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# Is Maritime Antarctic Ready for the Impacts of Commercial Tourism?

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Abstract: Antarctica has been turned into a tourist destination and this situation requires understanding how tourism activities and increased visitor numbers affect to wildlife. Some areas, as Maritime Antarctic, present higher sensitivity to this threat and that is the reason why many researchers have focused their studies on this area. Our paper reviews their work and proposes some discussion points.

## Antarctic tourism trends

Currently, tourists can visit Antarctica as easily as any other part of the world, though visitors are not everyday vacationers. Scenery, wildlife, adventure and a unique sense of remoteness are strong attractions to thousands of tourists. From small beginnings, around the 1920s, a substantial tourist industry has grown handling by ship 30232 visitors in 2004-05 season (IAATO 2006). Tourists, who pay large amounts of money to experience Antarctica, are exceedingly motivated to preserve what they have come to see, but their numbers are becoming worrying (ASOC 2000, 2002).

## State of the art: assessment of environmental impacts of Antarctic tourism

Antarctica symbolizes the last great wildernesses, so it is understandable that much research has focused on the effects of tourism activity.

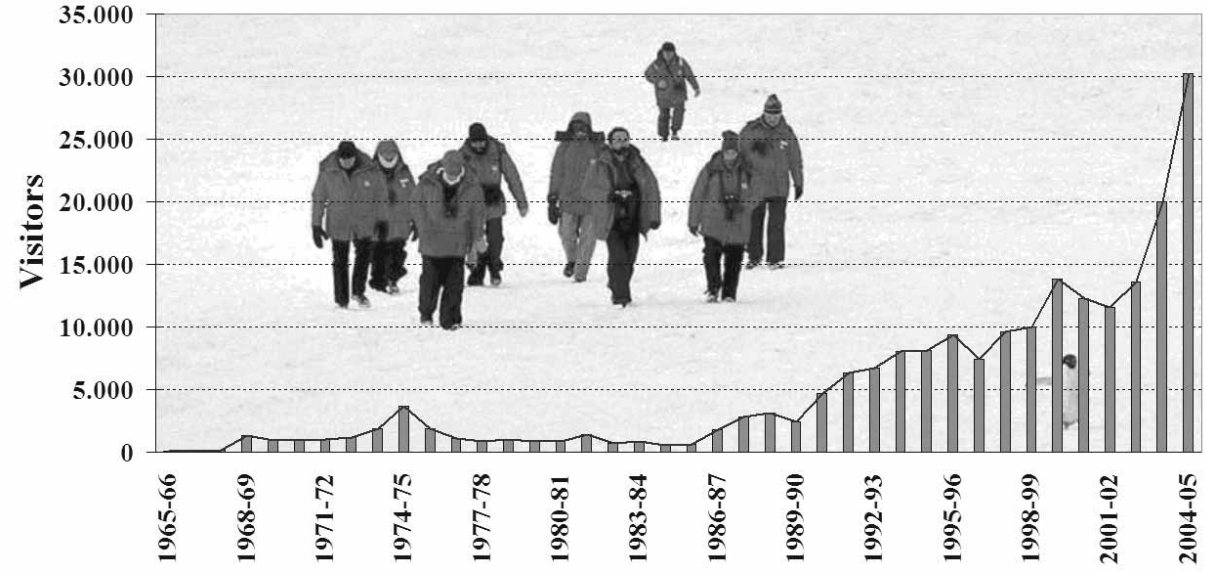


Figure 1: 1965-2005 Antarctic shipborne tourists trends. Chart doesn't include flight passengers (Bauer 2001, IAATO 2006).

But the assessment of environmental impacts of tourists and their activities in this region is still at its first stages. Potential negative impacts are often highlighted in the literature (table 1), and even though there are many descriptive surveys, very little quantitative data are provided. The main obstacle has been the absence of an initial environmental reference state. Some baseline data on specific visited sites are beginning to be compiled through initiatives as the Antarctic Site Inventory Project, operated and managed from 1989 to 2004 by the nongovernmental organization Oceanites, Inc. At 570 visited sites, the Inventory routinely collects (Naveen 2005):

- Basic Site Information, which includes descriptions of key physical and topographical characteristics: latitude and longitude, distribution of flora, seal haul-out and wallow locations, and discrete groups of breeding penguins and flying birds.
- Variable Site Information and Data, which includes weather and other environmental conditions (sea ice extent, cloud cover, snow cover, temperature, wind direction and speed), biological variables (number of occupied nests, number of chicks per occupied nest, ages of chicks), and the nature and extent of any observed visitor impacts (footprints or paths, cigarette butts, film canisters, and litter).
- Maps and Photodocumentation, which portrays the main features of each site, particularly the locations of colonies and assemblages of resident fauna and flora.

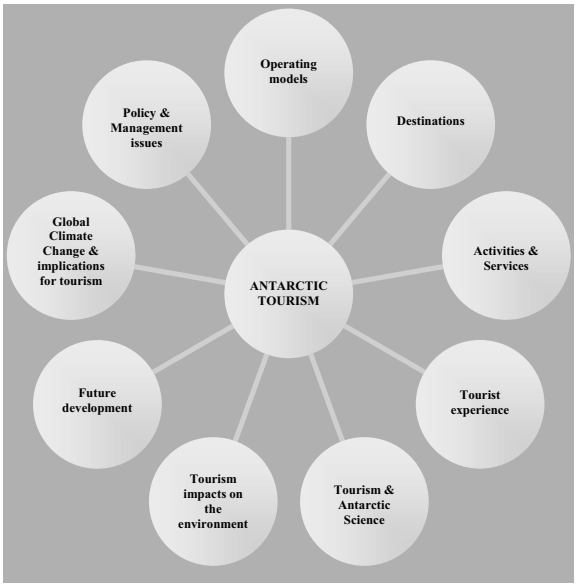


Figure 2: Conceptual framework of Antarctic tourism components. It is essential to have a correct understanding of these components before discussing the effects of tourism activity. We recommend as a first report the particularly noteworthy Bauer's (2001) Tourism in the Antarctic: Opportunities, Constraints and Future Prospects.

Table 1: Antarctic tourism impacts (IUCN 1991, Inskeep 1991, Mason & Legg 1999, Kriwoken & Rootes 2000, Bauer 2001, Hofman & Jatko 2001).

**Positive impacts:**

- Conservation of important natural areas and archaeological and historic sites.
- Improvement and monitoring of environmental quality.
- Increasing environmental enhancement; visitors gain a great enhanced appreciation of Antarctica's global importance and they act as an *Ambassador to Antarctica*.
- Scientific activities may also benefit since tourist visits can provide a useful link with the outside world and strengthen political support for Antarctic Science.
- Tourists are taxpayers and as such are the funding source of the research that is carried in Antarctica.

**Negative impacts:**

- Pollution: water, air, noise, visual.
- Waste disposal.
- Ecological disturbance at wildlife breeding sites.
- Trampling of vegetation (e.g. moss takes over 200 years to regenerate).
- Introduction of non-native species: microbes, plants and animals. These organisms could turn into invasive species because of the global climate change.
- Environmental hazards of accident with an elevated cost of cleanup operations.
- Damage to historic sites.
- Land use problems: disruption of routines at stations and of scientific programs.
- Non scientific collection.

This initiative has allowed to establish potential indicator species of environmental change, including seals, penguins, seabirds and flora, although the Inventory has focused on taking a census of four penguin species (gentoo, Adélie, chinstrap, and macaroni) and five species of flying birds (blue-eyed shag, southern giant petrel, kelp gull, and Antarctic brown and south polar skuas). There are great steps forward after more than ten years of Antarctic Site Inventory data collection (Naveen 2003): establishment of a methodology for a coordinated Antarctic monitoring program; the selection of indicator species to monitor; and the baseline to ascertain whether populations of these indicator species are being impacted directly or cumulatively. Nevertheless, even counting on these improvements, it is very unlikely to find a direct causal link between tourism activities and impacts in the ecosystem as a whole. If changes are detected, complex questions related to prey availability, reproduction, climate change and breeding territory make complicated to distinguish if it is human presence or other factors the ones behind these fluctuations.

An often-mentioned example could illustrate these difficulties: the research focused on the Adélie penguin rookery at Cape Royds, Ross Island. This population had a relatively constant bird number between its discovery in 1904 by Scott and Wilson and 1956. By 1962, the penguin population was almost halved. Many researchers attributed this decline to helicopter operations and other disturbances to birds by visitors. Overflight of the colony was prohibited and restrictions were placed on the number of visitors allowed in the area and their activities. As a result, the colony returned to its former size. Nevertheless, a strict cause-effect relationship has not been established: increases since 1968 have been in accordance to trends in colonies throughout the region.

It is possible to find other similar examples, as the study designed to examine tourism impacts on Adélie penguins near Palmer Station, western Antarctic Peninsula (Fraser & Patterson 1997). Within the context of a regional decrease in Adélie penguin populations, researchers considered the next question: are colonies in the Palmer Station area visited by tourists decreasing faster than non-visited colonies? After sampling for nine seasons, significant differences based on disturbances produced by visitors were not obtained. It seems that colony-specific differences in population trends are based on interactions between breeding habitat geomorphology and the effects of increasing snow accumulations during winter and spring due to climate warming in the Antarctic Peninsula (this region is one of the fastest warming places on the Earth with ~2.5º C rise in temperature over the past 50 years). Detecting the effects of human activity on Antarctic wildlife populations is beyond our current abilities to quantify and understand the natural variability in spatial and temporal scales manifested by these populations.

## Is commercial tourism the principal threat over Antarctica?

It is necessary to put Antarctic tourism activities into perspective before befall into pessimism. It needs to be reminded that the effect of this industry on the Antarctica may be considered insignificant if we compare it to the damage produced by the construction of permanent bases and summer stations. Headland (1994) estimated that, on the basis of presence days, less than 1% of human impacts can be attributed to tourism. The rest comes from scientists and government staff. Some researchers suggest to increases this percentage due to the large increases in tourist numbers. Moreover, human activities use less than 0.005% of the Antarctica area (the size of this continent is 14.2 million square kilometres, or nearly twice the size of Australia). First conclusion could be that most parts of Antarctica are never visited by tourists, but this is an excessively simplistic reasoning. Coastal areas are more vulnerable since they are free of permanent ice cover and these are the sites used by wildlife (penguins, seals and seabirds) for daily and seasonal activities (Stewart 2005). Antarctic tourist activity is concentrated in the austral summer (November to February), during the period of ice thaw, which corresponds to the breeding seasons of a large number of indigenous species (Mason & Legg 1999).

Other considerable problems such as the Antarctic ozone hole, the climate warming, or the introduction of exotic species are threatening the con-

servation of the Antarctica. Unfortunately, there is a clear association between some of these threats and tourism: the increase in temperature entails more ice free areas during the summer season, which could be visited for a longer period of time. Therefore, exotic organisms carried by visitors could establish permanent populations, or even turn into invasive species, disturbing the actual food web; the risk of transmitting important pathogens among wildlife sites by tourists would become greater, and so on.

## Why do we have to give priority to Maritime Antarctic?

Commercial tourism's risks might be aggravated in the Maritime Antarctic region, where the highest accessibility to coastal wildlife is found. First and second tourist destinations in 2004/05 for the entire Antarctic continent were located in this biogeographic region (Whalers Bay and Half Moon Island, IAATO 2006), since it is the easiest access to Antarctica from ports as Ushuaia and Punta Arenas. All tourism products (ship based, land based

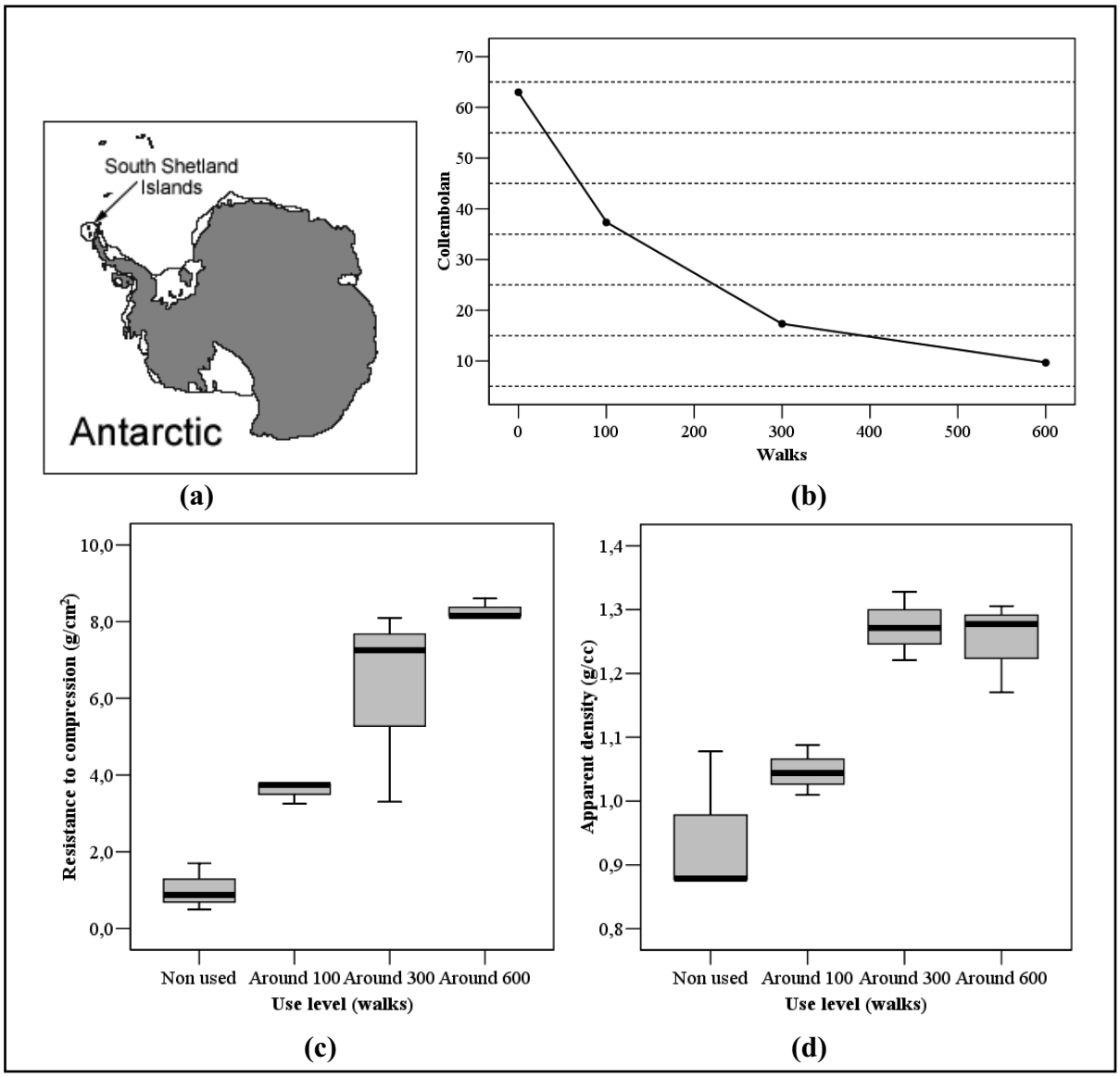


Figure 3: (a) South Shetland Islands, Antarctica. (b) Total collembolan abundance versus number of walks in an experimental area (2004/05 summer campaign). Under experimental conditions, human presence generates an immediate impact on the first centimetres of surface soil, which causes a progressive reduction of collembolans. (c,d) Box-plots by levels of use for resistance to compression and apparent density in the 2003/04 summer campaign. Data show that a minimum human presence is able to disturb physical characteristics of Byers Peninsula soils; nevertheless, a certain level of use is necessary to obtain substantial changes.

with air support, and overflights without landings) are not only present in this area, but they have an upward trend.

In view of it, our research team has developed a pilot scheme into edaphic, physical and biological characteristics as bioindicators for human impact on Byers Peninsula (figure 3). This is the largest ice-free area in the South Shetland Islands (Maritime Antarctic), with approximately 60 $Km^2$ in extent (one of the largest in the Antarctic Peninsula region). Currently, Byers forms the Antarctic Specially Protected Area Nº126, Livingston Island, due to its paleontological, geomorphologic and biological interest (SCAR 2003). In addition, Byers holds the greatest concentration of historical sites in Antarctica, such as remains of refuges and shipwrecks of early nineteenth century sealing expeditions. Currently, this place has not been subjected

Table 2: The two last decades of research have made possible to produce a series of basic tenets for environmental monitoring (SCAR 1996).

**Concerning the monitoring:**

- Environmental monitoring is only useful when it is firmly tied to an environmental management strategy.
- Monitoring is not the measurement of everything in a haphazard approach to detect change.
- Monitoring should be the precisely targeted measurement of a few key species, processes or other indicators, carefully selected on the basis of scientifically-sound, predetermined criteria.
- A generic hypothesis to cover all environmental monitoring would be "the activity of concern causes unacceptable deterioration of values or resources".
- Specific hypotheses appropriate to particular locations, the activities occurring at the location, and the values that might be impacted must be generated on a case-by-case basis.

**Concerning the design of monitoring programs:**

- Have a clear question: the thought process should have a question, suggest a hypothesis, select indicators and parameters, create a model, apply statistics and tests of hypothesis, and finally make interpretation.
- Have controls, both spatial and temporal where appropriate.
- Have a balanced design (e.g. similar sampling efforts at each impact level and time).
- Have replicates randomly allocated.
- Conduct preliminary sampling (pilot study) in order to assess the sampling methods used to ensure that they are efficient, don't introduce bias into the study, estimate error variability, include appropriate sampling effort to achieve the desired power, and determine natural environmental patterns to be incorporated into the study design (e.g. stratification).
- If statistical analysis assumptions are not satisfied (they probably will not be) then transform the variables before analysis, use nonparametric methods or use simulation or randomisation methods.
- Accept the results (and do not try to find statistical methods that give you the result you want).

**Concerning the variables, these must:**

- Exhibit changes beyond limits of detection.
- Be directly related to a testable hypothesis.
- Be known or measurable above natural variability (i.e. background levels).
- Give information from which management decisions can be made.
- Be able to sustain the monitoring activity.
- Be able to be sampled within logistical and time constraints.
- Be measurable on samples that can be transported without deterioration or be measurable on-site.
- Be amenable to quality assurance procedures including demonstrable precision, accuracy and repeated measures.

**It is also desirable that the parameters are:**

- Measurable by cost effective, simple and standard procedures.
- Strongly related by what is believed to be a causal link to a particular activity or process.
- A direct measure of change in a value of concern.
- Permit generalisations about causative agents.
- Definable in terms of limits beyond which changes are judged to be deleterious.
- Measurable without conflicting with scientific activities.

to significant levels of human disturbance, being investigation carried out through the installation of temporary camps or punctual visits the principal activity at Byers. These circumstances made of Byers a privileged observatory to analyse potential indicators of human impacts on a small scale before translating the methodologies to Maritime Antarctic visited sites.

Figure 3: (a) South Shetland Islands, Antarctica. (b) Total collembolan abundance versus number of walks in an experimental area (2004/05 summer campaign). Under experimental conditions, human presence generates an immediate impact on the first centimetres of surface soil, which causes a progressive reduction of collembolans. (c, d) Boxplots by levels of use for resistance to compression and apparent density in the 2003/04 summer campaign. Data show that a minimum human presence is able to disturb physical characteristics of Byers Peninsula soils; nevertheless, a certain level of use is necessary to obtain substantial changes.

## Which should be the future of Antarctic tourism assesment?

It is necessary to develop as soon as possible monitoring programs for tourist activities capable to detect cumulative adverse effects before these activities reach significant levels and generate irreversible disturbances in the Maritime Antarctic (Roura & Hemmings 2002). Initiatives as the Antarctic Site Inventory Project or the CCAMLR Ecosystem Monitoring Programme (Convention for the Conservation of Antarctic Marine Living Resources) have showed the correct guidelines for future research, but there is still a long way to cover.

Table 2: The two last decades of research have made possible to produce a series of basic tenets for environmental monitoring.

We need to identify potential stressors for breeding species and record responses to environmental disturbances due to tourists. A population response in terms of reproductive success or colony size (parameters used in current monitoring programs), doesn't allow us to identify the effect of human disturbance. Walker et al. (2005) found that breeding adult Magellanic penguins (*Spheniscus magallanicus*) in Patagonia appear to habituate well to tourists and breed in an area where about 70000 people visit during the season. In their study, baseline levels of corticosterone returned to normal after exposure of birds to humans. But they also observed that penguin chicks appeared to show a heightened adrenocortical response to handling stress in nests exposed to tourists compared to chicks living in areas isolated from human intrusions. Walker states: "given that developmental exposure to stress can have profound influences on how individuals cope with stress as adults, this potential effect of tourists on chicks could have long-term consequences". About this possibility, Regel and Putz (1997) pointed out that in Emperor penguins (*Aptenodytes forsteri*), human disturbance can result in an energetically costly increase in body temperature that accounts for up to 10% of the daily energy budget during molt. In any case, monitoring behaviour alone is insufficient to identify stressor factors.

As regards to field work, it is desirable to carry out non-invasive techniques to monitor wildlife populations. Remote sampling by aircraft or satellite is possible, but there are other options. For example, conservation physiology can assess the stress responses of animals resulting from apparently benign human activities such as ecotourism. Nimon et al. (1996) used data loggers located in artificial eggs to measure heart rate in nesting gentoo penguins (*Pygoscelis papua*) and determined that human presence as well as behaviours such as movement by humans caused an increased heart rate.

## Conclusions

International Polar Year 2007-2009 could be a great opportunity to start answering to some questions presented by the scientific community about long-term environmental monitoring in Maritime Antarctica (SCAR 1996): Which activities may have unacceptable effects? Which components of the ecosystem may be affected? Which indicator variables need to be monitored? Which values or resources should not deteriorate by tourist activities? The risks caused by all human activities in the Antarctica are greater than anywhere else, and commercial tourism is already coming. We have

to be ready to provide a suitable scientific support from which environmental management decisions can be made.

## References

Bauer, T.G. (2001). Tourism in the Antarctic: Opportunities, constraints and future prospects. New York.

Fraser, W.R. & Patterson, D.L. (1997). Human disturbance and long-term changes in Adélie penguin populations: a natural experiment at Palmer Station, Antarctic Peninsula. In: B. Battaglia, J. Valencia, and D.W.H. Walton (eds), Antarctic Communities: Species, Structure and Survival, p 445-452. Scientific Committee for Antarctic Research (SCAR), Sixth Biological Symposium. New York.

Naveen, R. (2003). Compendium of Antarctic Peninsula Visitor Sites, 2d edition: A Report To The United States Environmental Protection Agency. US Environmental Protection Agency.

SCAR (1996). Monitoring of Environmental Impacts from Science and Operations in Antarctica. Cambridge.

Tejedo, P. et al. (2005). “Measuring impacts on soils by human activity in an antarctic special protected area”. In: Terra Antarctica Reports (12), p 57-62.