



The effects of human activity and environmental variability on long-term changes in Adelie Penguin populations at Palmer Station, Antarctica  
by Donna Lynn Patterson

A thesis submitted in partial Fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management  
Montana State University  
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**Abstract:**

Human activity associated with tourism and research along the western Antarctic Peninsula has increased significantly over the past 25 years and predictions are this trend will continue. The potential effect these activities may have on wildlife populations has thus become an important wildlife conservation issue because wildlife and human activity tend to converge on the same ice-free areas. To examine if human activities due to tourism and research were negatively impacting Adelie penguins (*Pygoscelis adeliae*), I undertook a study that compared long-term population trends and other demographic parameters at visited and non-visited (control) sites on Torgersen Island, a popular destination near Palmer Station, Anvers Island.

A necessary prerequisite for detecting human impacts on wildlife populations is an understanding of the underlying factors associated with natural demographics. Recent evidence suggests that variability in Adelie penguin demography may be due in part to interactions between the topography of the breeding habitat and patterns of snow deposition. To test this idea, I developed a hillshade model of the island and used regression and discriminant function analyses (DFA) to examine population/landscape interactions. I then applied the results of these analyses to human impact questions.

Results suggest that population trends on Torgersen Island are strongly affected by colony aspect and colony area. Colonies with south-facing aspects are decreasing faster than colonies with north-facing aspects. Smaller colonies are also decreasing faster than larger colonies. Both trends are likely due to interactions between the effects of enhanced snow deposition and decreasing egg/chick survival due to predation and flooding.

To look for possible human effects, I paired colonies by area and aspect on visited and control sides of Torgersen Island. Tourism appears to be having no detectable impact on Adelie penguin breeding population size or breeding success on Torgersen Island; comparisons between population trends in visited and control sides of the island were either not significant or inconsistent with site-specific tourist visitation patterns. Some types of research, however, especially when associated with small colonies, may be detrimental to the long-term survival of these colonies.

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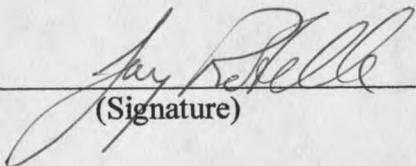
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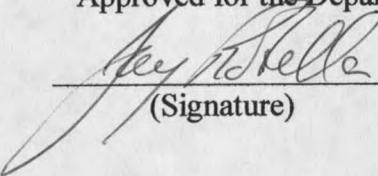
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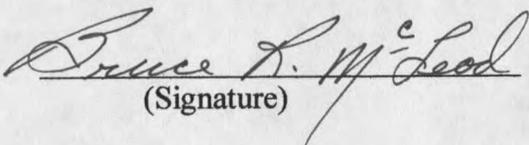
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## ABSTRACT

Human activity associated with tourism and research along the western Antarctic Peninsula has increased significantly over the past 25 years and predictions are this trend will continue. The potential effect these activities may have on wildlife populations has thus become an important wildlife conservation issue because wildlife and human activity tend to converge on the same ice-free areas. To examine if human activities due to tourism and research were negatively impacting Adélie penguins (*Pygoscelis adeliae*), I undertook a study that compared long-term population trends and other demographic parameters at visited and non-visited (control) sites on Torgersen Island, a popular destination near Palmer Station, Anvers Island.

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## INTRODUCTION

Human presence in Antarctica has historically been associated with negative, often devastating, effects on wildlife populations. Following the initial wave of exploration more than two centuries ago, first sealers and then whalers harvested many species of marine mammals to near-extinction (Bond and Siegfried 1979, Knox 1994). The sealing and whaling stations built to support the commercial harvest, especially in wildlife-rich areas such as South Georgia, Macquarie Island and the Antarctic Peninsula (e.g., Port Lockroy, Wiencke Island; Whaler's Bay, Deception Island), also had negative effects on surrounding seabird communities. Penguins by the tens of thousands were slaughtered for the production of unique oils or used to fuel the boilers that rendered oil from seals. Egging and hunting to supply food to the crews manning the stations also took a toll, and the resulting cumulative impacts led in many cases to the decimation of seabird populations at local to regional scales (Cawkell and Hamilton 1961, Croxall et al. 1984, Rounsevell and Brothers 1984, Culik et al. 1990, Woehler and Johnstone 1991).

Although the focus of human activities has shifted during the last 50 years from the exploitation of wildlife populations to scientific research and tourism, concerns about the real and potential impacts of anthropogenic activities still remain. These concerns are not unfounded. Where nesting areas were destroyed to facilitate station construction, as occurred in some extreme situations, penguin populations exhibited predictable decreases and only minimal recovery (Culik et al. 1990, Wilson et al. 1990). Gradual shifts by breeding populations of penguins away from research stations have also been documented (Reid 1968, Thompson 1977, Woehler et al. 1994), and an experimental

study by Giese (1996) that used station personnel as proxy tourists demonstrated that Adélie penguins (*Pygoscelis adeliae*) exposed to "tourism" had a lower reproductive success and more stress-associated behaviors.

However, to the extent that these observations warrant some concern about how research and tourism may impact wildlife populations, there is also a growing controversy regarding cause and effect. This has developed in response to investigations that reveal patterns unlike those described above. At some localities, for example, penguin populations either remained stable or actually increased following station construction and increased human activity (Young 1990, Parmelee 1992, Acero and Aguirre 1994). A controlled study by Cobley and Shears (1999) on tourist impacts at Port Lockroy, western Antarctic Peninsula, indicates that Gentoo penguins (*Pygoscelis papua*) not only increased dramatically in the area, but also showed no differences in reproductive success at visited and non-visited sites despite the presence of thousands of annual visitors. In a similar study, Fraser and Patterson (1997) demonstrated that there was no correlation between long-term changes in Adélie penguin populations in the vicinity of Palmer Station, western Antarctic Peninsula, and the human use histories of area rookeries. Comparable findings were also reported by Stonehouse (1965) and Taylor et al. (1990), who observed that over the course of long-term monitoring, variability in breeding populations of Adélie penguins in undisturbed control areas followed the patterns seen in areas impacted by human activity.

One benefit of this controversy is that subsequent debates have, in turn, led to the formation of a consensus view within the broader community of scientists, government

representatives, environmental groups and tour operators on how to clarify the issue of cause and effect. Three significant components have been recognized.

The first is to understand the nature of the problem and the potential sources of conflict. In Antarctica the activities of both humans and wildlife are focused on a small fraction of the landscape, namely the fringe of ice-free land that surrounds the continent. For wildlife this fringe offers breeding and resting areas, as well as unrestricted access to the marine resources on which most species depend. To humans these same ice-free regions are the prime staging areas for research and associated logistics operations, and the focal point of virtually all tourist activities, which are drawn to these areas due to the presence of wildlife. Sources of conflict are thus defined in terms of potential competition for space as research, and especially tourism, continue to develop (Harris 1991, Enzenbacher 1992).

The second is to incorporate research on human impacts within the broader scope of ecosystem studies. Variability in Southern Ocean ecosystems is strongly coupled to the direct and indirect effects of sea ice conditions, which can affect the demography of seabirds and marine mammals over a range of space and time scales (Testa et al. 1991, Fraser et al. 1992, Emslie et al. 1998, Smith et al. 1999). Except for the rare situations where construction activities may actually alter breeding habitat (e.g., Culik et al. 1990, Wilson et al. 1990), human activity is likely to manifest as an additive or cumulative impact, meaning detection will be difficult unless the causes of natural variability are understood (Fraser and Trivelpiece 1994, Woehler et al. 1994, Fraser and Patterson 1997).

The third is to encourage the development of long-term predator demographic studies to understand and prevent human impacts related to research and tourism. The debate on cause and effect regarding human impacts can partly be traced to conclusions that are based on different scales of measurement (Fraser and Patterson 1997) in which short-term studies that examine responses at the scale of the individual (e.g., Nimon et al. 1995, Giese 1996) are compared to long-term studies that look at change at the colony and population scales (e.g., Wilson et al. 1990, Blackburn et al. 1991, Cobley and Shears 1999, Cobley et al. in press). Previous exposure to disturbance, habituation, age structure, group or colony size and edge effect are but some of the variables that can complicate the comparison and interpretation of such scale-specific studies (van Heezik and Seddon 1990, Wilson et al. 1991). The proposed predator studies, originally implemented in the Southern Oceans to examine the effects of another human activity, commercial fishing (Bengtson 1978, Knox 1994), recognize that long-term demographic data may offer a standard by which to determine if observed variability is due to natural or human-induced factors (Whitehead et al. 1990, Fraser and Trivelpiece 1994, Woehler et al. 1994).

#### Project Scope and Rationale

The first expedition tour vessels sailed to Antarctica in the early 1960s, but the popularity of expedition touring in this region did not begin to increase until 1970 (Holdgate 1990, Enzenbacher 1992). Since 1970, the annual number of tourists visiting Antarctica has increased nearly ten-fold, exceeding 10,000 during the 1998/99 summer

season (NSF 1999). Numbers are not evenly distributed around the continent, however, and it is estimated that 90% of the tourists visit the western Antarctic Peninsula (NSF 1999). The region has become a choice destination for several reasons, but the primary reason is that from the southern tip of South America, access to Antarctica only takes 2-3 days by ship. The presence of international airports and major port facilities also provide key logistical support to ships and their passengers. These are also the reasons that during the past 25 years most countries have built more research facilities on the west side of the Antarctic Peninsula than in any other region of Antarctica (Harris 1991).

Another western Antarctic Peninsula attraction is its wildlife. The peninsula region has a disproportionately greater amount of ice-free land in close proximity to the ocean, which attracts birds and marine mammals in staggering numbers. The opportunity to see penguins is one of the main features bringing tourists into the region, with especially popular locations receiving in excess of 3000 visitors per season (Naveen 1996, NSF 1999). All three *Pygoscelid* penguin species occur here, including greater than 300,000 pairs of Adélie penguins, over 1.1 million pairs of Chinstrap penguins (*P. antarctica*) and nearly 50,000 pairs of Gentoo penguins (Woehler 1993). Penguins occur along the entire length of the western Antarctic Peninsula, and being flightless, tend to nest close to shore, often in large, dense colonies. Apart from being especially conspicuous, nest sites in close proximity to the deep anchorages required by expedition tour ships also makes penguins highly accessible to tourists and potentially vulnerable to disturbance (Culik et al. 1990, Wilson et al. 1991). Penguins are therefore ideal candidates to examine some of the disturbance questions and dynamics presented in the earlier text, and the main reason

why I selected Adélie penguins for the research I conducted in the vicinity of Palmer Station, a U.S. research facility on Anvers Island, western Antarctic Peninsula (Fig. 1).

### Patterns of Human Activity and the Distribution of Adélie Penguins

Fraser and Patterson (1997) recently summarized the broad patterns of wildlife-human interactions in the vicinity of Palmer Station, thus only the patterns most relevant to my research are presented here. Adélie penguins breed on five island rookeries (Fig. 2) that together held 15,200 breeding pairs when they were first censused in 1975. At the time of this census, these rookeries were open to all forms of human activity, including recreation by station personnel, research and tourism. In 1978, however, Litchfield Island was declared a Specially Protected Area (SPA) under the Antarctic Treaty. The island was thus closed to all recreation and tourism, and remains closed today. In 1990, similar restrictions were imposed on Cormorant, Christine and Humble islands. Research, though still sanctioned on these islands, occurs by permit only, and is restricted to activities that ensure minimum disturbance to wildlife populations.

Torgersen Island, in contrast, has remained basically unencumbered by restrictions since the mid-1970s with one exception, which is illustrated in Figure 3. Due to the terrain, scenery and accessibility, tourists were historically drawn to the north and northeast sides of the island, which coincidentally was also the side where much of the early penguin research in the area took place because of its accessible landing sites and relative proximity to Palmer Station. In 1990, after consultation with researchers involved in long-term research at Palmer Station, this division was made official by the

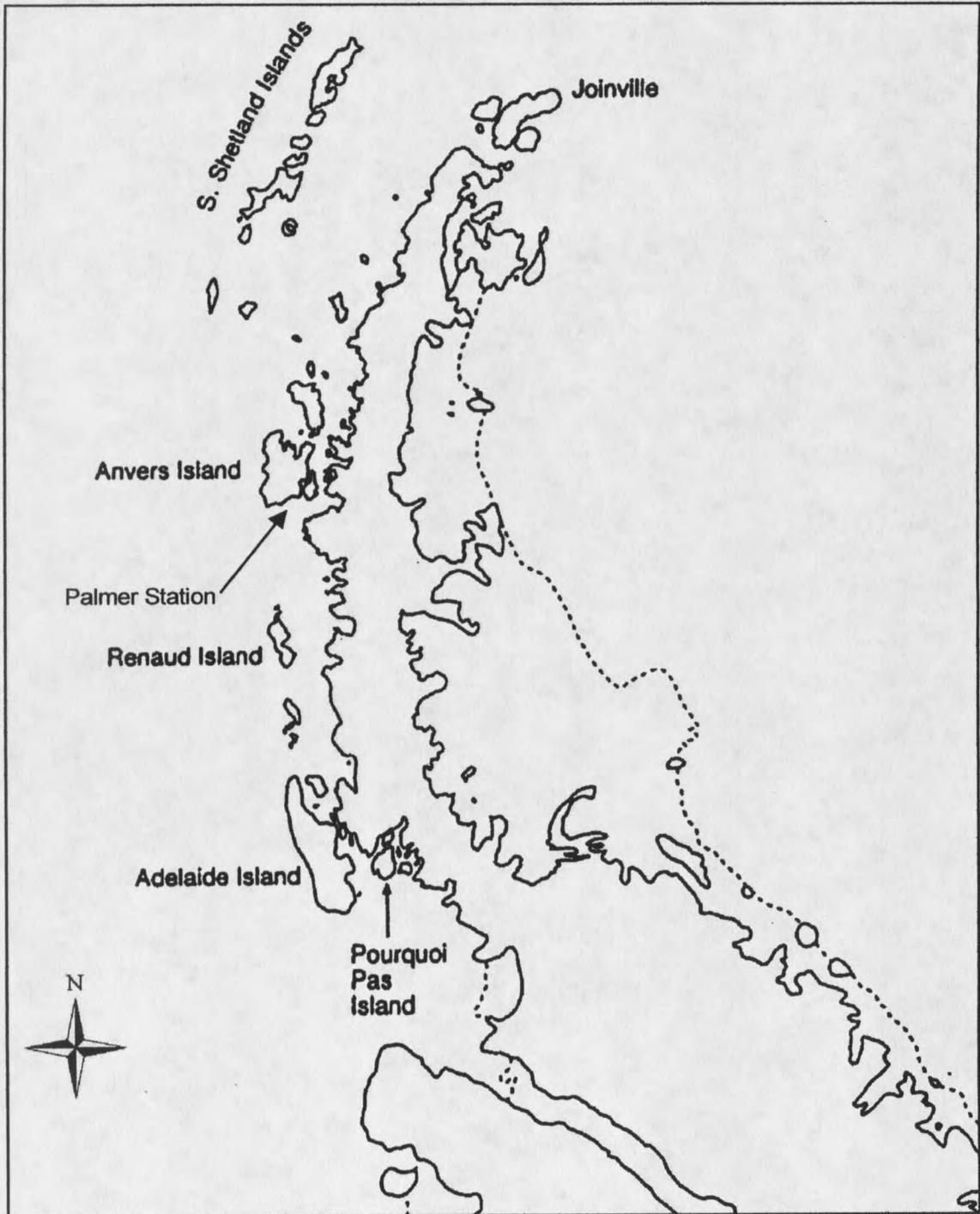


Figure 1. Palmer Station and the Western Antarctic Peninsula.

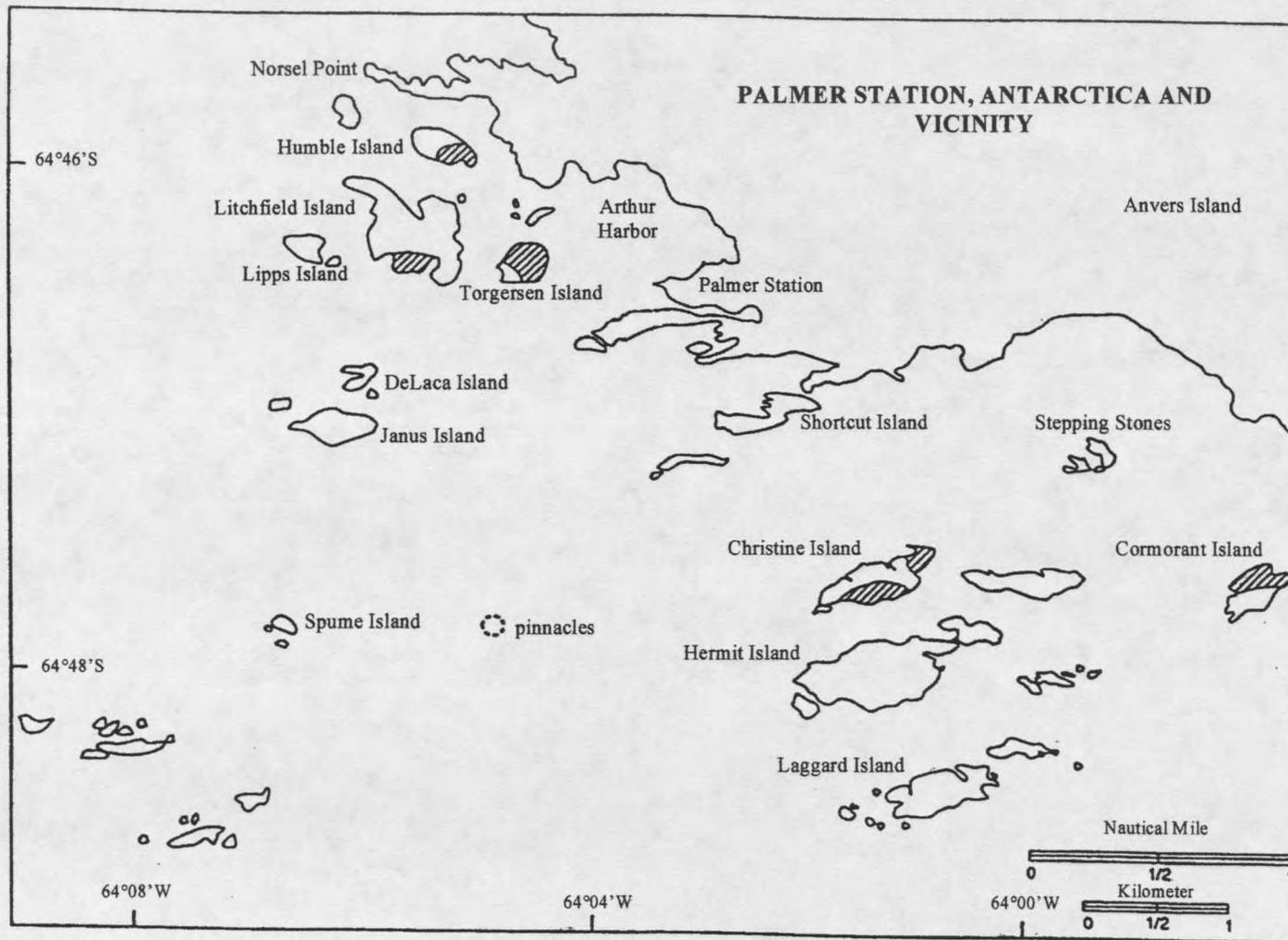


Figure 2. The Location of Palmer Station, Anvers Island. Adélie penguin colonies on surrounding islands are indicated by shading.

































































































