Managing Visitor Impacts on Natural Values in Hallasan National Park, Cheju Island, Republic of Korea

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ABSTRACT

Hallasan National Park is one of 20 National Parks found in the Republic of Korea and is located in the centre of Cheju Island, between the Korean peninsula and Japan. It is a very popular area for walkers and the focal point is the 1950 metre Mt. Halla. Mounting pressure to address serious track management problems created by heavy visitation to the mountain led the Cheju authorities to engage the Australian company Skyrail and through them, CSIRO, to undertake a feasibility study for a cableway in Hallasan.

The study found that the alpine area of Mt. Halla is the most vulnerable area in the National Park to disturbance and is already in disrepair from past and present visitor pressure. The construction of a cableway alone will not automatically improve the management of Mt. Halla, as any construction activities will create some degree of impact in the National Park, which will be additional to existing track impacts. However, a cableway could be a useful management tool if it is used in conjunction with a comprehensive plan to manage the track system. In the absence of any plan, track condition is expected to deteriorate and so there is an environmental cost in terms of soil erosion and visitor impact on vegetation and plant species even if a cableway is not constructed.

The natural values found within the National Park are detailed in relation to visitor impacts and a track management strategy for the National Park is suggested, which maintains existing natural and aesthetic values while allowing for some track closure and rehabilitation. Initial reactions suggest that as a direct result of the study, the Korean Federal government will supply funds to Hallasan National Park for track management, which has otherwise been managed by the local Cheju authorities without Federal funding.

1.0 INTRODUCTION

Between June and November 2000, staff from CSIRO Sustainable Ecosystems (then CSIRO Wildlife and Ecology) undertook an evaluation of flora, fauna and visual impacts as part of a feasibility study for a proposed cableway on Mt. Halla (Hallasan). Mt. Halla is located in the centre of Cheju Island, off the southern coast of the Republic of Korea (South Korea) and is the centrepiece of Hallasan National Park.

CSIRO was approached by the Australian company Skyrail to assist in the work as part of a larger study being undertaken for the Cheju Provincial Government. The study was commissioned by the Cheju authorities because of mounting pressure to address serious track management problems created by heavy visitation to the mountain. A cableway or ropeway is seen as one potential means of taking visitors off the track system while still allowing access to the mountain. Large sums of money have been spent on site hardening on the two most popular tracks but there is a long way to go before this work will be completed and in the mean time, visitor numbers are constantly increasing.

CSIRO's role in the work was to undertake an environmental assessment of the proposed cableway including route options, potential environmental impacts and the overall effect on National Park values. The detailed field investigations for the study were undertaken by scientists from Cheju University, co-ordinated by the Korea Research Institute for Human Settlement (KRIHS) in Seoul.

2.0 PHYSICAL SETTING

Hallasan National Park is one of 20 National Parks found in the Republic of Korea and is located in the centre of Cheju Island, between the Korean peninsula and Japan (**Figure 1**). The island is volcanic and is chequered with many small parasitic cones (Orums) and lava tubes. However, the volcanic feature that dominates the island is the dormant cone of Mt. Halla (Hallasan), which is the focal point of the 15,000 ha. National Park and is the highest point on Cheju, rising to 1950 m (**Figure 2**). Mean annual temperature for the National Park is 13.4 °C and mean annual rainfall is 1579 mm, falling as snow in winter over the mountain and over much of the island. Hallasan National Park was declared in 1970 to protect significant natural heritage values present on the summit and slopes of Mt. Halla; to provide a resource for nature study, hiking and mountaineering and to protect one of the three primary sacred mountains in South Korea.

There are many old tracks traversing through Hallasan National Park but there are currently four main tracks in use – Yongsil, Orimok, Kwanumsa and Songpanak (**Figure 3**). The cableway investigations were undertaken near these four tracks as well as in the Mt. Halla summit area.

3.0 NATURAL VALUES

3.1 Vegetation and Flora

The vegetation of Cheju Island can be divided into three broad zones based on altitude, representing a climatic gradient from subtropical at sea level to subalpine above 1400 m:

1) low altitude (<500 m) broadleaved evergreen subtropical/warm temperate forest
2) mid-high altitude (500-1400 m) broadleaved deciduous temperate forest
3) high altitude (>1400 m) needle-leaved evergreen subalpine forest

Hallasan National Park extends from just under 800 m altitude to 1950 m altitude and samples only the latter two vegetation zones. However, the National Park protects the majority of natural vegetation left on Cheju Island and protects all of the high altitude and most of the mid-high altitude vegetation. Lee, Ryu and Choi (1992) mapped 53.7 % of the National Park as *Carpinus tschonkii* and *C. laxiflora* communities; 25.8 % as *Quercus grosseserrata – Q. serrata* community; 8.3 % as *Pinus densiflora* community and 4.5% as *Abies koreana* community, the other 7.7 % comprising other non-tree communities.

The broadleaved deciduous forests of Hallasan are found on the lower slopes of the mountain and are dominated by species such as *Carpinus laxiflora*, *Carpinus tschonkii*, *Acer mono*, *Acer pseudo-sieboldianum*, *Quercus serrata* and *Taxus cuspidata* (**Figure 4**). Stands of *Pinus densiflora* are also common (**Figure 5**) and the understorey in these forests is dominated by the dwarf bamboo *Sasa quelpaertensis* (Lee, Ryu and Choi 1992). Creeks in this zone are boulder-strewn and appear not to support a distinctive vegetation type (**Figure 6**). Little detailed survey work appears to have been undertaken in these deciduous forests.

The needle-leaved evergreen forests are confined to altitudes greater than 1000 m and are dominated by the Korean Fir, *Abies koreana*. The vegetation types associated with *A. koreana* are variable both in structure and in floristics depending factors such as aspect and soil type. On the more protected southerly parts of Mt. Halla, *A. koreana* may form pure stands up to 20 m in height (**Figure 7**). Under exposed conditions, *A. koreana* forms a dwarfed Krummholz community to only 2 m in height (**Figure 8**) in association with *Betula ermanii* var. *saitoana* (Song and Nakanishi 1985, Kang, Kwak and Kikuchi 1997, Kim, Choo and Baek 1998).

Lee, Cho and Cho (1992) detail the subalpine vegetation found between 1440 m and 1700 m and divide the vegetation into five groups comprising a) *Abies koreana – Taxus cuspidata;* b)

Rhododendron yedoense var. *poukhanense – R. mucronulatum* var. *ciliatum – Sasa quelpaertensis;* c) *Ilex crenata – Eleaganus umbellata – S. quelpaertensis;* d) *R. yedoense* var. *poukhanense – Juniperus chinensis* var. *sargentii – R. mucronulatum* var. *ciliatum* and e) *Empetrum nigrum* var. *japonicum – J. chinensis* var. *sargentii*

Although this mixture of Krummholz and scrub conforms to the broad alpine community descriptions of Wardle (1974), like other mountains in Korea and Japan, Mt. Halla is scarcely high enough to support large areas of true high-alpine vegetation (Wardle 1977). Understanding the natural patterns of these dwarfed communities is complicated by the presence of human modified areas of secondary scrub that formed after clearing and grazing of *A. koreana* (Kim, Yoshikawa and Hukusima 1999).

The area above 1400 m on Mt. Halla therefore has an alpine component, with treeless vegetation on some of the smaller Orums, particularly those around WitsaeOrum, as well as around the summit area (**Figure 9**). There are many endemic plant species and plant species of conservation concern found in these communities.

Hallasan National Park protects an important altitudinal gradient of vegetation and a relatively small subalpine zone. This alpine zone is highly prone to damage from human usage due to the fragility of its soils and the harsh climatic conditions, which do not allow for rapid recolonisation after disturbance.

The flora of Cheju was categorised by Im (1992) into four groups based on their present distributions:

1) boreal plants advancing southward in glacial periods;
2) temperate plants spreading eastward from the Himalaya and China to Japan and passing through Cheju;
3) subtropical plants;
4) endemic species to and around Cheju.

The following table provides flora statistics for Korea, Cheju Island and Hallasan National Park (Lee, 1985; Kim and Nam, 1996; Kong and Watts, 1999).

	KOREA	**CHEJU ISLAND**	**HALLASAN N.P.**
Total Vascular Flora	4500	1453 (1795 taxa if varieties, subspecies and forms are included)	753
Endangered Flora	6	4	1
Protected Flora	52	26	6
Cheju Endemics	-	74 (mostly >1400m)	19
Korean Endemics	642	230	13
Alpine Plants	380	-	81

The flora of Hallasan National Park has strong affinities with the high mountains of mainland Korea and Japan at the species level and with northern hemisphere alpine vegetation at the generic and family levels.

For example, members of the Diapensiaceae have a distribution in high mountains of Japan, North America and the Himalaya as well as in Arctic tundra. *Diapensia lapponica* var. *obovata* is found on the summit area of Mt. Halla and is the only population known for Korea. It is likely to be a relic from Tertiary times and may be the ancestral population of arctic and American populations (Love and Love 1974). Populations of *Vaccinium uliginosum* (Ericaceae) and *Empetrum nigrum* var *japonicum*, (Empetraceae) found in the summit area are similar relictual populations although unlike *D. lapponica*, these species are also found on the mountains of mainland Korea, such as Mt. Sorak. (Lee 1998). Other species such as *Leontopodium hallaisanense* are entirely restricted to the summit of Mt. Halla.

Diapensia lapponica var. *obovata*, *Vaccinium uliginosum* and possibly *Empetrum nigrum* var. *japonicum* are all at their southern global limit on Mt. Halla (Kong and Watts 1999). The endangered orchid species *Aerides japonicum* and *Cymbidium kanran* are also found in deciduous forests on Cheju but it is unclear whether they occur in Hallasan National Park.

3.2 Fauna

Korea is located within the Palaearctic Zoological Region (Corbet 1978) and much of its fauna is closely related to that of China and Russia due to a zone of direct contact in the north (Won and Smith 1999). Cheju Island and the southern lowlands of the Korean peninsula generally have a milder climate than the rest of Korea and are therefore considered to occur within a wide transition zone between the Palaearctic and Oriental Zoological Regions. Due to this transition zone, the fauna of Cheju Island is also closely related to the oriental fauna of central China and Japan.

3.2.1 Birds

At least 300 bird species occur or have occurred on Cheju Island (*The Birds of Cheju Island*, 1998). In 1971, the total number of bird species recorded in Korea was 366 (Gore and Won 1971) but this figure may now be as high as 417 species (ILE 2000). 274 of these species are migratory, 48 are vagrants, and 95 are permanent residents of Korea. Cheju Island provides an important bird habitat and refuge within Korea, containing approximately 70–80 % of its total bird species richness. Field surveys conducted in winter, spring and summer recorded 59 bird species within Hallasan National Park.

Nine of eleven Internationally Protected Species recorded for Hallasan National Park were observed during surveys in 2000. Seven have also been declared Natural Monuments and six are designated as either Protected or Endangered by the Department of Environment. The two species not recorded recently were *Aquilia clang* (Great Spotted Eagle), a rare winter visitor, and *Terpsichore atrocaudata* (Japanese Paradise Flycatcher), which is an uncommon summer visitor. Of the nine rare birds that were observed during these surveys, seven are raptors (birds of prey) while the remaining two were *Aix galericulata* (Mandarin Duck) and *Pitta brachyura* (Fairy Pitta). The Mandarin Duck is a very rare winter visitor that was observed in numbers (100 individuals) on the Donaeko walking track while the Fairy Pitta is a rare summer visitor that was observed in small numbers on all walking tracks during the summer survey.

3.2.2 Mammals

Won and Smith (1999) provide an English translation of the comprehensive Korean mammal species accounts of Won (1967) and Won (1968), updating these accounts to current status using recent information. They cite 95 species of mammals in Korea (including marine forms), 42 of which are listed as rare, vulnerable, or endangered. Field studies conducted in winter, spring and summer 2000 recorded 10 mammal species within Hallasan National Park.

Five of the ten mammals recorded within Hallasan National Park are considered endemic to Cheju Island. These five mammals are *Mustela sibirica quelpartis* (Cheju Siberian Weasel), *Apodemus chejuensis* (Cheju Striped Field Mouse), *Micromys minutus hertigi* (Old World Harvest Mouse), *Crocidura dsinezmi quelpartis* (Cheju White-Toothed Shrew) and *Sorex shinto chejuensis* (Cheju Shinto Shrew). The Cheju Striped Field Mouse was formerly considered a subspecies of *Apodemus agrarius* (Striped Field Mouse), but is now considered a distinctly separate species based on DNA studies (Won and Smith 1999). The Cheju Striped Field Mouse only occurs on Cheju Island, but is reported to be one of the most abundant mammals on the island (Won 1967).

The Cheju White-Toothed Shrew was once relatively common throughout its range (Won and Smith 1999), occurring over a great altitudinal range from low to high elevations in a wide variety of habitats, but preferring the damp soils of deciduous forests, grasslands, and riparian communities (Won 1967, Won and Smith 1999). According to Park (1990), no records of this species had been reported on Cheju Island since the 1970s and the species was presumed extinct. However, 14 observations were made of this species in 2000 around Hallasan.

The Old World Harvest Mouse was the least observed of the endemic mammals on Cheju Island, but according to Won and Smith (1999), it ranges in suitable habitat throughout the Island, such as the lower slopes of hillsides and grasslands.

3.2.3 Amphibians and Reptiles

There is very little published information on the status, distribution and ecology of the amphibian and reptile fauna of Cheju Island. Field surveys in spring and summer recorded five amphibian species and eight reptile species.

One amphibian species is endemic to Cheju Island. This amphibian is *Hynobius quelpartensis*, a rare Salamander. However, the survey results indicate that this particular species was the most widespread and abundant of all the amphibians observed.

Three species of reptiles are considered rare. These are a skink (*Scinella laterale laterale*) and two species of snake (*Amphiesma vibakari ruthveni* and *Sibynophis chinensis*). *S. chinensis* is a Cheju endemic but was not recorded in the recent surveys. *Scincella laterale laterale*, *Coluber spinalis*, *Takydromus wolteri*, and *Amphiesma vibakari ruthveni* are in decline in many other parts of South Korea, but are relatively stable on Cheju Island.

3.2.4 Invertebrates

Some hundreds of species of invertebrates have been recorded in Hallasan National Park and a reduced list has been compiled based on those invertebrate species that are considered vulnerable to disturbance, such as endemic, rare and threatened species. Most of the endemic species are from the Order Coleoptera (beetles) and occur in forest leaf litter. Survey data confirms their association with forest vegetation, as all observations were made below the alpine zone at between 600 and 1000 metres in elevation.

The remaining endemics are from the Orders Dermaptera (earwigs), Neuroptera (lacewings), Mecoptera (scorpionflies) and Lepidoptera (butterflies and moths) and due to this variety, are found in a range of different habitats.

All of the rare and threatened invertebrates belong to the Order Lepidoptera (butterflies and moths). The rare butterfly *Parantica sita* was observed on all walking tracks between 900 m and 1200 m in elevation. The nocturnal moth *Callistege mi* was found for the first time on Cheju Island during the summer survey of the Youngsil walking track at 1400 m and the rare butterfly *Oeneis urda* was observed only in this locality. This species belongs to the Satyridae, which are primarily active during dusk and dawn, retiring to dense forest or heavy undergrowth during the day. The larvae of this family usually feed on the leaves of grasses. Hence, this species may depend heavily on alpine grasses for reproduction. The threatened butterfly *Eumenis autonoe* was only observed on the Kwanumsa walking track at 1500 m.

4.0 HISTORICAL IMPACTS

The land that now comprises Hallasan National Park has undergone two distinct periods of relatively recent human disturbance:

- *a long period of impact from clearing, grazing and burning on the lower slopes and grazing and burning in the subalpine zone, dating back some hundreds of years;*
- *a shorter period of impact from hiking and mountaineering initiated in the 1970's.*

Grazing within the National Park ceased in 1988 and though the impacts of this activity in the subalpine zone may be expected to be significant, only three post-hoc studies have been undertaken.

Lee, Cho and Cho (1992) suggest that the species diversity of plant communities in the subalpine zone of Mt. Halla was decreased severely by the impact of livestock and visitors and found that many areas on the lower slopes have been cleared in the past and now consist of younger regeneration. Lee, Ryu and Choi (1992) found that 65% of the National Park, particularly the lower slope areas, was secondary forest 20-50 years old. They mapped the treeless areas of the subalpine zone as 'natural prairie' in contrast to the opinion of Kim, Yoshikawa and Hukusima (1999) who suggest that much of the subalpine zone of Mt. Halla is a complex of ‘artificial’ shrub communities derived from grazing and burning of the Korean Fir (*Abies koreana*) community. However, their conclusion is based on the potential distribution of *A. koreana* under ideal conditions, rather than under the particular climatic conditions found on Mt. Halla. Given the complex history of eruptions and flows from Mt. Halla and the resulting variations in soil type, soil depth and degree of exposure to prevailing winds, it seems unreasonable to argue as Kim, Yoshikawa and Hukusima have that there were no natural alpine grassland, herbland or shrubland communities before grazing and burning. The high number of endemic species (74 above 1400 m altitude, Lee 1985) found in the sub-alpine zone also suggests that the vegetation mosaic found in the sub-alpine area of Mt. Halla is not only the result of past human disturbances.

A second major management issue above 1400 m altitude is the apparent lack of regeneration of *Abies koreana* in certain localities. Some areas that are now treeless once supported *A. koreana* forest prior to human disturbance and in addition, dieback is occurring in some areas. The grass S*asa quelpaertensis* which is dominant throughout the National Park has probably been advantaged by grazing and burning in the sub-alpine zone and become more common in the evergreen coniferous forest zone of Mt. Halla. Work in Japan has shown that *Abies* seedlings cannot survive more than 2 years after seed fall on dwarf bamboo litter and may require moss beds for germination (Nakamura 1992) and that there may be some allelopathic effects of *Sasa* on the germination of *Abies*. Hence, *A. koreana* may only be able to successfully germinate and when the dwarf bamboo stands undergo a mass flowering, death and slow regeneration, as occurs in *Sasa* and other bamboo species.

5.0 VISITOR IMPACTS AND PAST MANAGEMENT PRACTICES

The impact from more recent recreational use of the National Park is much more apparent. Significant damage has occurred on the main track systems – Orimok, Yongsil, Kwanumsa and Songpanak (**Figure 10**) – and particularly around the main summit area of Mt. Halla. While significant track maintenance involving hardwood steps and gravel (**Figure 11**), board walks (**Figure 12**) and large paving stones (**Figure 13**) has occurred on the track systems, particularly on the Orimok – WitsaeOrum – Yongsil circuit, the old track systems around the summit area are still eroding, despite significant efforts at stabilisation.

Erosion in the summit area led in 1986 to the closure of the shorter western access route to Mt. Halla from WitsaeOrum and in 1994 to the closure of the longer southern access route to Mt. Halla from WitsaeOrum

Significant restoration work has been attempted in the summit area. In particular, soil from lower elevations is placed in hessian-like bags (**Figure 13**) and transported to WitsaeOrum via a small monorail (**Figure 14**). Some plant seed from lower elevations was being accidentally transported to the summit area in this soil and to avoid this problem, the top 50 mm of topsoil from the lower elevation sites is scraped away and the subsoil is then used to fill the bags. However, the effects of using a low elevation soil at high altitudes is questionable and needs to be more fully investigated in relation to not only low altitude species and weed species becoming established, but also in relation to the suitability of this soil as a substrate for the species found above 1400 m. Observations suggest that the soil used becomes very compacted, sheds water and is not amenable to plant germination and growth.

Although the Hallasan summit area restoration works were pioneering in Korea, the success of the restoration approach used so far has been questioned by some experts (Park, Kim and Mun 1999).

Dr. Edward Kim from Skyrail conducted research into visitor numbers in Hallasan National Park as part of the study and found that between 1995-1999 over 2.3 million visitors visited Hallasan National Park with major peaks in visitation occurring in January (19%), May (15%) and October (11%) and to a lesser extent August (8%). Approximate round numbers of users on tracks in 1998 and 1999 were:

- *Orimok*: 350,000 & 200,000
- *Yongsil*: 150,000 & 125,000
- *Songpanak*: 50,000 & 125,000 (access to summit re-opened 1999)
- *Kwanumsa*: 25,000 & 25,000

Walking track maintenance has necessitated a large expenditure of money over the past five years, particularly on the first three tracks mentioned above. However, the long-term success of this stabilisation and hardening have yet to be determined as only 3 years of monitoring has been undertaken. It is expected that visitor numbers will continue to increase steadily and hence recreational impact will increase.

6. OPTIONS FOR MANAGING VISITOR IMPACTS

The issue of visitor impact in Hallasan National Park is a contentious issue both on Cheju and on the Korean mainland. Any solution to the National Park's track management problems must involve limiting the impact of visitation to environmentally, economically and socially sustainable levels. A variety of management options have been considered in the past and the following six have been consistently proposed by local authorities:

1. *maintain the status quo – spend money on existing track maintenance with no visitor number regulation or increase in National Park fees;*
2. *maintain or increase spending on track maintenance plus limit visitor numbers and / or increase National Park fees;*
3. *combination of 1) or 2) plus closure of some of the existing tracks;*
4. *combination of 1) or 2) or 3) plus Helicopter Access;*
5. *combination of 1) or 2) or 3) plus a Cog Railway;*
6. *combination of 1) or 2) or 3) plus a Cableway.*

Given existing erosion on all major tracks, even track closure will necessitate some money spent on stabilisation, as evidenced by the amount of time, effort and money being put into stabilising and restoring the summit area of Mt. Halla. Given the important natural and cultural values found in Hallasan National Park, any visitor impact management that is undertaken must be done in an environmentally and socially appropriate manner.

These six options can be categorised as either monetary or technological solutions. The first three fall into the first category while the second three fall into the second category. The technological solutions cause the greatest debate among National Park users and managers due to their potentially significant environmental impact. Hence, there is a dilemma in the authorities managing the National Park as to how to reduce existing visitor impacts without creating additional impacts from the solution.

In this regard, Options 4 and 5 would be inappropriate solutions. Option 4 would create additional impacts from both visual and noise pollution and would not be able to carry a significant number of people to ease existing pressure on the track system. This option would be most likely to create rather than reduce impact. Option 5 would require the construction of an unobstructed route and hence the infrastructural development associated with the construction of a cog railway would lead to the destruction of vegetation on very steep slopes and would lead to unacceptable environmental and visual impacts.

The Korean authorities still regard Option 6 as a potentially feasible technological solution if a cableway can be constructed in an 'environmentally friendly' manner. Skyrail was awarded a feasibility study tender based on the design, construction and maintenance of its Cairns - Kuranda Rainforest Cableway. The ability and experience of Skyrail in Australia to install and run a cableway system over vegetation without having to cut an environmentally destructive swathe through it and its use of helicopter installation of pylons and other infrastructure convinced the Korean authorities that a cableway may be a feasible option for alleviating pressures on the walking track system.

From CSIRO's perspective, if management of Hallasan National Park is to be assisted rather than hindered or complicated by the construction of a cableway, a cableway must fulfil the following criteria:

- it either stabilises or reduces visitor impact in the National Park generally;
- it reduces visitor impact on the Mt. Halla summit area particularly;

- it does not conflict with or compromise existing natural, cultural and social values;
- it is constructed with minimal environmental impact in relation to flora, fauna, noise and visual impact;
- it potentially subsidises track maintenance;
- it educates the public about the values of the National Park and its management problems.

Visitor numbers and track usage in Hallasan National Park are already high and difficult to manage, so the net effect of any cableway construction should be to move a significant proportion of people off the existing track system and on to the cableway. If a cableway attracts a new type of visitor rather than alleviating the pressure of existing usage, it will create a new impact and would not contribute to solving the existing track management problems.

7.0 CABLEWAY EVALUATION

The proposed cableway construction, irrespective of the final route, would involve three primary components: a bottom station facility where the cableway would commence, the cableway itself including pylons and a top station facility. These three components formed the basis of the impact assessment process.

Once potential route options had been identified after culling out initial options that had fundamental environmental, economic or social constraints, the next stage in route evaluation was to develop a matrix that identifies potential impacts of the ropeway and shows at which stage they may be critical, such as construction, operation and maintenance. This initial compatibility matrix did not contain detailed values for each route option. It was a 'first cut' at comparing the positive and negative benefits across the options and highlighting the most problematic areas. A second detailed matrix was then developed using the Rapid Impact Assessment Matrix (RIAM) of Pastakia and Jensen (1998) which compared detailed scalings and values for the important potential impacts. Relevant experts assigned values for five criteria based on their assessment of the data in relation to the three final route options - Yongsil, Orimok and Kwanumsa, as Songpanak was eliminated as an option. A null (do nothing/status quo) option was also evaluated and each option was examined at the construction, operation and maintenance phases (Appendix 1).

The results of the RIAM analysis were as follows:

- *Construction Phase*: Yongsil had slightly less impact than Orimok, which in turn had significantly less impact than Kwanumsa. All routes have significant negative impacts on biological / ecological values as well as sociological / cultural values.

- *Operation Phase*: Yongsil is more efficient to operate than Orimok and both are significantly more operationally feasible than Kwanumsa.

- *Maintenance Phase*: Yongsil is more efficient to maintain than Orimok and both are significantly more operationally feasible than Kwanumsa

It is important to note that the construction, operation and maintenance phases cannot be logically added to achieve an overall score, as the operation and maintenance phases cannot be compared back to the null condition. Most impacts on physical / chemical, biological /ecological and sociological / cultural values will occur when comparing the construction phase with the null condition. The operation and maintenance phases are more effectively used to ascertain the cost effectiveness of the different options in relation to economics and feasibility. All three routes have some negative environmental impacts but of the three route options investigated, it appears the Yongsil route overall has less environmental impact and is environmentally, socially and economically more feasible than either Orimok or Kwanumsa.

Considering all values, the Yongsil route was the preferred route for a cableway, if one was to be constructed in Hallasan National Park. All of the three route options were assessed in the absence of any track closures or other ancillary management actions that could be implemented as a part of a wider management plan that included a cableway. Within the Yongsil route option, three further options were developed in relation to the placement of the top station facilities, in order to avoid sensitive alpine areas or minimise visual impact.

The area that has suffered the most damage from visitor impact over the past three decades is the summit area of Mt. Halla, which is still undergoing active erosion despite rehabilitation efforts. The summit cannot support large numbers of visitors and for the construction of any cableway to be “environmentally friendly”, it must not proceed to the summit area. Indeed, for long-term conservation of the summit area, it may be advisable to close off all visitor access to the summit, including the Kwanumsa and Songpanak sides, at least in the short term until clear signs of recovery and stabilisation have been measured. Additionally, the visual impact of a cableway on the summit area would be highly significant and would be unacceptable to other visitor groups in the National Park. Sources of conflict will arise if viewscapes from popular tracks are interrupted by a cableway.

The treeless (alpine) area along the Yongsil route contains a variety of Conservation Required, Cheju Endemic and Korean endemic plant species. Given the limited distribution of these species, particularly the Cheju endemics, any development in this area has the potential for a significant environmental impact. Environmental conditions in this treeless area are severe and hence any impacts from construction would take a significant period to recover. Kong (1998, 1999) raises the potential impact of global warming on the distribution of restricted alpine species on Mt. Halla. Comparison of present distributions with data from the 1960’s, 1970’s and 1980’s indicates that the alpine plant species of Mt. Halla may be on a process of retreat toward the summit, probably due to recent climatic amelioration. If this is the case, any further development in the alpine area (including increased use of the existing track system) may pose a grave threat to the long-term survival of these species, which are already under environmental and human pressure.

Other potential issues above the treeline were the potential impacts on small streams, bogs and soaks which may prove to be specialised habitat for invertebrate or amphibian species and the potential effects on the subalpine environment of alterations to nutrient levels. Additionally, slope protection in extreme habitats may only be maintained by a few specialised species in any given area. For example, the holarctic-alpine *Loiseleuria procumbens* (Ericaceae) in Switzerland is extremely slow growing but forms a stable cover on windswept slopes. However, the species is susceptible to mechanical disturbance and nutrient addition and any local decline of this species from these causes may lead to soil erosion. There are only a handful of other species which can provide some protection in the interim and these species are therefore of critical importance in this ecosystem (Korner 1980, 1984, cited in Korner 1995). Species such as *Juniperus chinensis* var. *sargentii, Empetrum nigrum* and *Rhododendron* spp. may play a similar role on the Orums around Mt. Halla.

Given the concentration of conservation required, Cheju endemic, Korean endemic species and uncommon alpine plant communities on and around the Orums around the summit of Mt. Halla, there would be significantly less impact on these species if construction of cableway facilities occurred closer toward the *Abies koreana* treeline, if a cableway were to proceed. Additional difficulties would be faced above the treeline given the steep and potentially erodible slopes associated with development near the Orums.

If a top station was to be built anywhere in the treeless area, any walkway associated with it would need to be constructed with minimal impact and attention to soil conservation and plant regeneration in areas disturbed during construction. Much rehabilitation work has been undertaken in Australia’s alpine areas, particularly in the Kosciuszko summit area over the past 50 years, although it is a history filled with trial and error (Good in press). However, the metal mesh walkway constructed between Thredbo and Mt. Kosciuszko to minimise track impact has been successful and may be an appropriate type of walkway to construct to avoid new impacts in the alpine area of Mt. Halla. The advantages of a metal mesh walkway are:

- *they are strong and durable;*
- *the cost is comparable to gravel and hard facing;*
- *they are manufactured outside of the area and brought in by helicopter in 100m sections;*
- *they keep walkers off the ground - no track erosion, incision or vegetation damage;*
- *sunlight penetrates the walkway so vegetation underneath can continue to grow;*

- *the walkway heats up in spring and extends the growing season of grasses and herbs. If used over damaged tracks, they may speed up vegetation recovery.*

If the existing Yongsil track was kept open and a cableway constructed, the only option to avoid major visual conflict between users would be to bring the upper terminal location back to the treeline area, where cableway patrons and track users would both have an uninterrupted view to Mt. Halla from their respective areas. Single pylon structures rather than complex tower structures would also be desirable due to the permanent high visibility of the route above the treeline and the seasonal visibility of the route in winter below the treeline.

Hence, the construction of a cableway alone, even along the Yongsil route, will not automatically improve the management of Mt. Halla, as any construction activities will create some degree of impact in the National Park which will be additional to existing track impacts. However, a cableway could be a useful management tool if it is used in conjunction with a comprehensive plan to manage the track system. Even in the null option, track condition is expected to deteriorate and so there is an environmental cost in terms of soil erosion and visitor impact on vegetation and plant species even if no management action is taken and no cableway is constructed.

8.0 MANAGEMENT OPTIONS FOR MT. HALLLA & THEIR IMPLICATIONS

8.1 Track Management Strategy

It is essential that if a cableway was built on the Yongsil route, no access was possible from the cableway on to the existing track system or surrounding areas of vegetation. This would be difficult if the Yongsil track remains open. Given the grassy nature of the proposed top station area for the first two options, it would prove difficult to confine people to the cableway area and stop them from accessing the WitsaeOrum track via the Yongsil track.

Lance, Baugh and Love (1989) noted continued significant increases in footpath widening, erosion and vegetation trampling in the Cairngorm Mountains in Scotland during the 1980s, almost 20 years after an access road and chairlift were built in the area in the 1960s. Similarly, Laidler et al. (1978) noted serious vegetation deterioration in the immediate vicinity of the top station of the Front Table cableway on Table Mountain, South Africa due to trampling by cableway patrons.

It is clear that the construction of a cableway on its own will not solve Mt. Halla’s track and vegetation management problems. The overall strategy required, if a cableway is to be properly evaluated as a National Park management tool, is to re-evaluate the entire track system in light of the potential costs and benefits of a cableway. Options exist for a more comprehensive approach of closing certain tracks, regulating numbers and or increasing fees as part of a broad visitor management approach, which may or may not involve the construction of a cableway.

We suggested that the Cheju authorities adopt an overall track management strategy that facilitates access for both present and future increased numbers of park users, while avoiding conflict. This would entail the following actions:

a) maintain and fully stabilise the popular Orimok Track to WitsaeOrum, which has already had significant amounts of time and money spent on it;

b) stabilise and re-organise the facilities at WitsaeOrum so that they have less visual impact;

c) close the Yongsil Track beyond the 500 Generals viewing area and preclude access to WitsaeOrum from this point;

d) close the much less used Kwanumsa Track past the lava tube area on the lower end;

e) close the Songpanak Track beyond Azalea Fields;

f) stabilise and re-organise the facilities at Azalea Fields so that they have less visual impact;

g) close off all access to the Summit area in the short term – in the longer term, once the Summit has been stabilised, limited number Ranger guided walks could be undertaken from Azalea Fields to the Eastern edge of the Summit;

h) build upon the existing knowledge base and investigate the World Heritage potential of Hallasan National Park;

and then either:

i) to cater for increasing demands, construct the Yongsil route cableway to a point at either "c" and create a detailed and informative visitor interpretation facility at the bottom station, stressing the importance and fragility of the alpine and Summit areas and the reasons why access is currently restricted.

or

j) investigate the possibility of increased Federal funding for the management of Hallasan National Park or indeed the actual transfer of management to the Federal National Parks Authority. World Heritage listing may facilitate this process.

Whatever the management pathway chosen, an increased educational component for the public is crucial to the long-term management of Hallasan National Park. Importantly, such a facility should ensure that visitors are able to understand the fragility of the Mt. Halla summit area and the reasons why access is becoming increasingly restricted as visitor numbers increase.

8.2 World Heritage Potential

Given the importance of Hallasan National Park from a conservation and visitation point of view, a consideration of its World Heritage values would have merits as recognition of its values may also enable greater funding for track and facility maintenance from both Federal and international sources.

The Republic of Korea currently has five World Heritage Properties, all of which were inscribed on the World Heritage List for their cultural values:

1. Sokkuram Buddhist Grotto (listed in 1995);
2. Haeinsa Temple Changgyong P'ango, the Depositories for the Tripitaka Koreana Woodblocks (listed in 1995);
3. Chongmyo Shrine (listed in 1995);
4. Ch'angdokkung Palace Complex (listed in 1997);
5. Hwasong Fortress (listed in 1997).

In the case of natural properties (areas containing natural heritage), the World Heritage List attempts to be representative and to list sites that are of outstanding universal value from a scientific, conservation, aesthetic or natural beauty point of view. Sites must meet one or more of four criteria and fulfil the conditions of integrity as set out in the Operational Guidelines for the Implementation of the World Heritage Convention. Given the geomorphological, botanical and zoological values and significance of Mt. Halla, there appears to be great potential for Hallasan National Park to be eligible for inclusion on the World Heritage List as it would appear to fulfil all four criteria for inclusion. However, an adequate evaluation of the World Heritage values of Mt. Halla needs to be made by comparison with other similar areas, both in Korea and overseas.

The values of Mt. Halla should be evaluated against other high mountain areas in both South and North Korea. The only similar area on the World Heritage list at present is Yakushima (Yaku-Island) World Heritage property in Japan, which was inscribed in 1993. Like Cheju, the climate on Yakushima varies from sub-tropical, warm temperate to cool temperate, tending to sub-alpine and the vertical vegetation distribution is distinct, with sub-tropical vegetation near the coastline, and warm temperate, temperate, cool temperate and sub-alpine species further inland as altitude increases. However, the predominant bedrock on Yakushima is granite, with small areas of sandstone and shale and the cool temperate zone coniferous forest is characterised by *Abies firma*, *Tsuga sieboldii* and *Cryptomeria japonica*, rather than the cool temperate beech forests typical of the Japanese mainland.

A nomination including Mt. Halla would complement rather than duplicate the existing Yakushima World Heritage Property.

9.0 CONCLUSION

Although the work undertaken by CSIRO and Skyrail was initiated to investigate the feasibility of a cableway system, it soon became apparent that unless an integrated track and visitor management strategy is adopted, the construction of any new facility such as a cableway would only compound existing problems rather than solve them. The appeal of a technological solution is strong, but such a solution will only be accepted by the public if it can be readily shown that the overall impact on natural and cultural values within the National Park will be lessened. In the absence of an overall strategy, it cannot be readily shown that a technological solution such as a cableway will achieve the objectives desired for the management of Hallasan National Park.

When dealing with infrastructure development in National Parks, the basic step of identification of natural and cultural values and their acceptance as fundamental constraints on potential development should always determine the type of response to visitor impacts. Particularly if resources are scarce, permanent or temporary strategic track closures and concentration of resources into hardening existing tracks may go a long way toward managing existing visitor impacts without the need for technological solutions, at least in the short term. In the long term, a cableway may still need to be seriously contemplated if visitor numbers increase steadily as they have done.

Although the Cheju Provincial Government and South Korean Federal Government have not made a final decision on the cableway, the South Korean Federal Government has recently allocated a grant of 20 million Won (A$30,000.00) for initial track maintenance and rehabilitation in Hallasan National Park as a direct result of the CSIRO/Skyrail work completed for the feasibility study. Although not a large amount of funding, this is the first sigh that the Korean Federal government will spend money in Hallasan National Park, which has otherwise been managed by the local Cheju authorities without Federal funding. An investigation of the costs and benefits of keeping all four major track systems operational is also underway.

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Figure Captions:

Figure 1: National Parks of the Republic of Korea

Figure 2: LANDSAT TM Image (Bands 1,4,5) of Cheju Island Showing Hallasan N.P.

Figure 3: Major Tracks in Hallasan National Park

Figure 4: Broad-leaved Deciduous Forest of *Carpinus* spp., *Acer* spp. and *Taxus cuspidata* with *Sasa quelpaertensis* understorey. Orimok track, approx. 1000 m altitude

Figure 5: View from 500 Generals on Yongsil track, showing mixture of Broad-leaved Deciduous Forest and *Pinus densiflora* Forest at lower elevation. White flowering shrub scattered through area is *Cornus kousa*

Figure 6: Boulder strewn creek at lower elevation. Orimok track, approx. 800 m altitude

Figure 7: Sub-alpine Forest of *Abies koreana* with *Sasa quelpaertensis* understorey. Upper area of Kwanumsa track, approx. 1400 m elevation

Figure 8: Krummholz community of *Abies koreana* and *Betula ermanii* var. *saitoana.* Approx. 1500 m elevation, near Orimok track

Figure 9: Alpine area near Yongsil track, S.W. of WitsaeOrum. Consisting of shrubberies of *Rhododendron* spp. and *Taxus cuspidata* as well as communities of *Empetrum nigrum*. var *japonicum* and *Juniperus chinensis* var. *sargentii* on Orums in the middle distance

Figure 10: Existing track damage. Songpanak track

Figure 11: Hardwood steps and gravel used for soil stabilisation. Orimok track

Figure 12: Boardwalk. Orimok track

Figure 13: Large paving stones and hessian-like bags used for soil stabilisation, Orimok track

Figure 14: Monorail, on left of picture, used for transport of rehabilitation materials. Orimok track