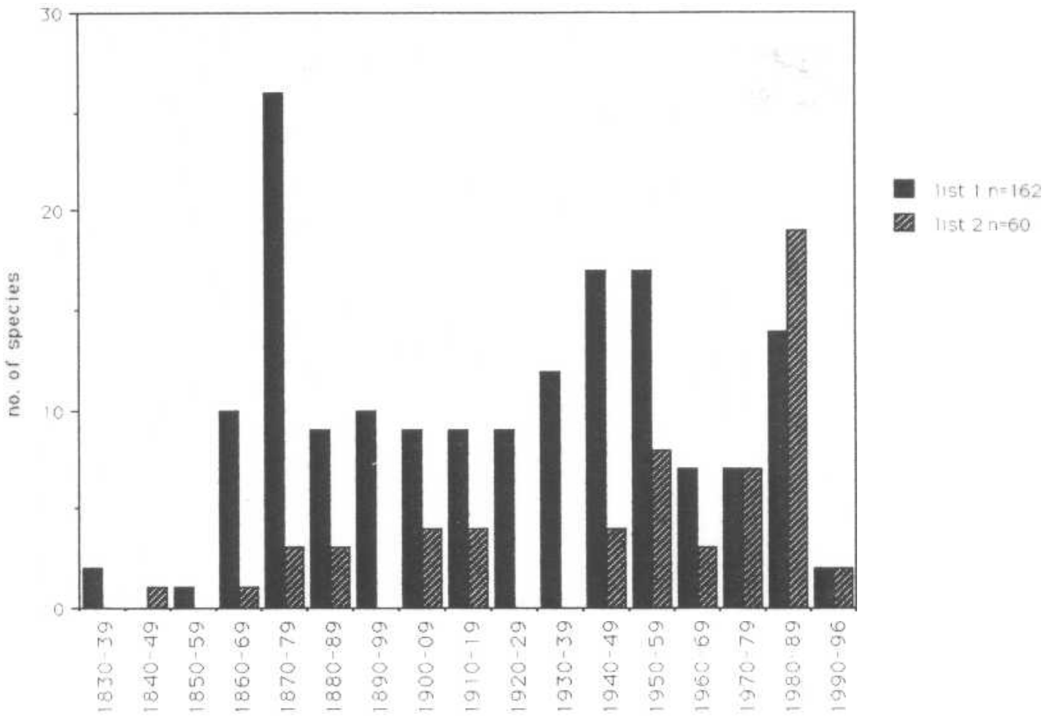

Figure 4. Number of species recorded as naturalised per decade in New Zealand.

Table 1. Spreadsheet giving an example of some ecological weed species in New Zealand and details discussed in the conference presentation by Carol West.

Based on lists of plant species in the document "Ecological weeds on conservation land in New Zealand: a database", compiled by S. J. Owen, January 1997 working draft (Department of Conservation, Wellington).

Species	Common name	First	Origin	Zone	EoS*	BSR**	Total
Acer pseudoplatanus	sycamore	1880	Europe	temperate	8	11	27
Acmena smithii	monkey apple	1982	Australia	temperate	5	10	20
Agapanthus praecox	agapanthus	1952	Sth Africa	temperate	3	11	17
Ageratina adenophora	Mexican devil	1931	C America	tropical	7	15	29
Ageratina riparia	mist flower	1931	C America	tropical	8	15	31
Agrostis capillaris	browntop	1867	Eurasia	temperate	8	13	26
Allium triquetrum	onion weed	1899	Europe	mediterranean	4	12	20
Alnus glutinosa	alder	1914	Eurasia	temperate	7	12	26
Alocasia brisbanensis	elephants ear	1867	Asia	tropical	6	11	23
Alternanthera philoxeroides	alligator weed	1906	Sth America	tropical	9	10	28
Ammophila arenaria	marram	1873	Europe	mediterranean	9	14	32
Anredera cordifolia	Madeira vine	1940	Sth America	tropical	8	9	25
Araujia sericifera	moth plant	1888	Sth America	tropical	8	11	27
Aristea ecklonii	aristea	1975	Africa	tropical	7	13	27
Arrhenatherum elatius	tall oat grass	1871	Eurasia	mediterranean	6	11	23
Arum italicum	Italian lily	1945	Eurasia	temperate	6	12	24
Arundo donax	giant reed	1836	Eurasia	temperate	8	13	29
Asparagus asparagoides	smilax	1905	Africa	tropical	9	12	30
Asparagus scandens	climbing asparagus	1970	Africa	tropical	8	12	28
Berberis darwinii	Darwin's barberry	1946	Sth America	temperate	7	12	26
Berberis glaucocarpa	barberry	1916	Asia	temperate	7	12	26
Bromus tectorum	downy brome	1870	Mediterranean	mediterranean	2	10	14
Buddleja davidii	buddleia	1946	Asia	temperate	7	12	26
Caesalpinia decapetala	Mysore thorn	1965	Asia	tropical	9	16	34
Calluna vulgaris	heather	1910	Eurasia	temperate	7	13	27
Carduus nutans	nodding thistle	1889	Eurasia	temperate	4	12	20
Carex longebrachiata	Australian sedge	1906	Australia	temperate	5	12	22
Celastrus orbiculatus	climbing spindleberry	1981	Asia	temperate	6	9	21
Cestrum aurantiacum	orange cestrum	1958	C America	tropical	6	13	25
Cestrum elegans	red cestrum	1958	C America	tropical	6	15	26
Chrysanthemoides monilifera	boneseed	1870	Sth Africa	temperate	6	12	26

*Effect on System (EoS) scores:

- capable of significantly changing the composition or structure of habitat
- suppresses regeneration
- plant's persistence over time

"Biological Success Rating (BSR) scores:

- maturation rate
- seeding ability
- persistence of seedbank
- effectiveness of dispersal
- establishment/growth rate
- vegetative reproduction

All score 0-3.