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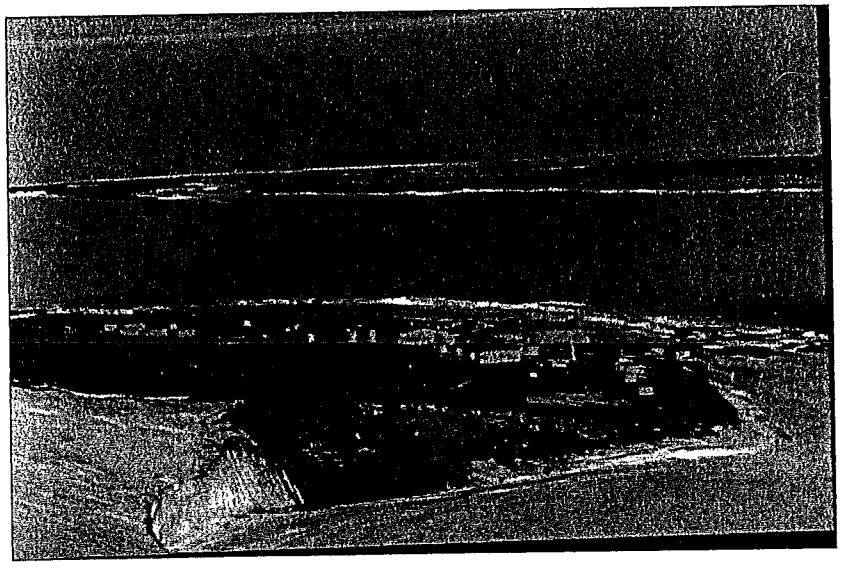
ENVIRONMENTAL AUDIT

Event K396, 1999



Joanne Bishop

ENVIRONMENTAL AUDIT OF EVENT K396 IN ANTARCTICA, 1999

Executive Summary

This report outlines the activities and associated environmental impacts of Event K396 in 1999.

A Preliminary Environmental Evaluation made predictions of any impacts prior to arriving in Antarctica. This audit states the observed impacts according to each activity completed by Event K396, and options for impact mitigation and alternative activities.

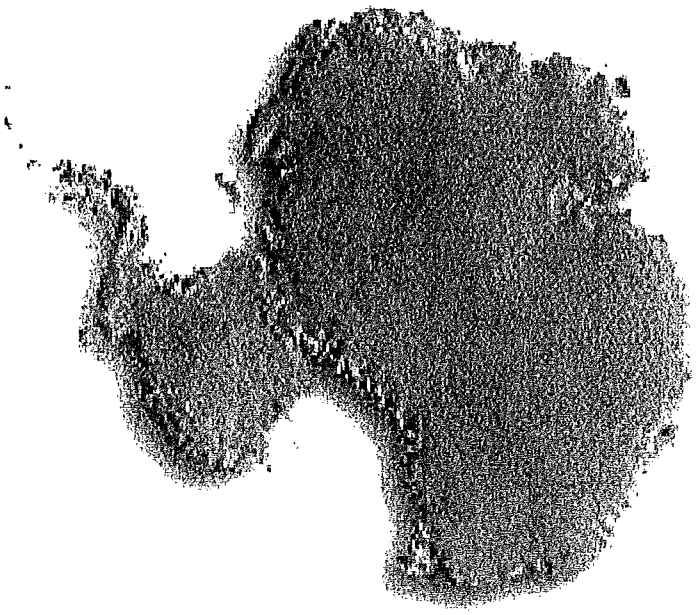
The Certificate in Antarctic Studies is a Graduate level course aimed at people who wish to further their study or work in an Antarctic related field. The value of this unique education opportunity is high. On completion of both the theory and practical field components, participants have expertise in a variety of issues regarding Antarctica.

The following points summarise the major findings of this audit:

- Event K396 performed a variety of activities as part of the field studies for the course. Each activity is discussed separately, and an itinerary outlines the location, number of people and logistics involved.
- Alternatives to the existing activities include- alterations to the location and nature of current activities, cancelling the field component, or no change to the existing activities.
- Environmental impacts that arose from the field activities are listed according to the activity. It is interesting to compare the predicted impacts in the PEE, to the actual impacts in this report. Cumulative impact assessment was addressed and the impacts were not found to be less than minor or transitory.
- Options for mitigating or minimising environmental impacts are available and listed for each activity. With little knowledge about the resilience of Antarctic ecosystems to disturbance, impacts should be minimised.
- The outlook for the course, as referred to in this report, is 5 years, hence the importance of regular monitoring.
- Overall, the education value of Event K396 justifies the field studies, but adverse impacts were detected as a result of activities.
- An Initial Environmental Evaluation (IEE) is recommended for the Certificate in Antarctic Studies, for the year 2000 and beyond. Cumulative impacts should be included in the IEE and a proactive approach adopted that strives to protect the environment for the future.

- All human activities have an impact on the environment. Greater knowledge must be gained concerning the interactions between humans and the environment. It is important to minimise environmental impacts and maximise the educational value.

- A course such as Event K396 has the potential to become a valuable education tool, as well as increasing peoples awareness and knowledge about Antarctica for its future management.



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Introduction

The terrestrial ecosystem of Ross Island, Antarctica is extremely sensitive to environmental change. Lichen and moss communities have specific threshold levels for survival and any change could result in irreversible damage to their fragile ecosystems. It is important that the unique Antarctic environment is protected for scientific purposes as well as it's aesthetic and wilderness values.

The Certificate in Antarctic Studies, 1999, was based at Scott Base on Ross Island. The course involved a practical study component in the field. This report aims to describe the activities completed by Event K396 and the subsequent impacts.

As well as listing the environmental impacts, the writer will address the concept of cumulative impact assessment, alternative activity options, measures for minimising impacts and a section on environmental monitoring.

The Preliminary Environmental Evaluation, which is discussed separately, predicts the impacts of Event K396 prior to departure. It is interesting to make comparisons between the predicted impacts and the impacts that actually occurred.

This report has an outlook of 5 years, when discussing cumulative impacts. With an outlook of 5 years, seemingly insignificant impacts become more concerning, especially if the same sites are revisited. All human activities have an impact on the environment, but they must be minimised where possible.

Antarctica is a special and extremely fragile continent and it has been named the worlds last remaining wilderness. A course such as Event K396 has the opportunity to become a valuable tool in educating people toward proactive management of unique ecosystems. A great deal can be learnt from Antarctica, but this must not be at the expense of the environment.

Definition of terms

Environmental Audit- "A measure of environmental risk and an assessment of environmental opportunities" (Hay, lecture notes)

Impact/effect- "Change in the values or resources attributable to a human activity. Impact is the consequence of an agent of change not the agent itself" (SCAR, 1996).

Activity- "An event or process resulting from the presence of humans in the Antarctic" (SCAR, 1996).

Grey water- Water used to wash dishes, cook with etc, does not imply urine.

Monitoring- "standardised measurement or observation of key variables or outputs over time, their statistical evaluation and reporting on the state of the environment in order to define quality and trends" (SCAR, 1996).

Background of Event K396

Event K396 is an inaugural course in Antarctic Studies and a component of the course includes studying in and around Scott Base, Antarctica. A Preliminary Environmental Evaluation (PEE) has been completed for the Scott Base component of the course, which outlines the proposed activities in Antarctica.

Seventeen students and 4 tutors made up Event K396 (figure1), and a total of thirteen days were spent on the continent. The month prior to departing for Antarctica was spent in multidiscipline study and looking at field techniques relevant to the practical component. Students were briefed on the environmental code of conduct, and about the general running of Scott Base to minimise any disruption to Scott Base staff and the environment.

" The Certificate in Antarctic Studies is designed to provide a high quality educational programme for students with an interest in pursuing postgraduate research in fields related to the Antarctic, and for people working in relevant professions and organisations who are able to make a significant contribution to their communities as a result of the programme" (PEE, 1998).

Graduate level multi-discipline study coupled with practical fieldwork and experience in Antarctica is new concept in Antarctic education. Courses such as this, generate students who are knowledgeable and experienced in numerous issues regarding Antarctica. It is a tool for generating ideas and improving proactive management for such a unique and fragile place. On completing the Certificate in Antarctic Studies, students will have the ability to educate others with the expertise and experience gained.

Figure 1: Event K396 (JH)

Preliminary Environmental Evaluation

Prior to the arrival of Event K396 in Antarctica, a Preliminary Environmental Evaluation (PEE) was completed. A brief account of field activities is provided, followed by a summary of the potential environmental impacts.

In the PEE the impacts of K396 Certificate in Antarctic Studies appear negligible. The protected areas that will be visited are listed. The PEE states that there will be no removal of geological samples, no trampling or disturbance to any ice-free areas and no tracks in previously untracked ground. A copy of the PEE can be seen in appendix 1.

The following environmental audit will describe the activities of Event K396 and the actual impacts that were observed in the field. Because the predicted effects of K396 were relatively non-existent, an Initial Environmental Evaluation was not done for the course in 1999. After an assessment of the actual environmental impacts an IEE may be required, especially if the course is returning yearly to the same sites.

Description of field activities

Refer to appendix 2 for a map showing the field sites

1. Water sampling at Scott Base

Small samples were taken from the salt-water intake tap in the wet lab, incubated and assessed for the numbers of faecal coliforms. A small amount of waste is generated as a result of the samples and includes the agar plates, paper towels and the collection bags.

2. Antarctic field training

The duration of this training was 2 days, the night being spent in a snow mound. Activities included safety training in self arresting and walking on snow covered slopes. The area was not far from Scott Base and is commonly used for this purpose. Following the safety training was a walk around an icefall. This required us to be roped together in four groups of six lead by an experienced instructor. This was not a new track, and completely covered in snow or ice.

The snow mound exercise occurred at a regular campsite, where evidence of previous snow mounds was still obvious. Snow mounds are not flattened back into the ground but are raised and accumulate snow around them. The majority of waste was taken back to Scott Base, including food scraps, paper, faeces and the like. Urine and Grey water was discarded at a designated flag. Concentration of urine and grey water will have increased while we were there but would eventually be covered in fresh snow and diluted.
There was no extensive search for rubbish, but during our stay each group was responsible for their designated area. Transport to both the training site and the snow mound site involved the use of hagglunds. Two were required in order to carry all of the people and the gear.

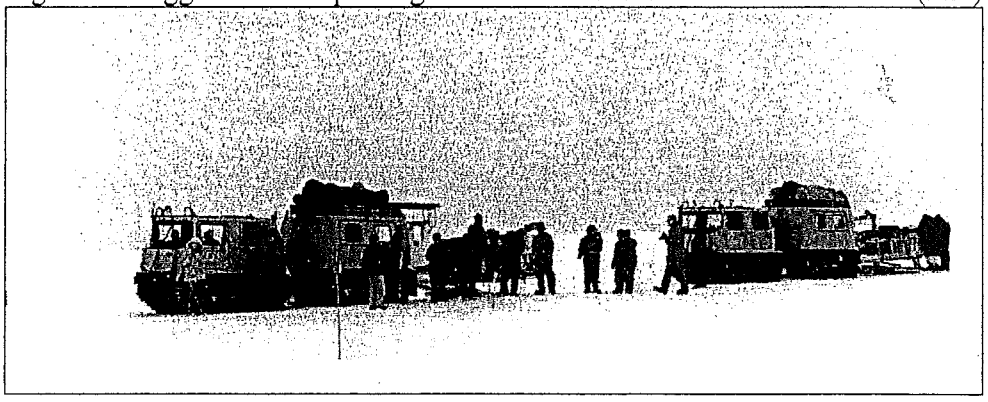
Figure 2 on the following page illustrates one of the groups walking through the ice-fall.

Figure 2: Walking in an ice fall at field training (JH)

3. Black Island

Logistics for the trip out to Black Island was huge for a group of our size (21). We required two hagglunds each with a compartment and large sledge attached, to transport us and the gear to the camp site (refer figure 3). The trip out there took approximately 5.5 hours because we went round the other side of the island and ended up coming back round to set up camp.

Figure 3: Hagglunds transporting us to Black Island (NN)



On our way out to Black Island we saw an emperor penguin walking alongside the ice road. The hagglunds stopped and we were allowed to get out and look at the penguin and photograph it. Guidelines were observed when moving around the penguin.

We camped in an existing camping area. The toilet facilities consisted of two buckets, one for urine and one for solids, sheltered behind a snow wall. All of the waste generated at the campsite was taken back to Scott Base and disposed of, including grey water.

The second day comprised of walking up a scree and ice slope to the study site. This involved walking over areas that were not covered in snow or ice and fragile. There was a partial track that had been made to assess the suitability of the area for our course and before this, the area was untracked. At the first ice-free area, we stopped and studied the geology and ecology. The ecology section involved looking closely at where you put your feet because the moss and lichen communities were tiny. It took about 3 hours to get to the actual study site, which involved a large number of people walking over areas that were ice and snow free. Figure 4 shows the study site for the ecology component. We got the opportunity to view a preserved seal; no one touched the seal. New tracks were formed as people made their way to the study area.

We discussed the geology briefly, but the weather began to deteriorate so we moved onto the ecology section. Rocks were removed from the study area to study later at Scott Base. To study the ecology, quadrats were placed on the exposed ground and soil was scraped from around each quadrat to enable future identification and study. Care was taken when making observations inside the quadrat, so as to minimise damage. People were standing randomly outside the quadrat areas and walking over previously untrampled ground. We spent about an hour recording observations and then made our way back down, due to adverse weather conditions. Walking down involved crossing scree areas and some group members did not use the formed route.

Figure 4: Study site for ecology study (NB)

Waste was removed to be taken back to Scott Base, and before leaving, the group formed a line and searched the entire campsite for anything that wasn't snow or ice. Figure 5 illustrates the search for litter.

Blocks of snow that had been piled around the edges of the tents and that had formed the toilet shelter were partially flattened by the group. The journey back involved a diversion to Castle Rock, where we could study the geology and admire the view. The track up to Castle Rock is well established and frequently used.

Figure 5: Litter removal (JB)

4. **Hut Point**

This area is a protected site and clear limitations have been set, regarding the number of people in the site at any one time and the activities within the site. Discovery Hut, which is limited to 8 people at any one time, is located within this site. A maximum of forty people is allowed in the area outside the hut. Our group was briefed on the code of conduct before we went into the protected area, and about how we should behave once inside the hut. Groups of eight at a time could enter the hut and take photos and look at the relics left by past explorers. In close proximity to the hut were two Adelie penguins. The group had to observe the rules about wildlife, especially with how close they got to the penguins.

5. Arrival Heights

A small group of people went up to Arrival Heights, the maximum number of people allowed in the area at any one time is six, and the time spent in the area is limited to 1-2 hours. This is a site of scientific significance and appropriate permission from Scott Base and Mc Murdo was required. In order to maximise efficiency, small groups from K396 accompanied the Scott Base science technician on his routine visits.

6. **Individual Projects**

A variety of studies were done by the members of K396. One study required the removal of soil samples, but analysis was done at Scott Base and no soil was taken back to New Zealand. Some necessary chemicals were taken down with the permission of Antarctica NZ. Negligible time was spent on personal research projects while in Antarctica, which consisted mainly of observations.

7. Recreation

Spare time saw the group skiing, walking up Observation Hill, climbing Castle Rock, walking around the base, catching the shuttle or walking to Mc Murdo Base. The opportunity arose to stay overnight in the A-frame hut, and for a few there was the chance to walk in the IMAX crevasse. Rules had to be observed when leaving the base, because of the extreme environment.

Figure 6: The flagged route up to Castle Rock (JB)

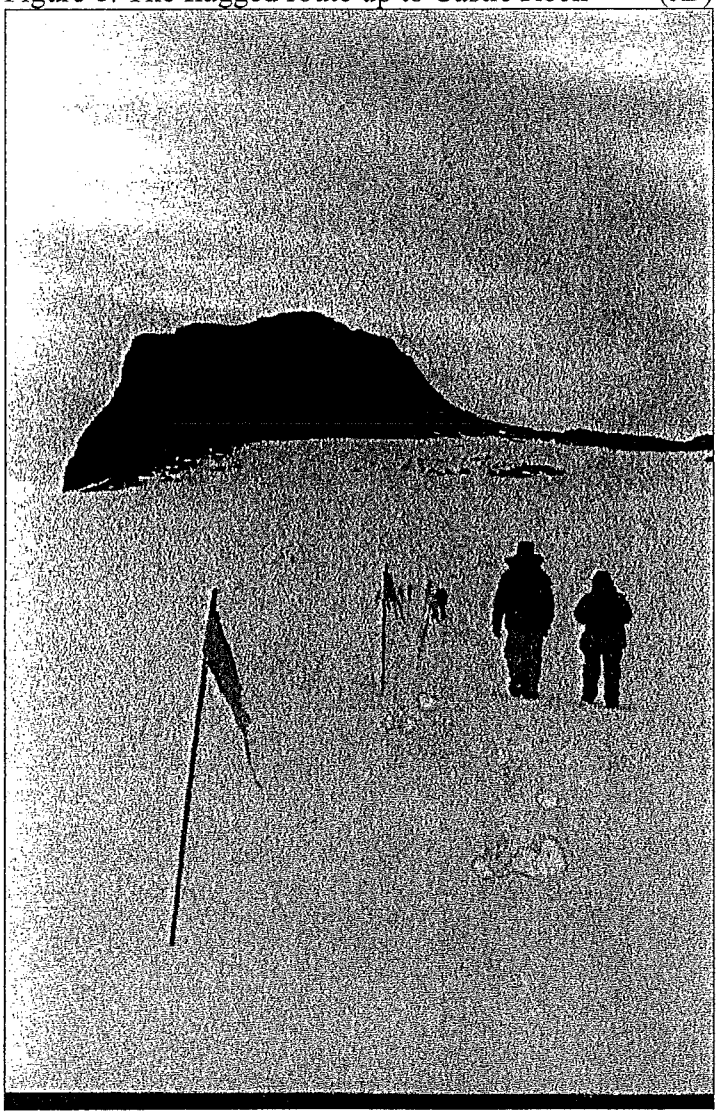


Table 1: Itinerary and summary of activities

Date	Location	Description of activity	Number of people (K396)	Transport
Feb 5th	Pegasus Runway	-Starlifter transports us to Antarctica	21	Starlifter
Feb 6th	Ice fall site (field training)	-Self arresting,ice axe and crampon skills. Guided roped walk around a marked ice fall	21	Hagglund (x2)
	Camp site	-Each group built a snow mound,and slept in it overnight. -Meal preparation.	21 total (split into 3 groups)	Hagglund (x2)
Feb 7th	Scott Base	-Put away gear from field training and prepared for Black Island.	21	N/A
Feb 8th	Black Island	-Transported to Black Island. -Set up campsite immediately on arrival. Constructed toilet shelter (snow wall). -Prepared meal.	21	Hagglund and sledge (x2)
Feb 9th	Black Island	-Commenced field excursion up Black Island. Walked over scree and ice and snow slopes to get to the study site. Studied the local geology and recorded observations. -Counted moss and lichen Populations inside quadrats. -Walked back down to the camp Site. Meal preparation.	20 (at top) 1 returned	Walk
Feb 10th	Black Island	-Packed up the camp site.	21	
		-Removed urine and solids buckets and collapsed the snow wall. -Flattened the blocks of snow that were around the tent edge into the ground. Searched the entire camp site for rubbish (anything non-ice) and took it back to the base.		
	Castle Rock	-Observed the geology, and view! -Returned to Scott Base. -Clean and sort gear.	21	Hagglund
Feb 11th	Scott Base	-Assisted around the base.	21	
		-Water quality sampling proceeds.	1-2 at a time	N/A
Feb 12th	Scott Base	-Water quality sampling	1-2	
Feb 13th	Scott Base/	-Water sample analysis.	1-2	
	Mc Murdo	-Social science-interviews	1 at a time	Shuttle/walk
Feb 14th	Scott Base	-Free time and base assistance	21	N/A
	Castle Rock	-Climbed to the top.	7	Skidoo/walk/
	A-frame	-Stayed overnight.	4	bike/ski
Feb 15th	Scott Base	-Returned to Scott Base	4	Skidoo/walk/
		-Free time	21	bike/ski
	IMAX Crevasse	-Guided and roped together, we walked into the crevasse	5(K396)	Hagglund
Feb 16th	Scott Base	-Base duties and free time.	21	
		-Polystyrene clean up around Construction site/wet lab clean.		
	McMurdo	-Bag drag.	21	Vehicle
Feb 17th	Scott Base	-Final preparations to leave	21	N/A
	Pegasus Runway	-Flight home to Christchurch	21	Shuttle

Future alternative field options

There are three major options when deciding on the future activities of Event K396, with regard to the field component of the Antarctic Studies course. It is likely that alterations will be made to the course activities as it was the inaugural course. They are discussed below:

1. No change to current activities
The existing activities of Event K396 may not require any alterations. For future years, where the course has a Scott Base component it may be run in exactly the same way as in 1999. The following report will endeavour to look at the environmental impacts, which may give rise to a change in the activities of Event K396.

2. Change to the field activities
Antarctic field training is a compulsory safety requirement, however if looking toward the future with a large group of students coming down each year, sites may need to be alternated.

The study site on Black Island could be repositioned to a lower level on the island. The existing site involves trampling over a relatively large ice-free area. Pedestrian damage to ice-free areas can be destructive to lichen and moss colonies as well as to the general ecosystem. An alternative that minimises damage to ice free environments, and still allows for the study of the ecosystem is desirable. It may be better to choose a site closer to the campsite. One such site was identified on the way up Black Island, a clear track led to the area, and the site offered conditions that were similar to areas higher up.

Rocks could be studied at the site rather than being removed for further study at Scott Base. Due to the adverse weather conditions and K396 being the inaugural course, rocks were removed. These same rocks could be stored and studied in subsequent years to minimise environmental change.

Minor changes to the field activities chosen for Event K396 could mean a significant reduction in adverse impacts. This is paramount because so much is still unknown about the carrying capacity and the ability of the ecosystem to recover from human disturbance.

3. Cancelling the field based component
This may mean that the entire course is based in the classroom at Canterbury University, Christchurch, and there is no visit to Antarctica. Alternatively it could mean that the field research is restricted to an area closer to the base in order to reduce environmental and transport impacts.

Table 2: Summary of advantages and disadvantages for alternative field options

Option	Advantages	Disadvantages
No change	No additional areas are impacted. Data has been collected at the 1999 sites and could be used for comparison.	Cumulative impacts from regular use of a site. Irreversible damage to ice-free areas on Black Island.
Change field activities/ activity site	Alternating sites will reduce pressure on the receiving environment. Less trampling over ice-free areas. Minimal change to the environment. Less irreversible damage to the ecosystem. Less cumulative environmental impacts.	Other areas impacted.
Cancel field based research	No adverse environmental impacts.	Education value reduced. Students don't get a real feel for the environment, and the value of protecting it. Research and information on ice-free areas will remain low, gaps in knowledge will persist.
Study closer to the base	Less environmental impacts, as the area is already impacted on by people.	Ecological study limited as moss and lichens will already be damaged, if present at all. Area close to base may not represent 'natural' Antarctica.

Environmental Impacts

This section is designed to give an indication of the environmental impacts that were associated with the activities of Event K396 in Antarctica. Table 3 summarises the key environmental impacts and cumulative effects.

1. Water Sampling

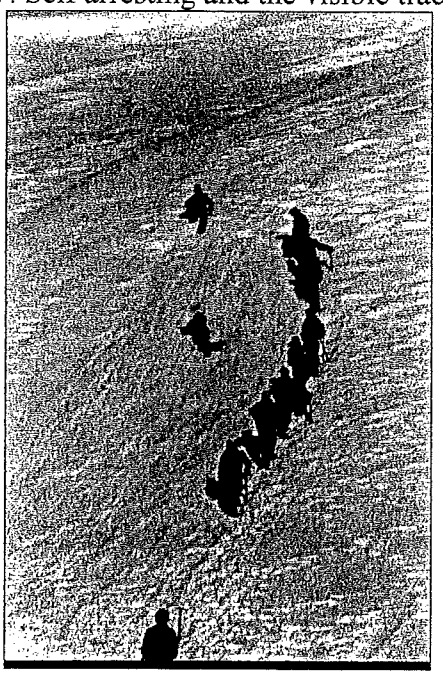
Little impact to the environment, as small samples were taken at the salt-water intake tap in the wet lab. There was the generation of a small amount of waste in terms of the agar plates (plastic), and paper.

2. Antarctic Field Training

Everyone in Event K396 was involved in the field training at the same time. Noise and air pollution from the hagglunds must be taken into consideration.

Tracks were made over the designated training slope, as skills were accrued in ice-axe use and self arresting. This was followed by four guided groups walking around a marked ice fall. During the ice fall exercise, tracks were formed and steps were cut into the ice slopes. These tracks could be seen from the bottom of the hill, leaving evidence of a large group in the environment. Figure 7 shows the group self arresting and the subsequent tracks on the snow slope.

Figure 7: Self arresting and the visible tracks (JB)



3. Snow mound exercise

Disturbance was caused to the local environment as we dug up snow to build our snow mounds (figure8). However, this was an existing snow mound site, and evidence of past mounds were still obvious.

Disposal of urine and grey water was at a designated flag which was yellow and dirty looking by the end. Solid wastes were returned to Scott Base for disposal. Cooking, eating, sleeping can result in littering, no extensive search for rubbish was completed.

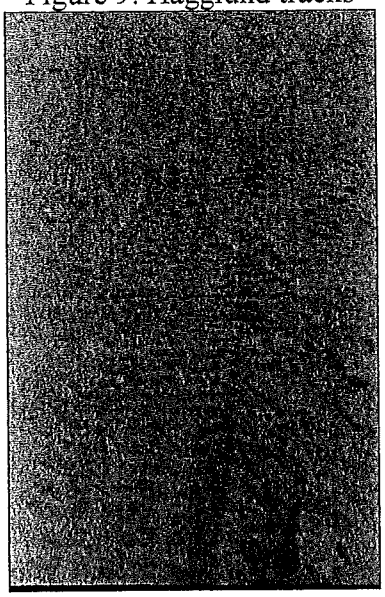
Snow mounds were not collapsed on departure and will persist in the environment accumulating snow around them. There is a possible danger of people falling into existing snow mounds when partially concealed.

Figure 8: Snow mound site (NN)

4. Black Island

Pollutants in the atmosphere from the hagglunds may be a concern. When travelling to and from Black Island, and up to Castle Rock the hagglunds used existing flagged routes. Figure 9 shows hagglund tracks on the snow.

Figure 9: Hagglund tracks



The only noted effects to wildlife occurred when we stopped and observed an Emperor Penguin wandering along the ice road. The large group and the hagglunds may have caused the penguin to rapidly toboggan away, even though the guidelines regarding wildlife were observed.

K396 used a pre-existing camp site, and constructed a snow wall to act as a shelter for the toilet facilities. All toilet waste was taken back to Scott Base for disposal.

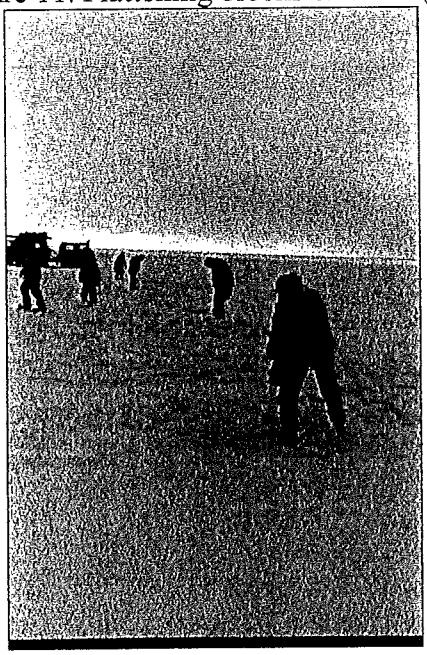
Fieldwork at Black Island required the group to walk over ice-free areas. Quadrats were placed on the ground, and soil scraped from around the edges to enable identification in subsequent years. Signs of trampling around the quadrat sites, in the ice-free areas was obvious (refer to figure 10).

Figure 10: Impact on ice-free areas on Black Island (JH)

Rocks were removed from the environment and taken back to Scott Base for further study. It is unlikely that these rocks will be returned to the original site. No rocks were taken back to New Zealand.

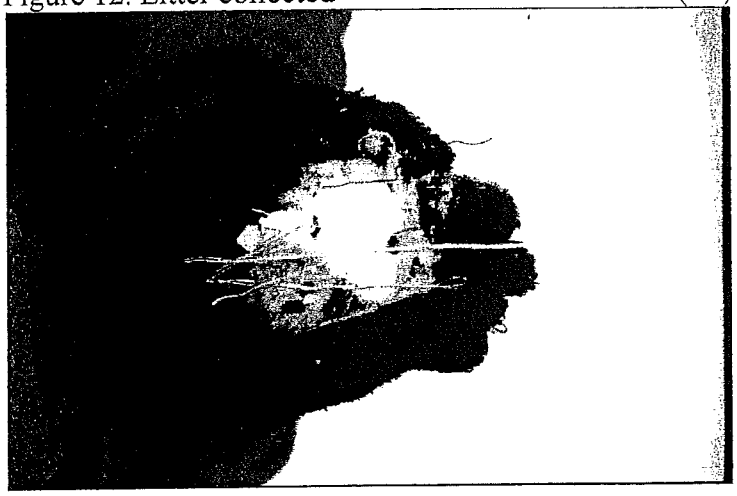
Event K396 walked in areas that were previously untracked and hence caused the formation of new tracks. Events at the camp site were minimal as the toilet wall (snow), the K396 sign of snow (Figure 16), and the blocks covering the tent edges were flattened. Figure 11 exhibits the group flattening blocks of snow.

Figure 11: Flattening blocks of snow (JB)



An extensive rubbish search removed anything that wasn't snow. As figure 12 shows, it was a worthwhile exercise.

Figure 12: Litter collected (JB)



5. Hut Point

On occasions, some members of Event K396 seemed too close to the two Adelie penguins that were nestled on a small mound. No distress was obvious when observing the penguins. Guidelines were reinforced.

There was negligible impact to Discovery Hut, as the group were well aware of and respected the code of conduct. Observations of other visitors caused concern. They were seen to be touching the trousers hanging up and other historic items in the hut.

6. Arrival Heights

There were no noted impacts, as the small group was always accompanied by the science technician. Miscommunication led to one member travelling up to Arrival Heights without the correct permission, but resulted in no impacts to the environment.

7. Individual Projects

Small soil samples were taken (with prior permission) from the road between Mc Murdo and Scott Base, and studied while at Scott Base. All other individual projects involved observations and took up little of the time in Antarctica, therefore impacts were negligible.

8. Recreation

All guidelines were observed in order to minimise any environmental impacts. Activities were all restricted to tracked routes and visited areas. The only questionable activity was the use of a hagglund or skidoo in getting to some of the recreation areas. There is a need to balance the benefits of convenience and safety against the environmental costs. Recreational activities were generally carried out on a smaller scale and in frequently visited areas. A mountain bike in Antarctica provided an interesting type of recreation (figure 13).

Figure 13: Recreation activity (NN)

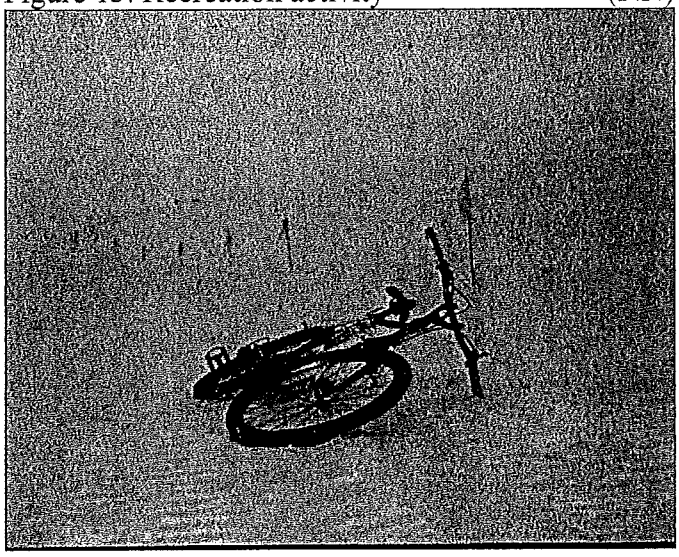


Table 3: Summary of environmental impacts and cumulative environmental impacts

Location	Activity	Environmental Impacts	Cumulative Environmental Impacts
Ice fall site	Self arresting Crampon and ice axe skills Ice fall walk	Damage to the snow slope Impacts are minimal due to the limited time spent in the training site.	Damage from regular use at the same training site Slope may be altered irreversibly from overuse
Snow mound site	Built snow mounds and stayed in them for 1 night. Toilet facilities made. Meal preparation.	Areas of snow dug up. Snow mounds not collapsed Concentration of urine and grey water at the designated flag Litter	Uncollapsed snow mounds persisting in the camp site. Landscape could be altered. Danger of falling into hidden mounds. Local pollution from urine and litter if revisited regularly-may need to remove urine as well as solids from the area.
Black Island	Transport Walking and studying in ice free areas. Camping for 2 nights. Toilet facilities made. Observing wildlife	Air pollution, noise pollution Irreversible damage to fragile ice free areas. Areas previously not walked on were tracked. New tracks formed. Rocks were removed. Possible impacts to the Emperor Penguin encountered along the ice road to Black Island.	Increased pollution to the atmosphere with the regular use of hagglunds in areas such as Black Island. Pollutants may accumulate over time. Damage to ice free areas is concerning if the same areas are going to be studied or new areas explored. Footprints and disturbed soils remain for a long time in such fragile ecosystems. Rock removal over several years may have serious effects on the area.
Scott Base	Water sampling	Waste generation(as with most activities)	Negligible
Hut Point	Viewing the general area and Discovery Hut.	Possible impacts to the 2 Adelie Penguins outside the hut.	Negligible, as the hut is frequently visited, and guidelines are set.
SSSI	Viewing this site of scientific significance.	None	N/A
Scott Base	Individual Projects	Negligible	Negligible
Varied	Recreation: Castle Rock, Observation Hill, skiing, IMAX crevasse etc	Pollution from transport if used.	Transport impacts

Cumulative Environmental Impacts

A definition of cumulative impact in the context of Antarctica is "the impact of combined past, present and reasonably foreseeable activities. These activities may occur over time and space" (IUCN, 1996, p 3). A cumulative impact may be a result of repetitive activity at a single site, or multiple activities, which by themselves are minor but collectively are significant. The assessment of cumulative effects allows for a better understanding of the whole ecosystem and not just the individual elements. "It is human interactions with ecosystems that must be managed rather than the ecosystems themselves" (Cocklin et al, 1990, cited in IUCN, 1996).
Cumulative impact assessment's tend to be more proactive in nature and can allow for the prediction of environmental impacts. By looking at the cumulative effects of an activity, you are

looking beyond the surface and symptomatic level, and toward managing the area to minimise any change.
It is important to discuss the cumulative impacts of groups such as Event K396. The group that comprised Event K396 was only in Antarctica for 2 weeks, so cumulative environmental impacts during this short time were negligible. If the outlook is for 5 years, the possible cumulative effects may be more concerning and this is what will be outlined in this section. The following sections highlight some cumulative effects that may cause environmental concern and are summarised in table 3.

1. Ice free areas

The impact that Event K396 had on the environment in one day up on Black Island was concerning. When trampling over ice-free areas it does not take long for the effects to be detected, especially if the area is previously untracked (refer figure 14). If any ice-free site is visited regularly there will be impacts to the fragile ecosystem, therefore sites may have to be alternated in the future years of the course.

Any human activity will have an impact, but the severity to which it occurs can be reduced. Existing tracks up the side of Black Island need to be used if revisiting the area. In one day, new tracks had clearly and unnecessarily been formed. Precaution should be taken at all times in ice free areas.

Damage to small moss and lichen communities is difficult to ascertain but is likely to be cumulative. Marking the study sites can be justified in terms of identification for future study, but can result in the surrounding area being destroyed in the process. One day a year spent walking and studying in an ice free area seems negligible, but over 5 years the environment is being altered faster than what is natural.

"A carelessly placed boot in a mature stand of lichens can eradicate tracts of the equivalent of an ancient forest in a few seconds" (Smith et al, cited in IUCN, 1996, p 47). Any changes to the Antarctic environment persist for long periods, and cumulative effects may not be outweighed by the benefits of studying in such an area.

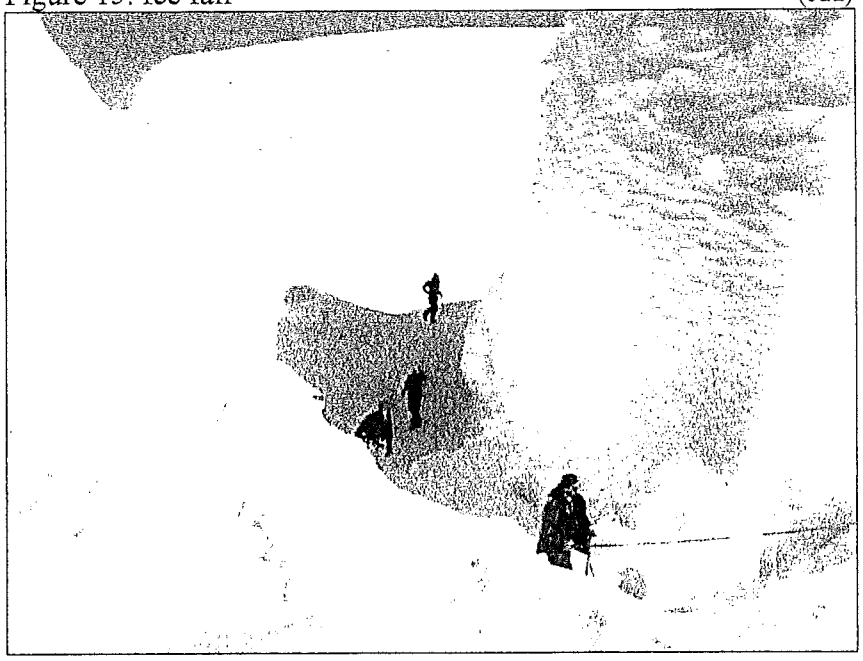
Figure 14: Damage to fragile ice-free areas (NB)

2. Field training site

Damage to the snow slope and the ice-fall area may worsen with regular use. The area is tracked but the routes have to adapt to the dynamic environment. The ice-fall area is not static and will require monitoring. A group the size of Event K396 left obvious signs of disturbance, seen in the form of tracks down the field training slopes. This is likely to be concealed in snow, but snow fall is minimal and effects are not necessarily reversible.

The walk around the ice-fall, shown in figure 15, involved cutting steps into the ice, which could have the potential to be a cumulative impact.

Figure 15: Ice fall (JH)



3. Snow mound site

Snow mounds that are not collapsed remain in the environment. Mounds built prior to Event K396 were still clearly evident, and some posed the risk of having someone inadvertently falling into them. Leaving the mounds in the environment will inevitably change the previously flat landscape. Wind blown snow will build up around the mounds and this may seem minor in the short term but could prove more serious in the future.

Disposal of urine and grey water may need attention if there is regular use of the area, by groups such as Event K396. The area surrounding the flag became yellow and dirty and is a possible environmental pollutant. Litter searches should be more extensive to minimise problems over the next years with the course.

4. Transport

The use of hagglunds by Event K396 could result in a cumulative addition of pollutants into the atmosphere. Noise pollution and effects to wildlife may worsen with regular use.

Summary of cumulative impacts
A lot is unknown about the impacts of activities. Particularly, there is little understanding of the structure and function of ecosystems, the effects of physical disturbance on Antarctic ecosystems and the potential of fuel as a pollutant. These three unknowns have the potential to be cumulative effects (RDRC, 1994). Vegetation found in ice free areas does not possess the resilience and capacity to recover from disturbance like other plants in the world. Low species diversity and severe growing conditions coupled with slow growth and community development mean impacts to ice free areas can be severe. Cumulative impact assessment addresses "environmental effects that can not be captured at the project level" (IUCN, 1996, p20). There needs to be "the recognition of the complex relationship between stressors and the receiving ecosystems" (IUCN, 1996, p21). Identification of cumulative effects has the goal of minimising future environmental impacts.

Measures of mitigating or minimising impacts

This section aims to suggest some options to minimise or mitigate the environmental impacts of Event K396. The water sampling exercise had negligible impacts and therefore little to mitigate. The plastic agar plates and excess paper waste could possibly be recycled. Recycling would require the waste to be transported elsewhere in the world however and the cost would not outweigh the benefits.

1. Antarctic Field Training
It is likely that snow fall would conceal the tracks made from the training. Field training was a safety requirement for our visit to Antarctica and minimising impacts to snow and ice is difficult.

An option would be to alternate field training sites, to reduce the usage in the one area. A lot is unknown about the effects of human activity on snow slopes, particularly regarding carrying capacity and the ability of the slope to return to it's natural state. Tracks around the ice fall were minimised by having everyone roped together in groups and walking in one line.

Alternatively, the field training could be done prior to Antarctica, in the Southern Alps, New Zealand. Conditions would be similar and the skills could be acquired with less pressure on the existing site in Antarctica

2. Snow mound exercise
Collapsing the snow mounds before departing the campsite would have reduced the impact to the environment. According to the Environmental Code of Conduct, campsites must be left in their natural state and this includes flattening the snow mounds. By flattening the snow mounds it removes the risk of someone falling through an old one.

A urine barrel may be more appropriate than the current flag that marks the area of snow where the urine and filtered grey water is disposed of. This would mean that the barrel could be removed and the waste taken back to Scott Base and disposed of. Another option is to alternate sites so that the urine concentration will not reach the high level that it did with Event K396. Frequent use of the site with large groups such as Event K396 could lead to cumulative pollution and aesthetic impacts.

Anything other than snow or ice should not be left at the camp site. An extensive search for litter should be performed to minimise this problem.

3. Black Island

Mitigation measures must include limiting the ice free areas that are studied and hence trampled over. The study site for Event K396 was relatively high on Black Island, which meant a lot of ice-free areas, were walked over. Sites lower down could provide similar study opportunities and would mean less impact to the environment.

"When working in ice free areas keep to the same paths and tracks when travelling to work areas." This is outlined in the Environmental Code of Conduct to minimise damage due to trampling. It is difficult to know whether this would be the best option when walking in a previously untracked study site. The site would only be visited once a year, and the creation of one track may not be justified. A single track walked over by a large group may take longer to recover than a few minor paths. This is indicative of the confusion that can arise from little knowledge about the interactions between ice free areas and human activities. Studying in a site closer to the camp site would be the more favourable option and will reduce the environmental impacts.

Mitigation measures must account for the cumulative impacts to the environment. The placing of quadrats has a minimal impact, but when coupled with random trampling around the study site, the cumulative impact becomes increasingly concerning. Studying and understanding the interactions between a large group and ice free environments would lead toward proactive management and impacts being avoided (IUCN, 1996). Rocks should not be removed from the environment to avoid changes to the environment.

Having the geological and ecological studies undertaken at a site closer to Scott Base would be the only way of minimising pollution from the hagglund. Other pollution is minimised by taking all liquid and solid waste back to Scott Base for disposal. The flattening of the toilet shelter made of snow blocks reduced camp site impacts.

Impacts to wildlife, if seen on route to Black Island are minimised by following the guidelines, which restrict how close you are able to get to the wildlife.

4. Individual Research Projects

A full description of the individual project, written prior to the Antarctica component, would highlight and allow for the mitigation of any environmental impacts. Most projects only involved observations and no impacts.

5. Hut Point / Arrival Heights/ Recreation

By following the appropriate codes of conduct any impacts can be avoided or minimised. Education and appreciation toward the guidelines that have been written, minimises any adverse effects of having people in such a special environment. In terms of recreation, walking on tracked areas reduces impacts and is essential for safety.

Monitoring of Environmental Impacts

"Monitoring is a fundamental element of environmental management and conservation" (SCAR, 1996, pvii). By one definition monitoring is the "standardised measurement or observation of key variables or outputs over time, their statistical evaluation and reporting on the state of the environment in order to define quality and trends" (SCAR, 1996).

Monitoring allows for the protection of the scientific value of Antarctica as well as improving environmental management strategies. Monitoring is also paramount for meeting the legal requirements of the Protocol (SCAR, 1996). Any alteration, even if seemingly minor, can be significant in Antarctic ecosystems. Minimal monitoring of the environment is a requirement of the Protocol and reflects the precautionary approach.

Article 3 of the Protocol outlines the principles regarding activities in Antarctica. It specifies that regular and effective monitoring is important for assessing impacts and detecting change (SCAR, 1996). It is important to select appropriate indicators for measuring the health of an ecosystem, for example community structure (Cocklin et al (1990), cited in IUCN, 1996).

In the context of Event K396, monitoring is important for the future of such courses in Antarctica. The report has outlined environmental impacts and discussed some of the possible cumulative impacts. With a 5 year outlook, ice free areas will need particular attention and monitoring if cumulative impacts are to be mitigated. This precautionary approach is crucial when so little is known about the threshold of such fragile environments. "Once a human impact has occurred, an area can no longer be regarded as 'pristine' and its value as a natural site may be compromised" (Towle, 1990, p111).

Overall, a clear procedure that monitors any changes due to activities in the field from groups such as Event K396, will allow the educational element to be maximised with minimal cost to the environment.

Figure 16: K396 sign constructed of snow, at Black Island

Conclusion

- The Antarctic component of the Certificate in Antarctic Studies involved significant amounts of time to be spent in the field. Several activities were undertaken by the members of Event K396.

- Field based work in the Antarctic environment had a high educational value, however there were environmental impacts.

- As with any activity, alternatives are available. The desirable alternative will be the activity that maximises the educational value and minimises adverse impacts on the environment.

- Environmental impacts that are discussed include:
  - damage to the Antarctic field training site with regular use
  - not collapsing the snow mounds
  - litter at the campsites
  - studying and trampling in ice-free areas on Black Island
  - removal of rocks, and soil disturbance on Black Island
  - formation of new tracks
  - wildlife impacts
  - transport and associated pollution
  - cumulative environmental effects

- Cumulative environmental effect assessment is a proactive measure for minimising environmental effects. It is increasingly important because little is understood about the resilience of an ecosystem to disturbance.

- Various options exist for mitigating or minimising environmental impacts in the field. Measures of mitigation include collapsing the snow mounds, changing the study location in the ice-free area on Black Island, and alternating study sites.

- Monitoring of the environment allows for the detection of any change. Any level of change can be significant to the fragile ecosystems of Antarctica, and monitoring is a proactive measure.

- From this report, Event K396 appears to have had a minor or transitory effect on the environment. Some impacts were not accounted for in the PEE, and this suggests that there needs to be an IEE for future courses.

- All human activity has an impact on the environment. Recognising the "complex relationship between stressors and the receiving ecosystems" is crucial for effective management (IUCN, 1996, p21). Because little is known about fragile ecosystems, such as ice-free areas, the precautionary approach and proactive measures should be adopted.

- The Certificate in Antarctic Studies provides definite positive outcomes for the future management of Antarctica.

Discussion

"The equation of animal and vegetable life is too complicated a problem for human intelligence to solve and we can never know how wide a circle of disturbance we produce in the harmonies of nature when we throw the smallest pebble into the ocean of organic life" (Marsh (1864), cited in Cocklin, 1990, p1).

The above quote recognises the disturbance that human activities can cause, as well as the amount of knowledge we do not have regarding ecosystems.

Event K396 was an inaugural course in Antarctic Studies involving a substantial amount of time in the field. A PEE was completed prior to arriving in Antarctica and indicated that effects on the environment would be less than minor.

An evaluation of the observed impacts that accrued from the field activities indicate that some impacts are not less than minor or transitory. Of particular concern is the impact to the ice-free area on Black Island. Signs of disturbance to the fragile ecosystem were detected after a short time in the area. The potential for the impacts to be cumulative is high, and proactive management must be adopted to minimise impacts. Alternative sites that have less disturbance and a high educational value are favourable options.

Impact mitigation and environmental monitoring are important measures to ensure the protection of Antarctica. Little is understood about the survival thresholds of many Antarctic ecosystems, and their ability to recover from human disturbance, hence care must be taken. Slight alterations to the activities, such as collapsing the snow mounds and alternating study sites would greatly reduce any impacts.

The educational benefits of such a course justify the field study component, and the knowledge and expertise gained seems to outweigh the costs.

Members of Event K396 were well informed and sensitive toward the environment and staff while in Antarctica.

The PEE states that there will be no trampling, tracking, disturbance or sampling in ice-free areas. It also states that there will be no tracking of previously untracked ground and no removal of geological samples including rocks. Observations of K396 during the activities saw some, or all of the above happening. The actual impacts were quite different than predicted but easily mitigated.

An Initial Environmental Evaluation (IEE) is recommended for future course field activities, especially when there is an outlook of at least 5 years. Detrimental environmental impacts must be minimised so as to retain the scientific, aesthetic and wilderness values.

On completing the Certificate in Antarctic Studies, students will have the ability to educate others with the expertise and experience gained.

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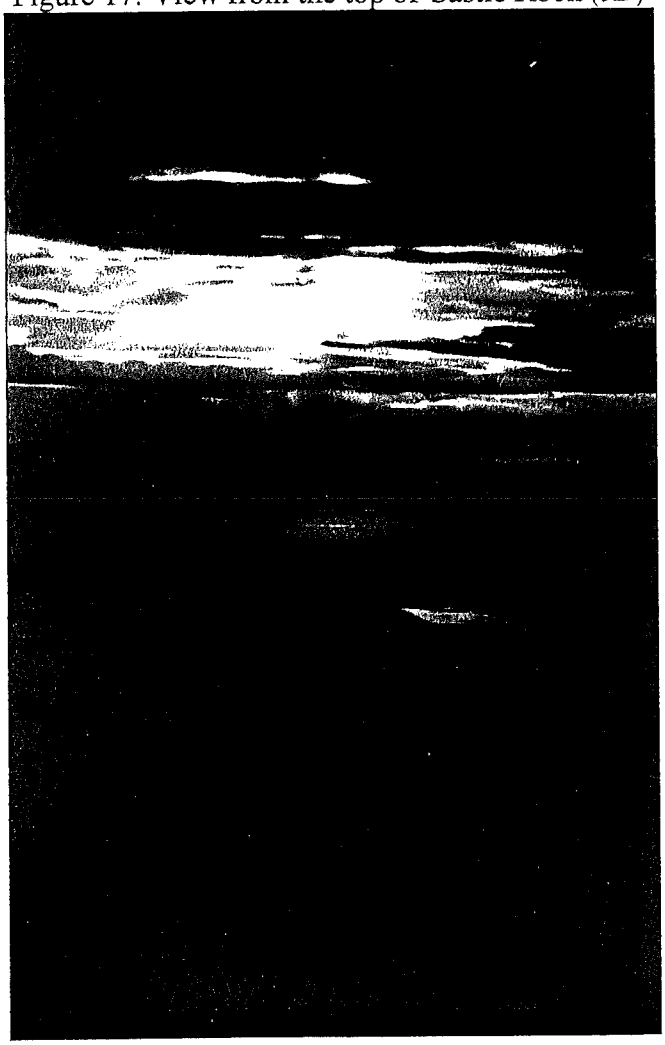
Photos
JB- Joanne Bishop
JH- John Hay
NN- Nicola Noble
NB- Nick Boniface

Figure 17: View from the top of Castle Rock (JB)



APPENDICES

Appendix 1

PRELIMINARY ENVIRONMENTAL EVALUATION (PEE)

Description of the Activity

1. Programme Title: K396 Certificate in Antarctic Studies

2. Programme Leader: Tim Higham (until course cordinator appointed)

3. Describe the main characteristics of your proposed activities in Antarctica.

The Certificate in Antarctic Studies is designed to provide an high quality educational programme for students with an interest in pursuing postgraduate research in fields related to the Antarctic, and for people working in relevant professions and organisations who are able to make a significant contribution to their communities as a result of the programme.

A 10 day field trip to Scott Base (5-14 February) follows six weeks of intensive study at Canterbury University and leads on to a significant supervised project.

The course is restricted to 20 students, accompanied by four course supervisors. Development and teaching of the course has involved input from all New Zealand universities.

Activities will be confined to the Hut Point Peninsula area and a two day overland field trip to Black Island (geological emphasis) on the Ross Ice Shelf. This will involve half the group on two separate trips. Travel will be via oversnow vehicle along the USAP Black Island traverse route. The vehicle will not travel over any ice free area, except on roadways near the US communications facility. The party will camp overnight either on the ice shelf or near the US facility.

4. List the areas in which you will be working and/or visiting. Provide maps detailing the proposed locations if these include less well known sites.

Hut Point area, Black Island.

Potential Environmental Impacts

5. Will the proposed activity:

a. Use any radionuclide or chemical in Antarctica? No

b. Use explosives in any way? No

c. Take to Antarctica any animal, plant, seeds, microorganism or soil? No

d. Enter any Antarctic protected area? Yes

If Yes, complete the following:

Name of Area	*Approx. date of visit*	*Duration of Visit & Party Size*
SPA 28 Hut Point	5-14 Feb	2-3 hours, max. 24 persons
SSSI 2 Arrival Heights	5-14 Feb	1-2 hours, max. 6 persons

Why does the work need to be carried out within the protected area and how does the activity accord with the requirements of the management plan for the area?

Familiarisation and education visit to the historic hut at Hut Point consistent with the goals of the management plan. The leader of the group visiting the huts will sign out the key from the base manager and is responsible for briefing the party on the AHT code of conduct, permit and management plan requirements. Limits on numbers within the hut will be observed at all times.

The visit to Arrival Heights will involve a sub-group of the event (6 persons) working on related atmospheric science issues. The visit with be coordinated with the Scott Base Science technician to minimise the number of vehicle trips within the SSSI. Students will walk into the SSSI if possible (ie if they do not have a significant amount of equipment to carry).

e. *Kill, injure, molest, take or otherwise harmfully interfere (including restraining, tagging, banding) with any terrestrial, freshwater or marine plant or animal?* No

f. *Take or remove any geological samples including rocks, soil and fossils?* No

g. *Install any equipment, markers, stakes and or cairns?* No

h. *Trample, track, disturb, flood, sample, use vehicles, erect buildings or structures in any ice free area ie bare ground?* No

i. *Occupy new camp sites, or track previously untracked ground?* No

j. *Have any other environmental impact not identified in the above eg visual impacts, generation of excessive dust and/or noise?* No