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WILDLIFE TOURISM, SCIENCE AND ACTOR NETWORK THEORY

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Abstract: Wildlife tourism is an important component of tourism worldwide. However, for many species little is known about the possible impacts from tourist-wildlife interactions. Previous research has identified barriers to such science being undertaken but this science–wildlife tourism interface remains poorly understood. Actor-network theory, with its attention to the actors and relationships that make science possible, was used to describe and analyze the development and decline of scientific research into the effects of tourism on wildlife in the Antarctic region. This study concludes that actor-network theory provides a robust description of the complex role and positioning of science in wildlife tourism, while at the same time suggesting that further attention to actors' relative power and scientists' normative beliefs are essential elements of analysis. Keywords: actor-network theory, wildlife tourism, sociology of science.

INTRODUCTION

The wildlife tourism industry is becoming an increasingly important component of tourism worldwide (Roe, Leader-Williams and Dalal-Clayton 1997). Paralleling the increased growth in wildlife tourism is the greater demand for closer interaction with wildlife in their natural habitats. Wildlife tourism is often considered to be a minimum impact activity (Green and Higginbottom 2001), however, in recent years it has been recognised that an increased understanding of tourist-wildlife interactions is an essential contribution to the sustainability of the wildlife tourism experience (Rodger and Moore 2004).

As wildlife tourism increases in popularity so does the need to research, understand and manage potential impacts on the wildlife and their environment. Science and research, complemented by long term monitoring, can contribute to increasing knowledge and better management. Long-term sustainability of this industry is critical and of increasing concern (Reynolds and Braithwaite 2001). The contribution of science and research to wildlife tourism is central to understanding impacts. Rodger and Calver (2005) further identified how science and research can contribute to increased conservation and education as well as anticipate potential problems. However, large gaps still remain in our understanding of impacts of tourists on wildlife, in particular the cumulative and long term effects of these interactions (Newsome, Dowling and Moore 2005).

Past research in Australia into barriers hindering scientists from engaging in research on wildlife tourism has identified scientists' paradigmatic positioning along with difficulties faced in conducting interdisciplinary research (Rodger, Moore and Newsome in press). In the past wildlife biologists and ecologists have not always seen the necessity or importance of research into these tourist-wildlife interactions. And, they regard wildlife tourism science as subjective rather than objective, and therefore 'flawed'. Furthermore, interdisciplinary research is often difficult to undertake, with this form of research bringing together different epistemologies (i.e., ways of understanding and studying the world) and a need for a common goal by the researchers (Moore, Newsome, Rodger and Smith 2009; Rodger et al in press).

This paper reports on how a successful natural science program directed towards wildlife tourism research and translated into management was achievable. Much can be gleaned by examining a research institution where wildlife tourism science was established as a research priority. Actor-network theory is used as a theoretical and methodological lens to analyze the development and subsequent decline of wildlife tourism science in the Australian Antarctic Division (AAD).

Actor-network theory developed in the 80s, with its origins in the sociology of science and technology. Since then actor-network theory has diffused into other areas including environmental (Jakku 2004; Kitchen 2000) and rural (Woods 1997) issues. In recent years actor-network theory has been recognized as an important analytical framework to study emerging tourism projects (Franklin 2004; Johannessson 2005; Van der Duim 2007; Van der Duim and Van Marwijk 2006). Actor-network theory was chosen for this research because it focuses analysis on the relationships between non-humans and humans, natural and social relationships, as a central part of the production of scientific knowledge. Actor-network theory has also been described as ''material semiotics'' or ''relational materiality'' because it extends the semiotic insight from language to include all materials (Law 1999). In this paper attention is given particularly to the key actors and intermediaries who were involved in the development and uptake of wildlife tourism research in the Antarctic region.

ACTOR-NETWORK THEORY AND WILDLIFE TOURISM RESEARCH

Also known as the sociology of translation (Callon 1986a), actor-network theory developed within the sociology of scientific knowledge.

This body of work was developed by Bruno Latour (1983, 1986, 1987, 1996), Michel Callon (1986), John Law (1986, 1994, 1999, Law and Hassard 1999) and more recently Murdoch (1995, 1997, 2001), and Jakku (2004). Actor-network theory proposes a radical constructivist semiotic approach advocating human and non-human entities should be treated equally for purposes of analysis (Ashmore, Wooffitt and Harding 1994). For actor-network theory, similarly to a number of other constructivist theories, scientific knowledge is a social product and contributes to the examination of the power actors hold or wield especially in the fields of science and technology (Callon 1986a).

This analytical and theoretical framework is concerned with the processes by which scientific disputes become closed, ideas accepted and tools and methods adopted. This theory rejects distinctions between science and technology. Instead it explores and follows the strategies actors use to mobilize allies, as well as resources, which ultimately results in the construction of heterogeneous networks (Garrety 1997). It examines how these networks result in science being ‘‘black boxed’’, meaning it becomes an established fact (Latour 1987). For actor-network theory the ‘‘appropriate method for examining science is not to start with particular assumptions about nature or scientists but, instead, to follow and describe what scientists actually do, that is, their interactions with other actors, both human and non-human, that they seek to enrol’’ (Fountain 1999:344).

Actor-network theory examines the mechanics of power through the construction and maintenance of networks (both human and non-human). Actors become involved in networks through the process of translation. Callon (1986a:25–26) described translation as: ‘‘Translation builds an actor-world from entities. It attaches characteristics to them and establishes more or less stable relationships between them. Translation is a definition and the delineation of a scenario.''

An important text in the actor-network theory literature is Latour's (1983) study of Pasteur's scientific career in 1881 and his successful enrolment and enlisting of outsiders into his study of anthrax disease. Latour (1983) highlights how Pasteur convinces other actors that it is his work, and his work alone, which will provide a solution to this disease. Michel Callon's study of a scallop industry in St Brieuc Bay (north western France) followed this and introduced and defined words such as translation, enrolment, interessement, and obligatory passage point (Callon 1986) (Fig. 1). He developed an actor-network account of marine biologists and their strategy to enrol the local fishermen, the scallops (Pectun maximus) and scientific colleagues in an attempt to preserve a population of scallops. The achievement of this was only possible with the co-operation of the other actors: the fishermen, their scientific colleagues, along with the role that the scallops played. This example was used to illustrate how the actor-network, which was constructed by the three researchers, failed once other actors dissented from the network (Callon 1986; Woods 1997). Most importantly the study highlighted how power is in the relations, not in the actors themselves, as power is dependent upon the actions of others (Latour 1986).

Actor-network theory therefore, relies on a large number of concepts including actors, networks, intermediaries and the elements of translation (Fig. 1). Law (1991) identified networks as transforming from heterogeneous into aligned, with such networks made up of people, organizations, machines, animals and more. This attention to networks allows examination of how the networks emerge, who or what each network involves, how they came to be, how they are maintained and how they compete with other networks. It is a means of examining why some networks become established and why others fail.

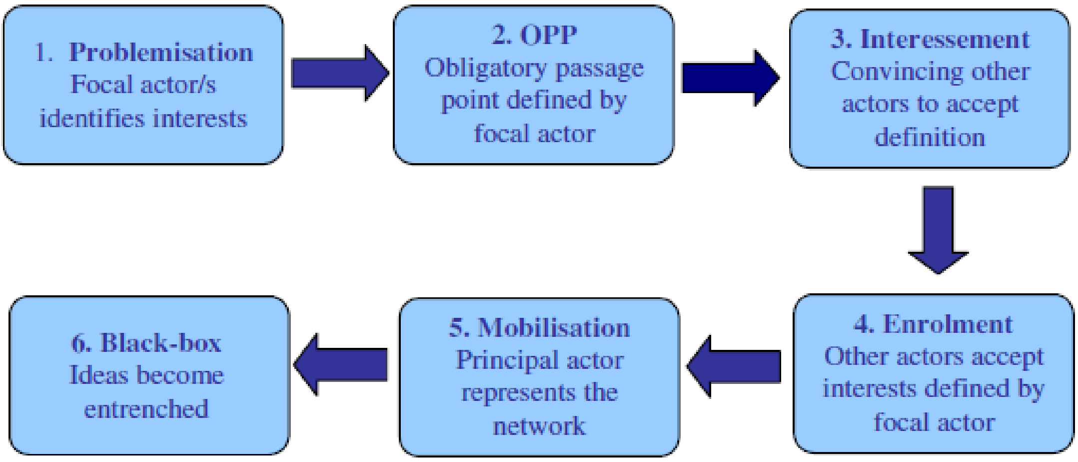

Figure 1. The Phases of Translation

Exploring how actors enlist other actors into their viewpoints to join their network and why this is not always successful (Latour 1996).

After networks have been formed, they may become unstable (Callon 1986a). Translation is an ongoing process as it is never permanent and may fail in some circumstances. The entry of new actors, the departure of existing actors, or changes in alliances can result in the ‘black-boxes’ (Callon 1986) being reopened and the contents reconsidered (Tatnall and Gilding 1999). A network only becomes strong and durable due to the bonds holding it together because it is comprised of a number of simplified networks. The network relies on the maintenance of these simplified networks for its continued existence. If not regularly maintained the network can break down, due to actors dissenting, and even reform in a different configuration or as a different network (Callon 1986a; Tatnall and Gilding 1999; Woods 1997).

Wildlife Tourism Research and the Australian Antarctic Division

Governance of Antarctica is a complex issue and falls under the Antarctic Treaty System (ATS). In 1961 there were 12 signatory nations to the ATS but this has increased over the years to 43 nations (Maher, Steel and McIntosh 2003). Australia, who has claimed national sovereignty in the Antarctic, helped to broker the ATS, which established governance for this area as no country has sole ownership. The ATS was officially passed on June 23, 1961. Australia has claimed 42% of Antarctica as sovereign territory and has had a continuous presence in this region since 1947 (Antarctic Science Advisory Committee 1997). To support the Treaty, the Protocol on Environmental Protection (The Madrid Protocol) was negotiated. This is an agreement between ATS nations focusing specifically on environmental management including regulations, impacts, protection, and adverse effects on the environment (Maher et al 2003). This protocol was originally drawn up in 1991 but was not ratified until Japan signed in 1998.

Australia has a long history of conducting scientific research in Antarctica. The AAD was established in 1948 by the Commonwealth Government of Australia to administer and provide logistical support for Australia's expeditions while maintaining four permanent research stations and managing, as well as undertaking, scientific research programs. The AAD, based in Hobart, Tasmania sends approximately 500 people south each year, of which 80 will spend the winter there (Australian Antarctic Division 2000).

Despite a reputation of remoteness and wilderness, or perhaps because of this reputation, tourism to this area including the sub-Antarctic islands is growing at an ever increasing rate (Enzenbacher 1994; Giese, Riddle and Kriwoken 2001; Maher et al 2003). Tourists travel to Antarctica predominantly by boat, but once there use a variety of transportation, including helicopter, zodiacs, and over-snow vehicles, before approaching wildlife as close as permissible by foot (Australian Antarctic Division 2004a). Modern ship based tourism to Antarctica began in 1958 (Headland 1994) and other tour operators followed. By the late 80s there were a minimum of four ships operating in Antarctica with the tourist season running from October through to April. By

1992/93 this had increased to 12 ships ranging in capacity from 38 passengers up to 530, and the total number of passengers carried over the season was 6,460 on a total of 60 cruises (Splettstoesser and Folks 1994). This had increased to over 27,000 visitors (including ship and land passengers) by 2005 (IAATO 2006). Future projections for tourism indicate that visitor numbers could reach 1.5 million tourists per season by 2010 (Australian Antarctic Division 2004a).

The majority of visitors (including tourists and members of expeditions) to this area are seeking close interactions with the wildlife (Australian Antarctic Division 2004a).[1] The special attraction of Antarctic is not just the unusual wildlife but also its lack of fear that allows these close interactions. A survey undertaken in 2003 of tourists joining a cruise ship to Antarctica found 94.2% of respondents were interested in viewing Antarctic wildlife with there being most interest in penguins (Tisdell and Wilson 2004). For this reason and because of the available data on the numbers and population trends of penguins, they became the focal species for the wildlife tourism research network analysed in this paper.

As visitors to the Antarctic region tend to concentrate their visits to only a few places, this raised concern about possible negative impacts on fauna (Giese 1996; Mason and Legg 1999). In the mid 90s little scientific knowledge was available on the short and long term impacts of tourism on the physical environment of Antarctica including the wildlife (Mason and Legg 1999). The desire of humans who were travelling to this region to interact with or study the wildlife, in particular penguins, raised questions on how tourist activities needed to be managed to protect the environment. Despite there being a general understanding and anecdotal evidence on how visitors can impact on birds, management agencies at this time were constrained by a lack of specific and scientifically rigorous knowledge (Giese 1996). In particular, knowledge as to how visitors may be impacting on wildlife and how to manage these interactions with the wildlife, including the penguins, was lacking (Australian Antarctic Division 2004b).

Even though the majority of tourism takes place on the Antarctic Peninsula (which is not a part of Australian sovereignty) the AAD still felt there was a need to begin examining the effect of increased visitor numbers on wildlife. Antarctic visitors, whether they be tourists or expeditioners, are having close interactions with breeding groups of seabirds (Giese and van Polanen Petel 2001). Although penguins spend up to 75% of their lives at sea they are often subjected to higher levels of visitor activity when they breed due to limited availability of suitable breeding sites and a breeding season coinciding with tourism season (Holmes, Giese, Achurch, Robinson and Kriwoken 2006). Therefore, the AAD established a research program into the disturbance of wildlife by visitors in 1995 (Australian Antarctic Division 2001). Much of their early research focused on the effects of visitors on penguins, including approach distances (Giese 1996).

The study reported in this paper focused specifically on the development of wildlife tourism research beginning in 1995 through to 2004 at the AAD. Over this ten year period, much scientific knowledge on the impacts of visitors on penguins as well as other species was produced (see Engelhard 1996; Engelhard, Baarspul, Broekman, Creuwels and Reijnders 2002; Giese 1996, 1998; Giese and Riddle 1999; Holmes, Giese and Kriwoken 2005; Holmes et al 2006; van Polanen Petel Q6 2005; Woehler and Croxall 1996). The overall aim of the research was to provide information for the development of scientifically based guidelines for managing interactions between people and the wildlife, in particular penguins (Giese et al 2001). The knowledge gained from this research was then taken up by the AAD in the development of management plans. Furthermore, guidelines on distances to be maintained between visitors and wildlife were developed as well as codes of conduct for pedestrian visits to wildlife breeding locations. From 2004 wildlife tourism research was no longer undertaken by the AAD. In the most recent Antarctic Science Strategy 2004/05–08/09 (Australian Antarctic Division 2004c), launched in 2004, wildlife tourism research was no longer a priority, aim or theme. This paper will use actor-network theory to examine the formation of wildlife tourism research through to its discontinuance in 2004.

STUDY METHODS

To understand, using actor-network theory, how wildlife tourism research in the Antarctic region developed, relevant actors needed to be identified. Human actors can consist of individuals or groups of humans. Interviews were conducted with human actors involved in wildlife tourism science in the Antarctic region, in particular those actors whose research focused on visitor-penguin interactions. The main procedure to identify participants was purposive, therefore actors who could provide insight into this case study were asked to participate. A snowball sampling strategy was also used to identify interviewees (Babbie 2001). At the end of each interview, the interviewee was asked if they knew of anyone else who would be appropriate to interview for this research. Interviews were conducted until theoretical saturation had been reached (Strauss and Corbin 1990) meaning further interviews were not contributing new information.

A focused interview technique was used because it allowed interviewees the opportunity to expand on their responses based on their personal experiences while still ensuring structure to the interview

(Frankfort-Nachmias and Nachmias 1996). Those interviewed were employed by Government organisations including the University of Tasmania, the Australian Government Antarctic Division and Tasmanian government departments including the former Department of Primary Industries, Water, and Environment and the Department of Tourism, Parks, Heritage and the Arts.

Human and non-human actors were identified from the interviews and documentation. The interviews were supplemented by documentation including journal articles, policy documents, tourism brochures, press statements, as well as a variety of reports including the Australian National Antarctic Research Expeditions (ANARE) strategic plans. Any public domain text with relevance to this research project was analysed.

The key data analysis method was discourse analysis to build theory using QSR Nvivo software for qualitative research. Discourse analysis allows the researcher to closely examine the language in use to look for patterns while Nvivo provided a means of storing, retrieving, categorizing and coding large amounts of text (Wetherell, Taylor and Yates 2001; Gibbs 2002). Analysis focused on interviewees' words, actions and the documentation to gain an in-depth understanding of the research topic. Excerpts from the data are presented in the results and discussion in order to let the human actors speak for themselves where possible (Maykut and Morehouse 1994).

The principal actor followed in this network was a small group of scientists who supported research into the effects of visitor-penguin interactions. They are referred to as the wildlife tourism scientists. They were either directly employed by the AAD or funded by a grant scheme from the AAD. Their aim was to advance scientific knowledge on possible impacts from visitor-wildlife interactions, with

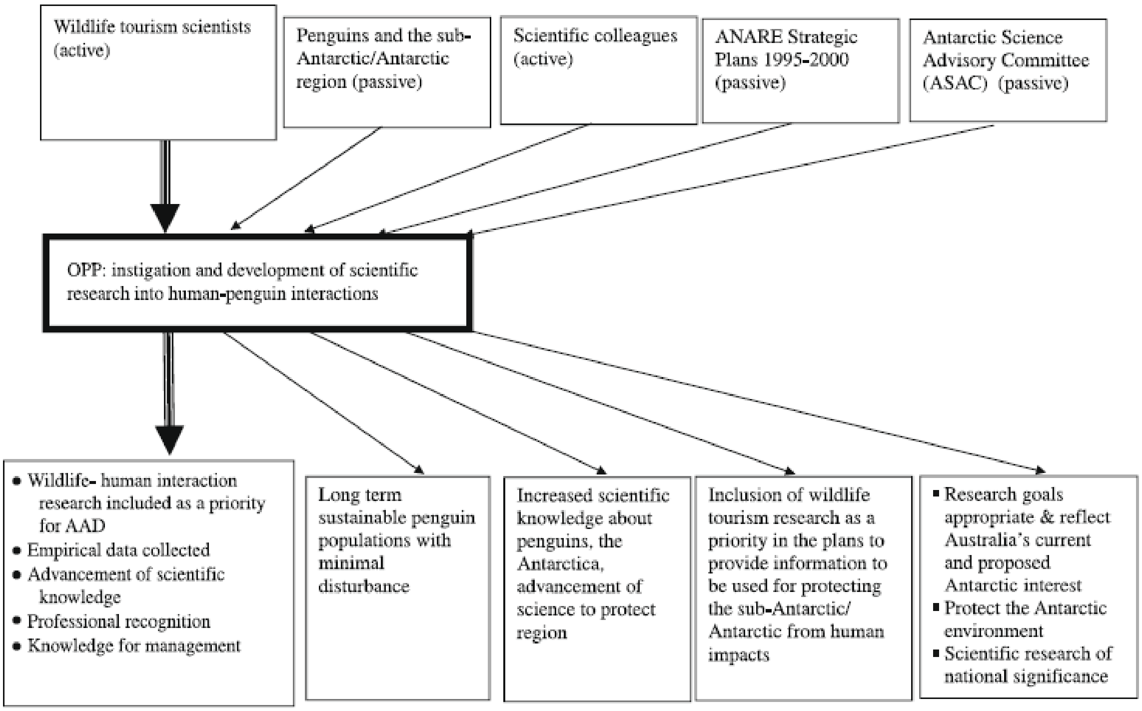

Figure 2. Wildlife Tourism Science Actor-Network

a focus on penguins. The non-human actors identified in this network included the penguins, Antarctica and the ANARE Strategic Plans. The human actors were the wildlife tourism scientists, the Antarctic Science Advisory Committee (ASAC) and scientific colleagues (Fig. 2).

RESULTS AND DISCUSSION

Formation of the Wildlife Tourism Research Actor-network

Problemisation, the first step in establishing an actor-network (Fig. 1), defines the nature of the problem and identifies the involved actors, both human and non-human (Law 1986). As actor-network theory is concerned with how an idea is conceived and then developed with or without resistance by those actors involved (Woods 1997), the various actors and their relationships need to be identified (Martin 2000). The relationships between the different actors contribute to understanding why some networks are successful and others fail. However, one needs to remember that the actors within the network discussed here also have roles in other overlapping networks.

The success of problemisation relies upon the principal actor defining the issue in such a compelling way it ensures the other actors accept their definition of the problem (Arksey 1998; Callon 1986a; Woods 1997). Problemisation for this network involved the wildlife tourism scientists becoming concerned about the possible effects of visitor-wildlife interactions in the Antarctic region:

> Antarctic tourism was increasing, expeditions to visit wildlife were increasing and we needed to understand what impact this could or would have. Wildlife is vulnerable to start with so we needed to study the cause and effect of tourism. (Scientist)

If the wildlife tourism scientists were to achieve their aim of undertaking wildlife tourism research, they needed to construct the problem in a certain way in order to engage the interests of other actors to be in line with their goal—the obligatory passage point (OPP) (Fig. 1). However, for the wildlife tourism research network to eventuate, the wildlife tourism scientists needed their scientific research to become ‘‘indispensable in the network’’ (Callon 1986a:204). To achieve this both the human and non-human actors in this network needed to be determined and defined in a way that a proposal for the instigation and development of wildlife tourism research would eventuate (Fig. 2).

Penguins were one of the key non-human actors involved in this network. Penguins were chosen as the focal species for the wildlife tourism scientists because they are abundant, as well as being the species that most visitors wish to interact with, placing them in a potentially vulnerable position. Scientific knowledge was needed to ensure that interactions between penguins and visitors were not resulting in negative environmental impacts and effective guidelines could be put in place where necessary. This was particularly important as many of these interactions were taking place during the penguins' breeding period, a time when the penguins could be particularly vulnerable to disturbance (Giese 1996).

Scientific colleagues were the next actor of importance to this network. This group consisted of scientists who were involved in the research in the Antarctic region from the AAD, organisations such as the Antarctic Cooperative Research Centre (funded by the Commonwealth Government of Australia and industry interests), universities conducting research in Antarctic and other scientists involved in the establishment of the scientific goals and priorities for the AAD (Australian Antarctic Division 1994). Enrollment of scientific colleagues by the wildlife tourism scientists was possible because of the latter's emphasis on the requirement for empirical knowledge on visitor-wildlife interactions for the protection of the wildlife and their environment. A dual emphasis on the need for increased scientific knowledge on penguins and such research advancing science, by the wildlife tourism scientists, contributed to movement of the network through the obligatory passage point (Fig. 1).

The ANARE Strategic Plans 1995–2000 were the fourth key actor. This was because wildlife tourism research needed to be incorporated into these plans for the AAD if research into the impacts of visitor-wildlife interactions was to take place. These were the first strategic plans for science in the AAD. Several new programs each with a Program Leader were developed, of which the Human Impacts Research Program was the most relevant to wildlife tourism (Australian Antarctic Division 1992, 1994). The Program Leader, Impacts Research Program, was appointed in 1994. Their responsibility was to develop the Human Impacts Research Program's strategic plans for the next 5 years of scientific research in the Antarctic region. After consultation with a variety of scientists involved in the Antarctic region, clear goals were identified and resources were allocated to areas of highest priority (Australian Antarctic Division 1992, 1994). Thus, the ANARE Strategic Plans included wildlife tourism science as a priority area of research.

The final actor was the Antarctic Science Advisory Committee (ASAC). In 1985 this committee, independent of the AAD, was formed to report directly to the Commonwealth Minister for the Environment (ASAC 1987). Their role was evaluating and reporting to the Government on the Antarctic program in meeting Australia’s scientific objectives (ASAC 2003). The Committee includes internationally recognized scientists and sets the scientific directions for Australia’s Antarctic scientific program as well as recommendations for future research (ASAC 2003). If the wildlife tourism research network was to be successful, ASAC needed to be enrolled and support research into wildlife tourism interactions. To enroll ASAC the wildlife tourism scientists needed to persuade them that they would only achieve their goal of protecting the environment through research into visitor-penguin interactions.

Although they play an important role in this actor-network commercial tour operators and tourists (referred to collectively here as the tourism industry) to the Antarctic region were not included as actors in this network. This is because the scientific network, which identified the actors in the wildlife tourism research network through self-referencing and snowballing, did not recognize the tourism industry as actors. This lack of recognition had adverse consequences for the network, an issue returned to later in this paper.

The next phase in translation is interessement (Fig. 1). In this study, it was where the wildlife tourism scientists attempted to impose their priorities on the other actors by blocking new possible alignments

(Callon 1986a). Each actor enlisted into the problemisation phase can be integrated into the plan or can ‘‘refuse the transaction by defining its identity, its goals, projects, orientations, motivations, or interests in another manner’’ (Callon 1986a:207). This stage of translation is reliant on the principal actor reinforcing the identities and associations identified in the problemisation stage. Here, the principal actor seeks alliances with other actors and attempts to convince them that their solution is the way forward (Kitchen 2000).

Interessement is a crucial phase of the actor-network process (Callon 1986) and is a competitive part of the building of an actor-network since actors are often implicated in the problemisation of other networks. In this case, the wildlife tourism research network developed with little resistance from other actors. Although the idea of wildlife tourism research was instigated primarily by a small group of scientists, it came about at an opportune time when most of the involved actors appeared to be open to the idea. The commencement of the Human Impacts Research Program, the employment of a Program Leader, and strategic planning developing for the AAD, made it an ideal time for the wildlife tourism scientists to establish their actor-network based in the Human Impacts Research Program. Furthermore, as one scientist commented:

I guess the focus of science in general began to change. The scientists began to think more about the impacts ... there was a paradigm shift, people started to think about their effect on the animal. (Scientist)

Interessement of the actors was straightforward and proceeded with little contest. It was assisted by several key opportunities available to and managed by the wildlife tourism scientists. These included the quantitative design of the research, general recognition by the scientific community (and managers) of the importance of scientific knowledge, anecdotal reports suggesting visitor-penguin interactions were having a negative impact, managers' need for knowledge and government reports (Table 1).

Table 1. Interessement of Wildlife Tourism Research

Actor	Interessement	Supportive evidence
Scientific Colleagues	Wildlife tourism scientists established alliances by appealing to their colleagues' normative beliefs about quantitative research and data to advance scientific knowledge. Quantitative design and method for their research.	''Consequently, despite having a general understanding of the effects of human disturbance on Ade´ lie penguins, management agencies remain constrained by a lack of specific and scientifically rigorous information. Experiments designed to quantify the effects of breeding success of specific types and intensities of human activity could provide information for the management of human behaviour around Ade´ lie penguin colonies.'' (Giese 1996:157)
ANARE Strategic Plans 1995–2000	Appealed to the need for good scientific data for management of human impacts as raised by 1992 report by ASAC.	I think it [wildlife tourism research] filled a management gap that they [managers] were aware of. . .if there is reasonably robust scientific information around that they can base management on then they will. (Scientist) Science assists in providing data and measurement to provide the basis of the policy. (Manager)
	Highlight the importance of their particular area of research over other human impact studies.	looked at the full spectrum on what you might consider to be human impacts. Anything from the old fashioned perspectives of fuel and waste through to more integrative ways of looking at the environment. It was felt research on disturbance was needed. Australia really led the way. . .(Scientist)
Penguins	Needed to illustrate signs of disturbance from interactions with humans.	"In a 1984 review of the status of seabird populations world-wide, 85 seabird species were either considered endangered or were being measurably affected by human activity. Recreational visits and tourism contributed to population decreases for almost 25% of these.'' (Giese 1999)
ASAC	Only possible if interessement of scientific colleagues was achieved. ASAC consults with wide range of scientists to advise on future research priorities.	There is a body called the Antarctic Science Advisory Committee which is an external committee independent of [the AAD]. And that body advises the government, so in the Antarctic Division [staff] work very closely with that Committee and in constructing the strategic plan, the plan is actually their plan although [staff] do all the work to establish it. (Scientist)

Following on from interessement is enrolment (Fig. 1, Phase 4). In this study, this was where the wildlife tourism scientists sought to reinforce the alliances they formed earlier on, and can in principle be achieved through negotiation (Callon 1986). Central to the enrolment of actors in the wildlife tourism research network was the Madrid Protocol and increasing tourism activity. In 1994, fours years before its international ratification, Australia enacted legislation to implement the Protocol. This bound all Australians by law to observe its provisions. The Protocol had developed due to growing concern among the parties to the Antarctic Treaty about the global importance of this environment and the increasing need to protect it from the effects of increasing visitor activity (Australian Antarctic Division 2000).

The Madrid Protocol was an important tool because it supported the need for wildlife tourism research. The Protocol highlighted the importance not only of Australia's obligation to undertake research to protect the wildlife but also how this research needed to include the effects of visitor-wildlife interactions, including tourism. Research was important to ensure detrimental changes to penguin populations were prevented and populations sustainably managed. If enrolment was to be successful then the wildlife tourism research needed to be approved by ASAC and included in the ANARE Strategic Plans.

To ensure the enrolment of scientific colleagues, ANARE Strategic Plans and ASAC the wildlife tourism scientists highlighted the robustness of their findings and their relevance to management. They also highlighted the quantitative approach used for their research. As one scientist remarked ''It was quantitative. It was the figures that sold it.''

Mobilisation of the network, the penultimate stage of translation (Fig. 1), was dependent on the actors all accepting the need for research into visitor-penguin interactions. The key task for the wildlife tourism scientists was to ensure that their role of representing the other actors within the actor-network was secured (Arksey 1998). This was achieved through the establishment of strategic plans for the Human Impacts Research Program for 1995–2000, which included specific themes and goals relating to wildlife tourism science, for example Theme 3, Characteristics of the Antarctic Environment, which aimed to:

> Examine the effects of physiological stress to mammals and birds (caused by operational procedures, scientific research manipulations and recreational activities) to determine whether stress can reduce the viability of individuals or populations. (Australian Antarctic Division 1994:76)

By the inclusion of relevant themes and goals in the strategic plans for the Human Impacts Research Program, the wildlife tourism scientists had consolidated their position as representative for all the entities in their network. These plans were supported by their scientific colleagues, and were agreed to by ASAC. This resulted in the wildlife tourism scientists undertaking wildlife tourism research to examine the effects of visitor-wildlife interactions.

However, to fully complete mobilisation of the wildlife tourism research network, these themes and goals needed to become actual research projects. By the 1996/97 season, wildlife tourism projects had begun and continued to increase in number over the next eight years:

within our program, in our human impacts program, we have people who are looking at the effect of tourists from some aspects of animal physiology, the animals being mainly seals and penguins in the Antarctic as that is what people want to see. So we are putting a part of our resources into a series of studies. (Scientist)

Projects included the effects of helicopters on Antarctic wildlife; impact of disturbance on breeding behaviour and physiology of southern elephant seals (Mirounga leonina); and population monitoring of Ade´ lie penguins (Pygoscelis adeliae).

Translation successfully occurred resulting in the wildlife tourism research network being ‘‘black-boxed’’ as all actors identified were enrolled. Complete stabilization of the wildlife tourism research actor-network could be seen in 2004 when not only were projects into the effects of visitor-wildlife interactions being undertaken, but managers were using the derived knowledge for management purposes:

> Information arising from this research is being used to develop the Australian Antarctic Division’s guidelines for managing human interactions with wildlife. This includes codes of conduct for pedestrian visits to wildlife breeding groups and guidelines for use of helicopters around aggregations of animals. Results from this research are also being made available to commercial tour operators and other Treaty Nations. (Australian Antarctic Division 2004b)

Disbanding of the Wildlife Tourism Research Network

Actor-networks are only possible while all the actors remain enrolled. Despite the increased number of projects and the uptake of knowledge for guidelines and management, the wildlife tourism research network came to what Callon (1986) referred to as ‘‘dissidence’’. Dissidence resulted in the wildlife tourism research network disbanding and illustrates how changing identities and relationships can result in the disbanding of established networks (Jakku 2004).

From 1995–2004, the Antarctic Science Strategies included wildlife tourism research. However, in a recent Antarctic Science Strategy 2004/05–08/09 (Australian Antarctic Division 2004c), launched in 2004, wildlife tourism research was no longer a priority, aim or theme. From the 2004/05 season onwards, the AAD approved only one wildlife tourism research project which involved monitoring for long-term or cumulative impacts on Southern Ocean seabirds (Australian Antarctic Division 2005).

Networks are only as stable as their alliances. Although the wildlife tourism scientists and wildlife remained enrolled in the network, dissidence came from scientific colleagues and the broader community who in turn affected the ‘‘alliance’’ with the ANARE Strategic Plans and ASAC. The wildlife tourism research network was reliant on their scientific colleagues remaining enrolled as the latter have influence and power in deciding the direction of future research by the AAD:

> Australia’s Antarctic science program for the next five years has been finalized after thorough external evaluation by the Antarctic Science Advisory Committee and widespread consultation with the scientific community. (Australian Antarctic Division 2004c:2)

Without the support of their scientific colleagues, research into the effects of visitor-wildlife interactions was no longer considered a priority for the ANARE Strategic Plans 2004/05–08/09. With both these primary actors (scientific colleagues and ANARE Strategic Plans) dissenting, the wildlife tourism research network disbanded. The decline of the wildlife tourism research network, once the scientific colleagues had dissented, illustrates that power is associative. Power is invested in the relations rather than the actors. As Latour (1986) noted, the exercise of power depends on the actions of others, resulting in power being translated.

Exploring the Wildlife Tourism Science Network

The above section used actor-network theory and a narrative style to explain the role of various actors in the development and decline of wildlife tourism research in the Australian Antarctic Division. This allowed for the influence of the actors in the development and disbanding of the wildlife tourism research network to be described. This section, with the use of extensive theoretical and empirical work from within the sociology of science, further explores the formation and disbanding of the wildlife tourism science network.

The establishment of the wildlife tourism research network at the AAD and affiliated organisations in 1995 was possible for a variety of reasons. The network developed at an opportune time when both the human and non-human actors were receptive to such research. In part this was due to concerns regarding increasing numbers of tourists and associated impacts. Therefore, translation of the network was straightforward. Additional explanations lie with scientists' normative beliefs, particularly with respect to the scientific method and professional recognition, and a changing environmental external to but impinging on the network's focus and research activities.

Scientists use the scientific method to ensure value free experiments are undertaken that use replication, quantification and statistical analysis to ensure data and findings are free from contextuality (Altrichter 1986). Empiricism and objectivity are fundamental to the positivistic Western notion of the scientific method. These concepts, especially empirical research, were used by the wildlife tourism scientists to interesse and enrol other actors into their network. The wildlife tourism scientists built an association with their scientific colleagues in large part due to the empirical approach they sought to apply to their work. This was needed because many of their scientific colleagues were from the natural sciences and held strong views on the importance of the scientific method and quantitative research. As one scientist commented ''It is good solid science, so there is no scientific weakness to it''.

Professional recognition, an important feature of the scientific community, contributed to the association holding the wildlife tourism research network together. In science, professional recognition is dependent upon the conformity to social norms of the scientific community (Storer 1966). Professional recognition and reputation are reliant on the exchange of new information. Communication can take place in a variety of forms, from publishing scientific work in a peer reviewed journals through to presenting at conferences, to being asked to give an invited review lecture (Mulkay 1991; Ziman 1984). Recognition by their peers of the importance of their work helped consolidate the wildlife tourism network. As one scientist remarked:

> Very quickly there were other countries jumping on the band wagon. They were seeing that yes, good solid science in this area is something that we can do. Australia really led the way and lot of other groups then jumped on the band wagon. I felt that one of the major successes to come out of ... [our] work is the recognition that it is good important work that should be done. (Scientist)

For the wildlife tourism research network to continue to remain black-boxed, the wildlife tourism research needed to become socially institutionalised at the AAD. Social institutionalisation is the creation and maintenance of formal structure (Rochester and Vakkari 1997) and includes the foundation of research associations and formal communication channels such as scientific conferences and journals along with the degree of integration of the discipline into university departments, government departments and teaching curricula (Rochester and Vakkari 1997). However, in this case social institutionalisation was not possible for the wildlife tourism research network. Examining power relationships within the network helps explain why.

Power is the probability of one actor within a social relationship being in a position to carry out their will despite resistance (Weber 1964). Power is achieved through associations, and actor-network theory illustrates how the use of power depends upon the actions of others in the network (Latour 1986). To achieve continued power associations the wildlife tourism scientists needed to promote their area of research and communicate the importance of their findings to their scientific colleagues and the tourism industry. Yet, in many ways this goes against the norms of the scientific community, which encourages scientists to remain disengaged and objective (see Cortner 2000; Mitroff 1972). Instead of entering into the political arena to highlight the importance of their findings and the necessity of their work, the wildlife tourism scientists relied upon everyone viewing their work with the same level of importance as themselves.

Over the eight years that wildlife tourism research was being undertaken, new scientists were employed at the AAD and the broader agenda of the Division changed. These appointments led to a change in the network. One of the new appointments, in an influential position, dissented from the network. Two interrelated reasons for their dissention are possible. The first was their perceptions of the benefits and importance of wildlife tourism research compared to other new areas of research and the second was their normative beliefs about science. With their dissention the power of association between the human and non-human actors was lost. This ultimately contributed to the network and wildlife tourism research declining. As this colleague stated, they had difficulty in seeing the relevance of wildlife tourism research:

> We have our own protocol posters around the place saying you can not go within 10 meters or 50 meters at some time of the year to penguins. That is rubbish because if you sit down near a colony they actually come up and climb on you. (New scientific colleague)

For this actor, the results from the wildlife tourism research were not providing evidence of negative impacts. Instead there were other more urgent areas where research was needed:

> Waste disposal, mining, nuclear, leaking oil pipelines that are sending out millions of liters daily. Having said that we reckon there are somewhere between 1 and 10 million cubic meters of contaminated waste in the Antarctic. (New scientific colleague)

Antarctica's public profile was increasing during this period of time along with the many environmental issues that the region faced. It was also highlighted how there was much research needed to ensure the pristine environment was conserved. The increasing awareness placed pressure on the AAD to broaden their agenda and ensure they were undertaking relevant scientific research contributing to the area's conservation. The majority of funding for the AAD comes from the Australian government and they play an important role in dictating future research. As the new scientific colleague noted ''We're paid by the government, the government sets its strategic plan for our activities and we have to deliver to the government on that strategic plan''. The Antarctic Science Advisory Committee (ASAC) advises the government on future research areas ''in the AAD we work closely with that committee and in constructing the strategic plan, however, the plan is their plan''. (new scientific colleague)

The new influential colleague's normative views on research into visitor-wildlife interactions was the second factor underpinning their dissention from the network. The paradigmatic position a scientist takes will influence their research, as scientists approach their work from differing philosophies (Crotty 1998). Many natural scientists are ecologists and biologists who have a positivistic approach to their work. This world view or paradigm has a strong belief in objective empirical science and the scientific method. This was similar to the view held by this actor who commented: ‘‘That is the most important attribute, it’s got to be objective.’’ Furthermore, they commented:

> I think people who tend to work in this area [wildlife tourism] are on the whole, less objective maybe than those who work in other areas. Frequently they are doing research in that area in order to find some numbers to support a position that they held at the beginning. That’s not the way that science works. (New scientific colleague)

Scientists operate within their paradigms or world views. The approach taken to research is determined by the epistemological and ontological position a scientist holds. This has implications not only for the research undertaken but also for the methodology used. This colleague perceived wildlife tourism research as being subjective rather than objective therefore allowing for personal interpretation, although the wildlife tourism scientists felt they were undertaking objective, quantitative research.

CONCLUSION

This paper used actor-network theory to examine how a natural science program directed towards wildlife tourism research and translated into management was achieved. The phase of translation, as developed in actor-network theory by Latour (1983, 1986, 1987, 1996), Callon (1986, 1986a) and Law (1986, 1994, 1999), enabled identification of the critical actors and then description of their actions leading to a successful wildlife tourism research program. These actors included wildlife tourism scientists and their colleagues, the Antarctic Science Advisory Committee, the ANARE Strategic Plans and the penguins themselves. Achieving an obligatory passage point, where the importance of wildlife tourism science was identified and shared, and interessement, where others (such as colleagues) become equally as committed, seemed critical phases. Enrolment of colleagues was in large part due to a common belief in the scientific method accompanied by quantitative methods.

Although the network was black-boxed (i.e., existed as a stable entity) for about eight years, this situation was not permanent (Callon 1986, 1986a). Primary reasons for disbandment were a change of actors in the network, and in priorities external to but influencing the network. A secondary reason was the inability of the wildlife scientists to promote their science where it mattered. In particular, the tourism industry not being enrolled into the network coinciding with the views of a new actor about the impacts of visitors on Antarctic wildlife relative to other threats and priorities to the Antarctic (other research was identified as having greater importance) and their judgment that the subjective nature of wildlife tourism research detracted from its quality contributed to declining support. The result was research resources being directed elsewhere.

Of importance theoretically and conceptually, this paper has illustrated that actor-network theory is a useful method for describing how wildlife tourism research developed in the Antarctic region. With assistance from the broader sociology of science literature it allowed for in-depth analysis of the reasons behind the outcomes observed. As such, actor-network theory is likely to provide a robust method for describing the development or otherwise of science and associated research agendas in wildlife tourism. These findings, suggest, however, that this application should be complemented by reliance on current and past efforts in the sociology of science, especially those focused on better understanding the power of actors and normative influences on the practices of science.

For tourism research, as a multidisciplinary enterprise, often with strong interest from and involvement of end users from the industry in research, it is essential to understand and be able to reflect on and ‘manage’ (as much as is ever possible) how science is practiced and what makes it succeed and fail. For tourism research with its numerous stakeholders and researchers, often with differing paradigmatic positions (Patterson and Williams 1998) and normative beliefs, actor-network theory provides a powerful way of revealing and then understanding how these differences affect scientific practices and success. And even more importantly for an applied area of research such as tourism, this theory potentially provides insights into how these differences can be successfully managed and optimized. The future of sustainable tourism depends on being able to manage these differences.

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