# University of Otago



# From science to narrative film: Communicating knowledge and inspiring interest in the Wedge-tailed Eagle



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#### Abstract

Eagles are a charismatic group of birds that have for centuries captured the attention of humans across the world. The Australian wedge-tailed eagle *Aquila audax* endured a history of persecution, was shot, trapped and poisoned relentlessly for over a century, but it showed remarkable resilience and today is still common throughout its range on the mainland. Because of this it forms a perfect example of the relationship between humans and their environment, and it provides an opportunity to initiate public education and inspire environmental engagement and appreciation among people. This is necessary in today's world where the increasing disengagement between people and the natural environment has implications for conservation success.

A large body of information on the wedge-tailed eagle exists in various sources (journals, books and films), but the majority of this is 'locked away' in the science literature which is inaccessible to many people. The objective scientific process of research and publication is aimed at broadening our knowledge base, but it has many associated problems which can make it a barrier between detailed knowledge and those wishing to access it. Most science literature also lacks the personal stories important in inspiring engagement and promoting the understanding of ecological relationships. There is therefore a growing importance for environmental science communicators to aid in the 'unlocking' of this knowledge to create 'knowledge societies' consisting of a freedom of truthful information.

Wildlife film driven by a personal narrative is one way to engage a wide audience and communicate knowledge. Such a film has not been used as a device to communicate knowledge or inspire environmental interest about wedge-tailed eagles before. Here I aim to address this by providing background information about the process of scientific research and narrative theory, which has been used to inform the creation of the fictional narrative film "A Wedged Tale," the major component of this thesis. (A copy of the film can be found in the back sleeve of this written document).

# Dedication

I wish to dedicate the natural history film "A Wedged Tale" to a childhood hero of mine who tragically passed away this year:

# **MALCOM DOUGLAS**

Australian Documentary Maker, Conservationist and Bushman



# 14<sup>th</sup> March 1941 – 23<sup>rd</sup> September 2010

# May he rest in Peace.

## Acknowledgements

This thesis is another chapter in my wedge-tailed eagle passion which has now spanned nearly half my life. I am indebted to my close friends and family who have constantly encouraged me to follow this life interest. In particular, I thank my parents for their ongoing love, support, guidance and encouragement which has helped me pursue and achieve some of my dreams. Mum and Dad, thank you for opening your home up and letting us use it as a base for the film, for putting up with all that you have, for supporting me and keeping my spirits up throughout the year.

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# **Table of Contents**

Abstract	<u>i</u>
Dedication	ii
Acknowledgements	iii
Table of Contents	iv
1. Introduction         1.1 Eagles and Conservation         1.2 The Wedge-tailed Eagle         1.3 Persecution         1.4 Western Australia         1.5 Eagles in Perth         1.6 Thesis Aims and Objectives	1 1 2 3 3 3 4 5
<ul> <li>2. Eagle Discourses: A Literature Review</li> <li>2.1 Importance of Ecology and Personal Engagement</li> <li>2.2 Science Literature</li> <li>2.3 Books</li> <li>2.4 Films</li> </ul>	6 6 7 14 16
<ul> <li>3. The Science Literature Process</li> <li>3.1 Importance of Science Communication</li> <li>3.2 Problems with the Science Literature: a personal perspective</li> </ul>	18 18 20
<ul> <li>4. Narrative and Film</li> <li>4.1 Introduction to Narrative Theory</li> <li>4.2 Elements of Narrative Theory</li> <li>4.3 Effectiveness of Narrative</li> <li>4.4 Use of Narrative in Film</li> <li>4.5 The White-tailed Sea Eagle: A Case Study</li> </ul>	<b>30</b> 30 30 34 34 35
5. The Film: "A Wedged Tale" 5.1 Introduction to and Aims 5.2 What Facts to Include? 5.3 Character 5.4 Setting 5.5 Plot 5.6 Character Change and "Level of Fiction"	<b>39</b> 39 40 41 43 45 46
6. Conclusion	47
6. References	48

### **1. Introduction**

#### **1.1 Eagles and Conservation**

Eagles are a charismatic group of birds that have for centuries captured the attention of humans across the world. For example, the eagle (Aquila) appeared as one of the earliest insignia in ancient Roman military history (Yates 1870), and the bald eagle *Haliaeetus leucocephalus* is still widely recognised today as the national bird of the United States of America (Terres 1980). Their large size and role as top predator in global ecosystems makes them conspicuous and easily remembered. Yet this is not always for positive reasons, and consequently many large eagles have suffered greatly from persecution (hunting, trapping, shooting, poisoning) by humans. Also, their high trophic position in the food chain has meant eagles often bear the brunt of environmental modifications; e.g. the bald eagle declined severely in the Northern Hemisphere following extensive use of DDT in pesticides (Hickey and Anderson 1968). For these reasons a large percentage of eagle species today are threatened (Tingay and Katzner 2010).

Environments across the world are under increasing pressure from human development (Meyer and Turner II 1992), and degradation from human activities often results from a lack of environmental understanding. The absence of natural history from many people's lives is an important reason for this lack of understanding (Wilcove and Eisner 2000; Low 2003), and there is an urgent need for environmental education to address this problem. The best way to educate is by encouraging direct engagement with the environment (Nevard and Penfold 1978). Such engagement is becoming increasingly important for private and government organisations wishing to incorporate community groups in decision making, groups which in turn find benefits of being involved in local projects (Johnston 2008). One way to achieve this is to use a charismatic species to inspire other people about nature. Eagles are a perfect example of such a species, not only because of their size and conspicuousness, but also because many species have shown resilience to human actions, despite years of persecution. They help illustrate a relationship between humans and the environment, one which has evolved from them enforcing direct manipulative control on their natural surroundings, to one where they must learn to live in a balance with these surroundings in a sustainable way (Low 2003).

#### **1.2 The Wedge-tailed Eagle**

The largest Australian bird of prey (raptor) and one of the largest members of its genus, the wedge-tailed eagle *Aquila audax* (Figure 1) grows to almost one metre in length and has a wingspan of up to 2.5m (Brooker 1996; Pizzey and Knight 1999). The sexes are similar in plumage but show reversed sexual size dimorphism, with females and males having average body weights of 4.7 and 2.5 kilograms, respectively (Brooker 1996).



Figure 1. Adult wedge-tailed eagle Aquila audax.

Plumage of wedge-tailed eagles becomes darker with age, ranging from the golden brown appearance of juveniles to the almost black (apart from the pale wing bar and chestnut nape) form of adults, normally reached at 6–7 years when breeding commences (Ridpath and Brooker 1986*a*). Monogamous pairs hold breeding territories containing several nests (Ridpath and Brooker 1987), defended aggressively from other eagles with conspicuous aerial displays (Brooker 1974). This is similar to that described for other large eagles (e.g. golden eagles *Aquila chrysaetos*, Dixon 1937; Collopy and Edwards 1989). Nests can reach sizes of 1.8 m wide x 2.9 m deep (Gaukrodger 1924), and are lined with fresh eucalypt sprigs during breeding (Hollands 2003; Olsen 2005). Commonly clutches are of two eggs, but in many cases only one offspring is reared to fledging (Cupper and Cupper 1981). After remaining with their parents during a post-fledging period of 3–4 months (Allott *et al.* 2006), immature eagles may travel 784–868 kilometres from the natal area (Ridpath

and Brooker 1986*a*; Marchant and Higgins 1993), and for some time occupy a wandering existence before finding mates and establishing breeding territories themselves (Leopold and Wolfe 1970).

#### **1.3 Persecution**

Like many other charismatic fauna, the wedge-tailed eagle has suffered extensive persecution by humans. It was shot across Australia for the majority of the 1900s because of its alleged predation on lambs, making it arguably one of the most persecuted raptors in the world (Olsen 2005). Bounties on eagles were paid by state governments, and hundreds of thousands of birds were killed throughout a period of extensive persecution. In the ten years between 1950 and 1959 in Queensland and Western Australia, about 120 000 such bounties were paid (Beckman 1988). Subsequently many studies were conducted in various parts of the country on the ecology of this raptor, with emphasis on the proportion each species of prey animal comprises in their diet, in an effort to establish the true impact of eagles on lambs (see Marchant and Higgins 1993 for review; also Olsen 2005; Cherriman 2007). Wedgetailed eagles eventually received protection throughout Australia in 1989 (Brooker 1996; Parker 2000). Although the Tasmanian subspecies A. audax flevi is listed as Endangered under Environment Protection and Biodiversity Conservation Act 1999 (Threatened Species Section 2006), the nominate race remains common throughout its range on the Australian mainland.

#### 1.4 Western Australia

Western Australia occupies about one third of the total area of Australia, making it the largest state in the country (Australian Bureau of Statistics 2010). It is a stronghold for the wedge-tailed eagle and therefore it is highly important that the history and current status of the species is understood in this state. In Western Australia 147 237 eagles were killed in the forty-one years between 1928 and 1968 (Serventy and Whittell 1976): these numbers only account for numbers of bounties paid, and actual number of deaths would have been higher. Bounties on the eagle ceased in 1967, but in 1980 it remained without protection (apart from in the Shire of Kojonup) and was still declared vermin in 17 shires (Brooker and Ridpath 1980). It is now protected as a native species under the Western Australian *Wildlife Conservation Act 1950*, although it remains listed as a pest species under the *Agriculture and Related Resources Protection Act 1976* (DEC 2005), which means damage licenses can still be granted to kill eagles under extreme circumstances. Despite its protection and these

regulations, wedge-tailed eagles are still shot and poisoned illegally in some areas (Ian Falkener and Mike Griffiths, personal communication), and perhaps the most important threats are habitat modification and human disturbance during breeding. Other more modern threats include collisions with wind turbines (Dennis 2006), powerlines, vehicles, and perhaps unknown environmental contaminants.

In concluding statements of their extensive research forty years ago, Ridpath and Brooker (1986*a*: p.256) state:

"[This research has] shown that eagle populations are self-sustaining in much of the arid zone. Even so, the scales could be tipped against the wedge-tailed eagle if major changes occur in this habitat as a result of new practices in the use of the land. Similarly there could be serious consequences if killing rates in marginal areas were to increase greatly. Our studies suggest that the effects of such changes on populations would not be immediately obvious."

This is because '...vulnerability is a feature of reproductively conservative, long lived, large raptors such as eagles' Ridpath and Brooker (1986: p. 255). In other words, territorial birds may reproduce successfully throughout their life, but as there is a high chance that many of their young will die before they themselves breed, the species could crash when these breeding pairs eventually die of old age. Ridpath and Brooker's (1986: p.256) concluding statement was thus:

"Vigilance will be needed, and entails monitoring."

It therefore remains necessary to monitor eagle ecology and modern impacts on the species to ensure its conservation. In doing so, there is a perfect opportunity to initiate public education and inspire environmental engagement among people.

#### 1.5 Eagles in Perth

Wedge-tailed eagles nest in close proximity to Perth, Australian's fourth largest capital city. Several pairs of breeding eagles have been studied in the Perth region for about 10 years, with research being conducted on diet, territory size and general breeding biology (Cherriman 2004; 2007; 2008; unpublished data). Using this iconic species, Insight Ornithology<sup>1</sup> has conducted research and education to communicate meaningful environmental messages to the public. This is for two main reasons:

<sup>&</sup>lt;sup>1</sup> A small business based in Perth, Western Australia, established by Simon Cherriman in 2008.

- To educate others about wedge-tailed eagle ecology and emphasise the importance of ongoing research for conservation.
- To use this iconic bird to encourage people to engage with and appreciate the environment.

During a period of research and education in 2008, it became evident that there is a large variation in the public understanding of the wedge-tailed eagle's ecology, conservation status and threats. Many people do not know this species nest on the doorstep of most capital cities, while others believe it is still a threat to lambs and should be shot. This is because the public consists of a broad and varied audience which includes individual land holders, land managers, local community groups, wildlife rehabilitators, conservationists and government departments, and there are issues with the communication of knowledge on the eagle to these different groups, all of which have different priorities. It is envisaged that Insight Ornithology will continue with eagle research and communication in the Perth region well into the future, with the hope that it can address some of these issues, 'bring everyone onto the same page' with regard to understanding of the species, and in general encourage environmental awareness and engagement.

#### 1.6 Thesis Aims and Objectives

The aim of this thesis is to create a previously unexplored source of information and inspiration about the wedge-tailed eagle: the 'fictional' narrative film. This film forms the major component of the Master in Science Communication degree, and is the end product of the process discussed in this written thesis. (A copy of the film "A Wedged Tale" can be found in the back of this written document). We will explore the term 'fictional' in more detail in **Section 4.2 (p. 25) and Section 5.6 (p. 41)**, but here I should indicate that in the context of this thesis it refers to having elements of both truth and untruth. The aim of the written component is to explore and analyse various means of communicating knowledge of, and interest, in the wedge-tailed eagle; and to discuss how this knowledge, together with the theory of fictional narrative to convey fact and inspire environmental engagement, informed the final film produced. It also aims to discuss the role of science communication in today's world, and the importance of knowledge being available equally to all people in a 'knowledge society'.

To begin with it is necessary to review the literature available about the Wedge-tailed Eagle, and analyse this in terms of its effectiveness as a source of knowledge.

# 2. Eagle Discourses: A Literature Review

#### 2.1 Importance of Ecology and Personal Engagement

In order to educate the wider community (which includes those groups mentioned in **Chapter 1, "Introduction"**) about environmental issues, it is necessary to engage them and give clear information on how these issues relate to *them*. This is best done by communicating using ecology as a central topic: by understanding the way the environment works as a system, then explaining that humans (even scientists) are in this system because they are engaged with all its components (Low 2003).

A large body of information on the wedge-tailed eagle exists to date, and there are several methods by which it has been communicated. Unfortunately most of the detail appears in the scientific literature, and is not readily accessible to a wide audience. There are also a few books, both for the scientific, general and young audience, and two known films focused specifically on the eagle itself. These other discourses, together with the information in the scientific literature, provide a solid grounding for expanding this knowledge to the wider community.

However, there is a division of this information which creates problems with the communication process, which will be elaborated upon in this chapter. The information can be thought of as existing loosely in two different formats: scientific, which occurs only in science journal publications available to relatively few people, and general, which occurs in all other sources mentioned above. The difference between these two is that the scientific knowledge contains more detail about eagle ecology than other sources, but because of the 'objective scientific method', has little information about researchers and their personal engagement with the environment. Science language is often too complex for general readers, who can therefore feel easily disengaged with the subject matter. On the other hand, general information may be presented in a less scientific way and readers can feel involved in the subject matter; such engagement is very beneficial in understanding ecology. However, these general sources often lack important detail.

This barrier between scientific and popular information sources creates a problem. There is an obvious need for scientific research and publication, and science papers cannot be expected to be written for a general audience. The emphasis is therefore with science communicators: Cribb and Hartomo (2002) put forward the strong notion that those people in society who invest heavily in discovering new knowledge should invest the same if not more effort in ensuring this knowledge is shared. Only when this is understood will scientists will realise the true benefits to humanity. We will explore this more in **Chapter 3**, **"The Science Literature Process"**.

This chapter is focused on providing background information on the current level of knowledge about the wedge-tailed eagle. I present an historical review of the methods of communication already used for this species, and analyse each of them in terms of their effectiveness at relating information, and their accessibility to a general audience, based on my experience so far as a science communicator. I attempt to concentrate especially on how each source involves personal engagement with the reader as mentioned above.

#### **2.2 Science Literature**

Since its first description by Latham in 1801 (Marchant and Higgins 1993), the wedge-tailed eagle has been well described in Australian literature, field guides and bird books (e.g. Cayley 1950; Simpson and Day 1986), and has gained frequent mention in anecdotal observations and publications by Birds Australia (formerly the Royal Australian Ornithologists Union). Although this eagle's image became well known, its ecology remained largely unstudied in formal government-funded research until the 1960s. By this time pressure had mounted to properly investigate its diet to decide if persecution by sheep farmers was warranted.

Consequently Leopold and Wolfe (1970) undertook a research study for the Commonwealth and Scientific Research Organisation (CSIRO), based in Canberra. This research demonstrated that collecting prey remains from nests during the breeding season gave an accurate description of the number and type of prey eaten. Mammals were shown to be the most favoured prey of wedge-tailed eagles, with European rabbit *Oryctolagus cuniculus* and hare *Lepus capensis* comprising 60% of their diet by number. Some sheep were eaten as carrion, but predation on viable lambs was found to be minimal. It was concluded that although eagles kill the occasional lamb, they do not cause enough deaths to have an adverse impact on the sheep industry.

This pioneer study remains one of the most detailed sources of information available on the eagle to date. It was the first document to present evidence of what eagles ate in pastoral areas, as well as the methods used to investigate this, and give quantitative rather than anecdotal information against the destruction of the eagle. In this way it created a benchmark for future studies. Leopold and Wolfe also give two key pieces of background information which add depth to their research by providing ecological context. Firstly, their detail on eagle breeding biology creates understanding of population numbers, food requirements and behaviour throughout the year. Secondly and more importantly, the section 'Historical Background' (p. 2) gives insight into the changes in land use and fauna composition throughout the early years of European settlement. This context, often lacking in modern studies, is vital in helping readers understand how the ecosystems in which eagles live were changed (from largely natural areas to mostly pasture) as people became integrated into the landscape, offering some explanation of more recent environmental function.

Although it is classed as a 'scientific' approach, Leopold and Wolfe use clear, simple language, there are no complex statistical analyses, making the study easy for a wide audience to interpret. Photographs, which are often not favoured by more modern environmental science journals, further outline their methodology and findings. Although this paper is now more than forty years old, which may limit its use as an 'up to date' reference, it has been digitised and is still available through an online journal. For these reasons this paper is very effective at engaging the reader and promoting an ecological understanding. The only shortcoming is it may not be easily accessible to a wide audience.

A much broader study in Western Australia, which represents nearly one third of the continent and at the time was the source of a large proportion of complaints by pastoralists, followed that of Leopold and Wolfe. This was carried out over a ten year period during the 1960s and 70s, and resulted in a wealth of information in publications on eagle behaviour (Brooker 1974), diet (Brooker and Ridpath 1980), age, movements and management (Ridpath and Brooker 1986*a*), breeding success (Ridpath and Brooker 1986*b*), and nest sites and spacing (Ridpath and Brooker 1987). The diet research concluded that the eagles ate a wide range of food types, but where available preferred mammals greater than 500g in mass and birds greater than 100g. Again sheep comprised a low proportion of eagle food overall, and rabbits were the most common prey, providing further evidence against eagle persecution.

This study remains the most comprehensive, long-term study of eagles at a population level to date. Such studies are vital in understanding species' threats and management requirements and it is unfortunate that no parallel research has occurred since. It was the first research to show a variety of long-distance movements by newly fledged juveniles, thus (together with some data acquired by Leopold and Wolfe, 1970), ground-breaking in showing the requirements of eagles on a broad landscape scale. Brooker (1974) gives detailed information about eagle behaviour and this paper presents it in general language that is easy to understand. No statistics or complicated science precludes readers from interpreting behavioural descriptions. Brooker and Ridpath (1980) is similar. The other publications are slightly more scientific and involve statistical analyses which take some understanding. During my Honours research I had to read these several times to digest the information and gain insight into the studies; a general audience may need further interpretation. However, some photographs and figures aid with this process. The reader can also relate to some findings on their own terms: for example, movements of hundreds of kilometres travelled by eagles (Ridpath and Brooker 1986*a*) are comparable to those distances we humans move in vehicles. These publications have also been digitised are available through online journals, but again their shortcomings are their limited accessibility to an audience with access to these journals.

Another aspect of the two research projects (six journal publications) discussed so far, which stands out from other research conducted since, is the amount of detail contained about research methodology. This is probably because these studies were the first of their kind and it was vital to document all procedures undertaken. Such detail helps engage the reader as they are given the whole picture and require no prior knowledge of the eagle or related studies conducted elsewhere. Rather than follow a 'paper trail' of numerous references embedded in the text, then having to research what each of these references link to, the reader is able to simply follow what has been done and why, creating a sense of engagement and understanding. There is also some degree of engagement as the reader can relate to the researchers' activities by reading the methodology sections and following their personal experience.

Subsequent research in the 1980s and 1990s involved smaller scale projects investigating more specific ecological aspects such as diet and nesting success. Hull (1986) examined eagle food at a few nests close to Melbourne and achieved results similar to previous studies. Robertson (1987) was able to demonstrate that seasonal conditions, which in turn influenced rabbit abundance, controlled eagle breeding density, and also showed that this density has an upper limit which was determined by eagle territoriality. Sharp (1997) provided some notes on eagle breeding diet, with implications that eagles probably do not pose a threat to endangered species. The species list of eagle prey was broadened by studies which looked at predation on

endangered mammals off the coast of Western Australia (Richards and Short 1998), and various locations in New South Wales and Queensland (Debus and Rose 1999). All these studies complimented the publications by Leopold and Wolfe, and Brooker and Ridpath, by adding information about the species in different Australian regions, though these were only short-term projects and do not provide as deeper insights. While Robertson (1987) and Richards and Short (1998) have been published in electronic format, both Hull (1986), Sharp (1997) and Debus and Rose (1999) have not, limiting their accessibility. These studies are mostly useful when considered in the context of previous research.

During the 1980's there were also two detailed laboratory studies on wedge-tailed eagle eyesight. Reymond and Wolfe (1981) found that a human's visual acuity in low luminance was surprisingly higher than that of an eagle under the same conditions. A similar experiment was then conducted to measure the eagle's visual acuity across a range of light conditions, and the maximum acuity, which proved to be more than twice that of a human in high luminance, was determined (Reymond 1985). These studies show that eagles have evolved the ability to perceive high resolution in good light conditions and as a consequence their ability to visualise detail in low light is compromised. Both papers are currently available in electronic format in the online journal Vision Research. Despite this, they are extremely complicated sources of information containing complex scientific language which relates to the physics of light and visual acuity calculations. Although understanding eagle eyesight is just as important as other ecological information, these papers do not provide a useful source to the layperson.

The introduction of the Rabbit Calicivirus Disease (RCD) to the Australian mainland in 1995 provoked more formal scientific research, which aimed at investigating the impact of large declines in the eagle's main food. A study in western New South Wales demonstrated that in the absence of rabbits, eagles switch their diet to include species that are more abundant, such as reptiles (Sharp et al. 2002*a*). This finding was significant as it was able to create an accurate picture of eagle food habits during modern ecological changes. It was important in continuing research on eagles and updating the scientific knowledge base. Using additional data from the broader study, which took place over four years, the authors also published extensive detail on eagle nesting density (Sharp *et al.* 2001) and some important findings on the reliability of the methods used to evaluate diet (Sharp *et al.* 2002*b*). The latter paper was useful for scientists conducting future diet studies but not solely as an educational source. While these papers are all accessible online, each involves complex statistical analysis of the data obtained, and requires prior knowledge of the subject, which could immediately create a barrier to a lay audience. Language used is at times complicated and scientific and would require some interpretation to make them suitable as a general educational resource.

Formal research continued in the late 1990s and 2000s with most research being in the form of five university Honours projects, conducted in different parts of Australia (Winkel 1993; Silva 1998; Collins 1999; Parker 2000; Cherriman 2007). Winkel (1993) spent long hours watching sheep paddocks from hides and noted any eagle interactions with lambs in Queensland, where rabbits are absent and where no previous research on eagle diet had been conducted. There was no evidence to suggest eagles were responsible for any significant lamb losses. Silva's (1998) and Collins' (1999) studies were unique in that they used video cameras to monitor parental behaviour at nests, giving new information on this aspect of eagle ecology which had not previously been investigated. Parker (2000) and Cherriman (2007) repeated standard diet study methods to look at eagle food in two regions where it had not been researched before.

As Honours projects these theses did not contain vast detail on an eagle population compared to previous formal studies, largely because of their timeframe (most were only one or two years), but the information contained in each is important in the context of other literature. Unfortunately all theses were inaccessible to the general public, and only accessible to other scientists/academics at cost from their respective academic institutions; most of the general public would not know these exist. The findings of the first four named above were recently published in one issue of *Corella*, a journal of the Australian Bird Study Association, which was a useful step in spreading this knowledge. This publication was largely the result of Stephen Debus from the University of New England, who was passionate about keeping all knowledge on the species up to date. As an educational resource, this volume uses simple language, has detail about methodology, and with included photographs, is highly effective as a source of knowledge. The problem with *Corella* is that it does not have an online journal and most papers must be purchased as hard copies, again limiting availability.

Apart from these Honours projects, there have also been several other published reports on wedge-tailed eagle ecology during the 2000s. Harder (2000) presents a

concise, detailed paper on diet and breeding biology in New South Wales during one nesting season. This paper is well written in simple language and contains information on a variety of ecological aspects. There are no complicated statistics and no prior knowledge required to understand facts. These aspects make it an excellent resource for the general public, though once they are limited to those with access to the Corella journal. In a similar 'non-scientific' fashion, Allott et al. (2006) documented the breeding cycle from egg-laving to fledging at one nest in Oueensland. Dennis (2006) studied general eagle ecology and made comments about the possible effect of wind farms on eagles. Debus et al. (2007) provide vast detail about diet and parental behaviour at nests, adding to the findings of Silva and Croft (2007) and Collins and Croft (2007). A common theme of these recent publications is that all are conducted over relatively short periods of time, usually one or two years. The advantage of such short-term projects is they are intensive, and more observation time at one or two nests allows some finer ecological details to be examined, giving an intimate look into the eagles' life cycle, compared to extensive studies monitoring multiple nests which may overlook some detail. In combination with long-term research, they are effective in helping fill knowledge gaps. For these reasons, each of these papers forms an excellent general resource about the wedge-tailed eagle.

More currently, Olsen et al. (2006) present a study on trophic relationships between wedge-tailed eagles and neighbouring white-bellied sea eagles Haliaeetus *leucogaster*, the inaugural study of its kind in Australia. They found that there is little overlap in the diets of these two large raptors, and competition for territory during the breeding season is not based on dietary overlap. Information presented in this paper is unique as it provides understanding of the ecological relationships between wedgetails and another similar eagle, something which had not been described before. The same authors also investigated eagle diet and territory occupancy in the areas of Canberra researched by Leopold and Wolfe during the 1960's, in an attempt to document any changes in eagle diet forty years after the pioneering study (Fuentes et al. 2007). This paper shows that many nest sites were still occupied, confirmation of the static nature of eagle territories. They also demonstrated that eagle diet had changed to include more kangaroos and birds and less rabbits, indication that the breeding population in this area was stable. Both publications are well structured and are excellent educational resources. Fuentes et al. (2007) is particularly useful in providing a historical picture of the ecological changes to the environment have not affected the persistence of resident eagles. This is a further indicator that eagles are

here to stay and humans must learn to live in the same environment in balance. Once again, however, access to these papers is restricted.

The most recent research published was from a Masters project conducted in southern Victoria, similar to that of previous Honours research. Patterns in nest site characteristics (Foster and Wallis 2010*a*) and eagle diet (Foster and Wallis 2010*b*) are described in two separate papers. While this study does not contribute anything vastly new to current information, it is valuable in filling geographical knowledge gaps. Like other recent papers the language used is simple, data are not overly statistical, and interpretation is easy for a wide audience.

Other scientific writings about wedge-tailed eagles occur as short notes and anecdotal sightings published in various journals and other Australian publications, and have not been part of formal studies. Most of these relate to eagle food. For example, eight piglets were taken from a farm by a pair of eagles nesting nearby (Anon. 1944). Eagles sometimes hunt in pairs to kill small lambs (Cain 1936; Debus 1978), and work cooperatively in larger groups to bring down adult kangaroos (Geary 1932; McGilp 1936). Two adult eagles were witnessed feeding on a deer calf which they were most likely to have hunted cooperatively (Anon. 1995). Threatened burrowing bettongs and hare-wallabies have been removed from a breeding enclosure at Dryandra Woodland, near Narrogin in Western Australia (Friend and Beecham 2004; Fulton 2006). At one nest in New South Wales, 120 rabbit carcasses were counted, and at another where rabbits were not abundant, galahs were the main food source, as well as foxes, hares, small kangaroos and goanna (Hobbs 1962). Mammals as small as rats can be eaten when in high abundance (Berney 1906). Emu chicks and a black bittern Ixobrychus flavicollis were observed to be hunted by wedge-tailed eagles by Burton and Morris (1993). Remains of birds including great cormorants Phalacrocorax carbo, spoonbill Platalea sp. and grey teal Anas gibberifons were found at a nest in central western New South Wales (Brooker 1983), and larger cockatoo species (yellow-tailed black-cockatoo Calyptorhynchus funerus and galah) have been taken in flight (Haby 1997). There are even reports of attacks on humans: seven wedge-tailed eagles dive-bombed a group of children who were not accompanied by any adults (Le Souef 1905).

Although they provide interesting insights into the biology of the wedge-tailed eagle and its interactions with people and other animals, these writings are not stand alone sources of information. Some of the older references, especially those pre-1950, are not strongly scientific at all and give quite interesting information about human attitudes and behaviour towards the species, and the environment in general, during this era.

It is evident that there is vast detail on the wedge-tailed eagle's ecology available in the scientific literature, and the number of papers published has increased each decade since the 1970's. A common theme to almost all references discussed is their limited access to a wide audience. Furthermore, most papers discuss the information objectively which lacks personal engagement, distancing the audience. The latter problem has been somewhat addressed in books, as we will explore now by looking at some other methods of communication.

#### 2.3 Books

During the same era as the initial intensive eagle research by scientists (i.e. 1960s-70s), several photographers were working to bring the lives of Australian raptors to the attention of the public through their camera lenses. A father-son team from New South Wales published the book *Hawks in Focus*, and this became the first project to successfully photograph at the nest all 24 Australian raptor species (Cupper and Cupper 1980). Together with writings of their photographic expeditions, the Cuppers' book provided detailed information on the wedge-tailed eagle, also containing one of the first photographic records of a clutch of three eggs in this species. A subsequent book presented a similar view of birds of prey in Australia to that of the Cuppers. The Book *Eagles, Hawks and Falcons of Australia, First Edition* showed rare images of these birds in their natural environment, with a collection of personal essays about the photographer and his experiences in taking them (Hollands 1984). The text was revised and the book republished in a Second Edition more recently (Hollands 2003).

These types of texts offer detail on the wedge-tailed eagle's life-history, and together with amazing photographs, allow a wide audience to gain a better understanding of the species. Both Cupper and Cupper (1980) and Hollands (1984; 2003) add field characteristics and identification guides as appendixes in their books, which add to their practicality and effectiveness as resources for a wide audience. They are advantageous for several reasons: 1) photos of raptors and their behaviour are easy to interpret and do not require any prior knowledge like some science literature does; 2) written personal stories are not jargonistic and allow a wide range of people, not just photographers, to engage with the authors; 3) books are usually distributed widely and there are no restrictions with access as is the case for scientific papers.

Australian raptor ecology was further enhanced by "Australian Birds of Prey: the biology and ecology of raptors" (Olsen 1995). The descriptive yet simple and at times poetic language used, together with life-like colour images of birds by wildlife photographer Nicolas Birks, brought all 24 species into further reality. This book was successful in bridging the gap between the complexity of scientific procedures and findings in published literature, and a lay audience, by using a more creative (simple, vivid, highly descriptive) personal writing style. Because of the author's background in science and research, it can be thought of as one of the early steps in science communication for wedge-tailed eagles. The combination of visual and written information make this a highly important resource. The unfortunate thing with this book is that it is now out of print, preventing newly interested people from obtaining their own copy.

A more recent publication by Penny Olsen took the same approach as her earlier book but for the wedge-tailed eagle alone (Olsen 2005). As the author noted, given the eagle's past history and maligned reputation, it was "...somewhat surprising that there has been no previous attempt to summarise what [was] known into a dedicated book..." at the time of publication. This book reviews the eagle's life cycle in detail, incorporates scientific research into descriptions of various ecological aspects, and contains a broad reference list, the latter being very useful in pointing readers in the right direction to obtain further information. This makes it the most recent and comprehensive collection of knowledge on the wedge-tailed eagle to date, and together with Olsen (1995), forms some of the best sources of information available to a general audience.

David Fleay was a well known Australian conservationist and owner of Healesville Sanctuary in Melbourne during the 1950s, being the first to breed wedge-tailed eagles successfully in captivity. His stories were published by a family member in the book "David Fleay's World of Wedge-tails: the writings of David Fleay on the Wedgetailed Eagle" (Fleay-Thompson 2002). This collection of personal stories illustrated with archival photographs describes the intimacies of captive eagles, their bonding with humans, and several important aspects of the breeding cycle that could seldom if ever be witnessed in the wild. It is also obvious in the text how humans' attitude to wildlife and approach to conservation have changed greatly in recent decades. A deep insight into the species is given through the eyes of one eagle, "Horatia," who was hand-reared as a nestling and in essence becomes Fleay's 'mate,' taking food from his hand, offering him nest material, and protecting him from wild eagles. This more spiritual aspect to the wedge-tail's life cycle is one of the first references to recount information through personal story, which effectively engages the reader, making it unparalleled.

On a similar spiritual level but using paintings rather than written stories, the species is promoted in a large 'coffee-table' book "Spirit of the Wedge-tailed Eagle" (Olsen and Price-Jones 2007). This book contains life-like images of the wedge-tail painted by Humphrey Price-Jones, an international wildlife artist residing in New South Wales. It captures the eagle at a variety of ages (from young chicks to dark adults) and situations (in flight, perched, feeding, breeding pairs, etc), and the images are interlaced with short passages of information about the species and quotes (mostly from early science journals), captivating the reader. It is effective at conveying the beauty of this eagle to the public, although its artistic nature means there is a lack of any deeper detail about its ecology or conservation.

Other published texts consist mostly of children's picture books and juvenile literature or fictional stories (Dutton 1980; Thomas 1999; Riley and Traynor 2001; Thiele 2003; Pyers 2006). While they do little in the way of communicating science and detailed information, these books accurately portray the eagle as a charismatic Australian species. Importantly, they serve as a medium to promote young readers' interest in eagles during their childhood and hopefully inspire further learning as they become older.

#### 2.4 Films

There are only two known films which focus on and provide information about the wedge-tailed eagle in Australia. Other than these, the species has also featured briefly in a television series *Eagle* (BBC Wildlife Specials 2004), which gives limited information about wedge-tails, as well as a variety of the world's eagle species.

*Wild Tasmania* (2007) a story about the plight of the Tasmanian subspecies of wedgetailed eagle, is the only known professional film focussing on the species (ANHU 2007). Introduced by Sir David Attenborough, the film shows how this endangered race is declining throughout its range during a time of intensive logging practices, partly because it requires large stands of old growth forest in which to breed. There is also the persisting attitude that eagles pose a threat to livestock and consequently some are still persecuted (Mooney and Holdsworth 1991). The film is a classic example of a wildlife documentary communicating a sensitive issue to a wide audience using blue chip footage of eagles in their natural habitat, ultimately giving the viewer a sympathetic view of the eagles' situation. It has huge value as an educational resource because of the unique footage taken at eagle nests which is the first of its kind.

The other known film is an amateur documentary called *A King on Outstretched Wings* (2008) produced by Insight Ornithology. This collection of film taken at nests during the breeding season shows the life history of the eagle from egg to adult. Although there is no specific narrative and the footage is low quality, it was made with the intention of getting a basic message into the public forum, and it provides grounds for making improved films in the future.

As we have explored in this section, there is vast detail on the wedge-tailed eagle, with most of the detail being available only in the scientific literature. However, this detail is limited to those interested in and able to source and interpret this information, which usually does not include the general public. This inaccessibility is a theme to almost all the journal papers discussed. The style, scope and language of some of the aforementioned science journal papers also limits the audience; these are seen to be the main reason science communication in general is often ill-effective (Treise and Weigold 2002). The lack of personal interaction or feel to 'stereotypical objective science' is another of its shortcomings, further distancing an audience. Therefore, in terms of communication, the extent of published literature does not reflect public perception and understanding of this species in Western Australia. It is obvious that there is the need for interpreting and communicating knowledge 'locked away' in the scientific literature in order to make the current knowledge base on wedge-tailed eagles available to a wider audience.

### 3. The Science Literature Process

#### 3.1 Importance of Science Communication

"Knowledge is far more useful in the hands of billions of people than it is locked away in institutional libraries or withheld by higher classes of society."

"True communication is not about sharing information, it is about sharing meaning and reaching a common understanding."

These quotes from Cribb and Hartomo (2002) so accurately sum up the importance of communicating scientific knowledge to a broad spectrum of the populous in today's technologically-driven world. It is necessary for the public to have accessible, succinct and reliable information (Shortland and Gregory 1991). From a political standpoint, neither science nor technology are possible without strong public support (Valenti 1999), and this knowledge therefore aids people in making effective decisions about science policy (Treise and Weigold 2002). In addition, it is important for the populous to understand the role of science-based institutions, such as universities (Jensen 2005). Cribb and Hartomo (2002) add it is fast becoming apparent that a lack of even communication to societies throughout the world is enhancing social problems of class divisions. Familiarity with scientific concepts is necessary for people to make better decisions about how they live their own lives, and to maintain good health and overall wellbeing. Science communication can also be a pleasurable and rewarding activity (Shortland and Gregory 1991), and scientists are becoming increasingly aware of the need and keen to share their insights about the world around us.

Despite its importance, the literature suggests that science communication is seldom done effectively (Kim 2007). It is generally accepted that the communication of science occurs via a two-way feedback loop: science – media – society. Science knowledge for most people comes from the mass media, and the key concepts and ideas discovered in scientific research are often filtered by this medium (Treise and Weigold 2002). Therefore, the effective communication of science is often defined by how well scientists are able to communicate with journalists (Valenti 1999). Yet differences between the appearance, attitude and approach of these two professions highlight several problems within the communication process. One of these is background education: most news reporters receive training in the discipline of media and journalism, rarely social science or science/engineering (Treise and Weigold

2002), and consequently have different priorities with regard to the type of information they wish to convey. For example, the precise, often technical language of scientists is not well suited to the lay audience of the media. Also, the media's choice of publicised stories is often influenced by demand for sensationalised current-affairs (Corbett and Durfee 2004); thus, important scientific discoveries may not be prioritised unless they are likely to be 'front page' news. Another consideration is the images that come to mind when the terms 'science' and 'scientist' are mentioned. A stereotypical professor with a white coat and glasses working with chemicals in a laboratory is perceived by the public as complex and uninteresting. That is, science has a certain reputation which also creates a gap between academia, the media and the public forum (Shortland and Gregory 1991).

This suggests that alternative approaches to the communication of science are needed. The trend towards scientists becoming communicators themselves is one such solution to 'skip the media link' and is a necessary step to help overcome some of the problems mentioned above. This also allows for scientists to bring in the personal element missing from much of the published literature discussed in Chapter 2. "Eagle Discourses". Some suggest that there are problems for the scientist wishing to broadcast their own research. According to Treise and Weigold (2002), these include language, organisational and professional impediments, and the lack of any real rewards from taking the initiative to communicate. Despite these apparent hurdles, it is becoming easier as a scientist to source information on how to become an efficient communicator. This is especially relevant in the current age of the internet which has created a readily accessible global network of educators (Holliman et al. 2009). Several books explain not only the importance of being able to communicate knowledge, but give step by step procedures of how to conduct effective written and oral presentations to both scientific peers (Laszlo 2006) and the general public (van Emden 2001; Walters and Walters 2002). This very course (the Masters in Science Communication) is focussed on expanding the number of students with training of how to become better communicators of science, by using several channels through which information can be broadcast: for example, filmmaking, writing, public educational displays, podcasts and museum exhibitions.

As we explored in the literature review, much of the information on wedge-tailed eagles, and the detail about how this information was discovered, exists in a few key scientific journals and several general audience books. Two of these books in particular provide a step in the right direction toward unlocking the information from

the science literature and making it available to a wide audience. Olsen (1995, 2005) are effective texts because they are essentially written by a science communicator, someone who has taken the information directly to the public without the interim phase of the media. Here, I wish to emphasise the importance of this type of communication by discussing some problems with the science communication process from a personal perspective. My aim is not to say the science process is defective or that there is one single better alternative, but to highlight the problems with it and give reason and support for alternative means of communication, with specific reference to the case of eagles.

#### 3.2 Problems with the Science Literature: a personal perspective

In the last six years I have had growing experience in being a scientist with the progression towards becoming a communicator. My interest in eagles remained a hobby until I completed an Honours research project on their diet and territory size (Cherriman 2007). This provided an opportunity to apply some logical format to my thoughts and knowledge about eagles - the 'scientific method.' In other words, I was able to align what I knew about eagle ecology to a coherent order, conduct further research in the context of this order, then produce results and discuss what these meant in a wider context of research in this field. This gave good insights into the scientific world as a vehicle to communicate knowledge, but it also began to highlight some of the problems with accessing the information, synthesising it and using it in an effective way to produce new knowledge. It also made me worried about the value of adding to this ever-growing source of information 'locked away' in the scientific literature. Was I really contributing anything to the broader community by following the science research path? Here I wish to describe some of the problems I encountered, and to give a background on why I was interested in exploring other means by which to convey knowledge. These problems include access, depth of research, information loss across generations and further filtering in the peer review process. Such problems have previously been pointed out, and the argument that the workings of the scientific world has many foibles has been discussed in depth by sociologists of science (e.g. Kuhn 1962, Latour and Woolgar 1979). Initially I will provide a personal perspective, then expand on the issues discussed in light of several relevant texts from the Sociology of Science.

The first problem is access to information. It was obvious that one must be a subscriber to a particular journal, or be a scientist or science student to have access to

published papers. It became apparent that while a subscriber, scientist or student has *access* to a wealth of journals, it does not mean they will find the right journal containing a particular paper that is relevant to their topic of work. A process of detailed research and refinement, and some knowledge of the names of relevant journals, remains. This issue is further influenced by the field of science that is being researched. Much of the important information in some fields may only be present in a few key journals, while other fields may have information spread across a wide range of publications, making it more difficult to find. For example, I only gained access to the paper most relevant to my topic about eagle diet (Brooker and Ridpath 1980) some months after the literature review was completed. In this case, the vital information was eventually accessed, but it quite easily could have been overlooked.

Research publication date presents further problems with access. Some of the most comprehensive detail about certain topics of science exist in quite old literature. However, some of this knowledge, particularly that published more than two decades ago, may be very hard if not impossible to access. This is particularly relevant to wedge-tailed eagle information: forty years after it was done, the long-term ecological study conducted by Brooker and Ripath mentioned in **Chapter 2, "Eagle Discourses"** is still the most comprehensive work on this species, but it is found only in three journals and is probably known about and accessed by few people. It is only in recent times that pre-1990 (or thereabouts) journal articles, which existed only in physical format, have been digitised and placed into electronic databases available online. Indeed, some of these still remain inaccessible in electronic format. Thus, there becomes a danger of *missing* publications, or pieces of the jigsaw puzzle, which are absolutely necessary to consider as we are building a picture of a particular area of research.

It has been mentioned by some scientists that the literature reviewing process is not designed for the researcher to access *all* the information about a subject. Rather, literature is necessary to use as evidence that will substantiate an argument already formed. In these cases the scientific method becomes fraught with danger. A selection process whereby the researcher may include and dismiss available information to prove or disprove his preformed ideas creates enormous bias to a situation. It is akin to a journalist dismissing vital facts from a newspaper article which would otherwise add important context to the story.

While access might be gained to a wealth of information, there is then a problem relating to the depth of knowledge. This refers to how much research and literature reviewing is required before a particular topic has been covered thoroughly. Initially it can be very hard to find relevant information, but once a few journal papers or books are sourced, the amount of material can eventually become overwhelming. The researcher must then decide the point at which the synthesis of previous information ends and where its contextualisation and the generation of new knowledge, begins. Again, there is the danger that vital information will be missed. This problem seems to be exacerbated the large numbers of new publications (particularly journal papers) that are produced each year in popular areas of science. As more and more research in a particular field is conducted, the new researcher is faced with an ever-growing library of knowledge to locate and synthesise. This problem is particularly evident in the field of Environmental Science, which has been an increasingly popular discipline in the last two decades with the growth of the Environmental movement.

A scientist or researcher must obviously continue the literature reviewing process throughout the course of their study and writing, and remain vigilant, to help mitigate this problem. This is a logical part of the process, but even so, it does not ensure previous research will not be missed. Another way to solve this is to apply a timescale: only consider publications that were published over a certain time period (e.g. in the last ten years); this is in fact a common rule in modern academia. By filtering information in a chronological way, knowledge synthesised is thought to be concise and up-to-date. While this may help with time and effort spent reviewing literature, it can become extremely risky in the learning process as it unavoidably involves assumptions which can result in the skipping of some information. Acquiring an historical timeline for a certain field of science is time consuming but can give a powerful perspective on developments in that field (see Latour and Woolgar 1979).

Nevertheless, such detailed histories are seldom used, which leads to the next problem: information loss across generations. By considering information that is only published in the last decade, one makes assumptions that this is the only material relevant. Assuming relevance means relying on the reviewing and synthesising work done by previous scientists which, despite the strict 'scientific method', is still not free of errors. Human error comes in to play in all facets of society. To help illustrate this problem it is necessary to introduce an example I encountered during laboratory work, described in Cherriman (2007).

While determining the best method used to quantify the number of prey animals present in regurgitated wedge-tailed eagle pellets, I found several papers which had conducted previous research in this area. Glading et al. (1943) determined that regurgitated raptor pellets could be useful for analysis to determine the prey species eaten. Importantly, he stated that the use of nocturnal raptor (i.e. owl) pellets was accurate in quantification because they usually contained whole specimens of the birds' prev – e.g. three birds, one mouse, etc. *However*, Glading *et al.* (1943, p. 102) emphasised that '...pellets of the hawks [which include eagles] tested were unreliable as a quantitative indication of food habits and even a rough qualitative list of items found in hawk pellets is open to question as being truly representative of items eaten.' This is because unlike owls, hawks and eagles do not swallow their prey whole, they ingest portions of a particular prey animal, and their pellets contain only fragments of this prev animal which are of no use for quantitative studies. Despite this, many subsequent Australian raptor studies (e.g. Baker-Gabb 1984; Hull 1986; Aumann 1988, 2001) still used pellet analysis to quantify the diet of hawks and eagles. They referenced the research of Glading et al. (1943). This study was published more than forty years prior to their work, but they either did not locate the original publication at all, not review it in sufficient detail, or simply misunderstood the significance of these findings.

This example highlights the need for vigilance in both the reviewing of literature and the knowledge in a particular field of science, and emphasises the importance of constructing a detailed literature history (Latour and Woolgar 1979). It also suggests that authors can easily and might well cite a publication by simply finding that it exists after reading it in the reference list of another paper, but not actually locate and read it.

Further filtering of knowledge occurs during the process of publishing scientific studies. Journals have strict regulations with regards to how new information will be published, and there are a series of steps which facilitate this process. The most important of these with regard to the informational processes outlined here is peer reviewing. Other scientists, usually those with experience in the same field, are responsible for analysing the facts and ideas portrayed and assessing the validity of new journal papers before they are published. Here the human error can arise again, as different reviewers often have contrasting viewpoints about the paper. During my Honours research I was occasionally given contrasting suggestions from alternate supervisors who were in very similar fields of environmental research. These

contrasts can be influenced simply by varied experience, or by ego and intellectual property.

Two texts that exist in the Sociology of Science which have taken the above points into deep consideration include Structure of Scientific Revelations (Kuhn 1962) and Laboratory Life (Latour and Woolgar 1979). While these investigations do not specifically aim to examine problems with science practice as a means of communication (the main topic of this thesis), there are several overlapping themes between this theme and their broader sociological view of science, which provide an important perspective. Kuhn's classic text created a locus in the Sociology of Science from which many subsequent sociologists expanded arguments questioning the previously considered authoritative nature of the science 'world'. In a similar way to my personal experiences, Kuhn began life as a scientist (physicist) but soon encountered problems with how workings in this discipline were conducted. Because of Kuhn's personal accounts, the book can be interpreted as somewhat autobiographical which helps a great deal in guiding the reader's understanding of topics discussed. Kuhn's main argument is that science exists in the form of 'paradigms': each field of science consists of a paradigm in which theories and ideas remain constant according to the 'rules' of that paradigm. Each paradigm is commanding and unchangeable. This was an early interpretation of the inflexibility of science disciplines which was revisited by Kuhn in later editions of Structure, and has since been moulded into a more open view, one that recognises that science theories undergo constant change both within and between disciplines (Moore 1980, Sankey 2002). Interestingly, Kuhn notes in his introduction that his intention in writing Structure was to provide other physicists with insight to the problems he recognised to aid with their own careers, but ironically the text was adopted on a much broader scale by sociologists.

Laboratory Life expanded on this argument by documenting a thorough study of science in practice in a neuroendocrinology laboratory (Latour and Woolgar 1979). An 'observer' was placed in a functioning laboratory to practice as one of the scientists and at the same time keep detailed records on the workings of daily activities in the laboratory. This included the layout of the laboratory, the different types of scientists and technical officers working within it, the ways these people communicated with each other, the various experiments conducted and machinery used, the types of research done, and the role of the laboratory in engaging with the outside world. This study was much like that of an anthropologist conducting research

on a tribe of natives, although the observer's study, however, was well known to his 'subjects.'

In *Laboratory Life* we follow the observer's journey and learn the importance of his findings about the laboratory in a sociological context. The theme that emerges presents workings in the laboratory as primarily about using 'inscription devices' to create information and take it through various stages of production, for example:

ANIMAL TEST/BIOASSAY  $\rightarrow$  ANALYTICAL DEVICE  $\rightarrow$  COMPUTER  $\rightarrow$  ROUGH TABULATED RESULTS  $\rightarrow$  REFINED RESULTS  $\rightarrow$  FIGURE OR DIAGRAM TO APPEAR IN JOURNAL ARTICLE.

At each stage of information transfer the previous 'device' loses its importance, and the focus then becomes the way in which the next 'device' holds that information. Latour and Woolgar (1979) argue that complicated apparatus in the laboratory are merely a representative of an object, theme or scientific discovery, and without this apparatus these objects/themes/discoveries do not exist. In other words, what are written as facts are actually mythologies. The claim by scientists that they are workers producing facts is rephrased as scientists being "... writers and readers in the business of being convinced and convincing others," the endpoint of such writing process being a journal article. This is the final polished output of the research process, a 'hard object' which represents a 'scientifically proven fact'. A single journal paper then enters the outside world to be distributed to other scientists, entering a whirlpool of thousands of similar papers, each having been anointed with significance through their publication and each purporting to embody a particular fact or facts. But the worry is with the process of fact production, where an emphasis is placed on how important the context (or series of steps) is, tends to be ignored when scientific 'facts' are published. These 'facts' lose their true meaning when quoted alone and not considered as one point along a timeline of contextual information, or as Latour and Woolgar (1979) say, the "...circumstances of discovery and the process of informal exchange are both crucial to the productive process: they are what allows science to exist at all" (p. 252). This is and additional concern, particularly when considered in conjunction with my earlier concern regarding the risks of misinterpreting journal articles which seemed to be evident in Glading et al. (1943).

Others have since commented on this mythological portrayal of 'facts'. For example, Sankey (2002) states that a fixed reality independent of human thought and perception does exist, one which is not comprehendible to humans. On the other hand, the world which humans perceive (through scientific 'facts') is composed of our concepts and sensory input, and it is *this* world (or 'mythology' when viewed from a sociological perspective) which becomes pliable as result of changes in scientific theories (Sankey 2002).

Laboratory Life delves into other social factors which are less connected to communication but which further highlight the possibility of human elements disrupting the production of facts. One of the most relevant of these is political influence (Latour and Woolgar 1979). References are made to circumstances where scientists are often working with politicians 'breathing down their neck'. Furthermore, an examination of journal paper production is conducted in such detail that an approximate cost of each paper produced is provided. This introduces a whole new attack on science's validity in mentioning the monetary influence on institutional behaviour, and the competitiveness which emerges among scientists to gain ongoing research funds. The following quote sums this up well:

"[Scientists are] strategists, choosing the most opportune moment, engaging in potentially fruitful collaborations, evaluating and grasping opportunities, and rushing to credited information. In interviews it is not merely peripheral concerns which excite and interest them. Their political ability is invested in the heart of doing science. The better politicians and strategists they are, the better science they produce." (p. 213).

Latour and Woolgar then go on to discuss how the production of new papers involves reviewing other papers and the contextualisation of newly produced laboratory information. They comment on the dilemmas that are created through quoting and misquoting previous research, and they identify this as "...a constant struggle for the generation and acceptance of particular types of statement" (p. 81). These insights align with my discussions above about problems with access, depth of knowledge and information loss across generations. While my examples focus on how the problems of the scientific method affect the communication of certain published information, *Laboratory Life* examines these foibles from a much broader point of view, encompassing the very validity of science itself. One of the authors' concluding remarks that "most published papers are never read, the few that are read are worth little, and the remaining 1 or 2 percent are transformed and misrepresented by those who use them" (p. 252) exemplifies my argument.

The many faults in the science 'world' discussed by Latour and Woolgar (1979) would be harshly received by scientists practicing today, and there lies a possibility of a wedge being placed between these two perceptions of science. It is important to

point out that the same types of methodological contexts that influence the portrayal of scientific findings as facts can be applied to the Sociology of Science depicted in *Laboratory Life*. For example, an assumption is made that recording the number of citations that a scientific paper has had since publication provides an accurate measure of the paper's success. An important consideration is that 'science' encompasses an extremely broad range of disciplines. It is a vast generalisation to assume that all errors highlighted in *Laboratory Life* apply to all these disciplines in the same way. The arguments depend on the division of science being discussed. However, the authors are not oblivious to this, noting in Chapter 6 that "Obviously, our own account cannot escape the conditions of its own construction" (p. 253) and "the notion of constructing order from disorder applies as much to the construction of our own account as to that of the laboratory scientists" (p. 254). The main message is to bring a detailed critique of science methodologies to the attention of scientists and sociologists alike.

Recent texts by sociologists (e.g. Collins and Evans 2002) have analysed this history and made efforts to see positives from both fields of academia, even going so far as to recommend that there are benefits to scientists taking a 'bird's eye view' of how they conduct their work. Collins (2007) presents an interesting account of some practical considerations and uses of the Sociology of Science for scientists and educators. He initially tells of personal experiences in his field (Sociology of Scientific Knowledge) and describes the same kind of research as that depicted by Latour and Woolgar (1979) using an analogy of birds and ornithology: "We were the ornithologists whose job was to understand the nature of the birds much better than the birds could ever understand it." He then goes on to justify this by saying "If you want to know about ornithology, don't ask birds". In the early development of the field, scientists were ignorant of the kind of research done in the Sociology of Scientific Knowledge, and as Collins puts it, this was because "...scientists need philosophy of science like birds need ornithology" – in other words, they don't!

Other texts have welcomed this kind of critiquing. Murray (2006), the editor of the Journal of the American Chemical Society, presents an argument encouraging efforts to understand science researchers and their way of thinking. "I applaud these impending efforts to understand us researchers, since we understand ourselves so poorly. I encourage the sociology researchers to not just send us questionnaires, but to take the trouble to 'live' in a science community."

Collins (2007) emphasises that science educators should not hide the fact that science is rarely ever about a structured discovery of facts in a short period and more about years of criticizing, adding to, and shaping previous research until ideas become solidified. This view is shared by other authors including Kuhn (1962) and Latour and Woolgar (1979). As mentioned above, these comments could serve to create a barrier between the cultures of Science and the Sociology of Science, a 'them and us' scenario. However, Collins takes this topic forward by also critiquing sociological views of the science 'world', arguing that "... the parade of epistemological failures in the Twentieth Century, from logical positivism to falsificationism, followed by the detailed descriptions of scientific practice developed since the 1970s, have been taken as a license to forget scientific values." He rightly adds that "...scientists and technologists are fallible vet we must not fall into the trap of thinking that this should turn technological judgement into populism." In other words, science and scientific research remain a strong part of modern society, there are many methodological problems associated with how they are practiced (as in Kuhn 1962 and Latour and Woolgar 1979), but both scientists and sociologists alike must recognise these issues, adopt a broader outlook and continue to develop knowledge for the greater good.

Interestingly, Collins (2007) begins his article with an engaging but incomplete narrative. He presents various aspects of his argument relevant to the title, then ends the paper by concluding the narrative. In this way a sociological issue appears 'sandwiched' in a story which is an engaging and effective communication method. I related much more to the sections of *Laboratory Life* which appeared more like a narrative arc, rather than those theoretical sections. For example, the section on the history of the development of a particular hormone over an eight year period (see Chapter 3: 'The Construction of a Fact') was presented using a temporal structure, much like a narrative, which was also engaging and easy to follow.

It is clear that there are numerous problems with the science literature as a means of communication. While it is true that these problems do not only apply to scientific literature, and can be just as applicable to other discourses such as the Sociology of Science, the problem remains that there is a barrier between scientists and a general audience. It is an important consideration that the scientific literature is used in collaboration with other discourses (see Schallenberg and Piña-Gasca 2010). There are indeed examples of scientists in certain disciplines publishing research then effectively interpreting it to engage the wider community. González-Espada (2009) found writing newspaper articles about a range of science topics was both effective at

reaching, affecting and initiating responses from a wide audience, and a rewarding activity. But in many cases there is still an increasing urgency for many scientists to become communicators of their own research (Cribb and Hartomo 2002).

While the knowledge on wedge-tailed eagles stored in scientific journals is important, it needs to be made widely available if it is to contribute and be of any use to society an ultimately to broader land management strategies that are beneficial to both the birds and humans. I found myself in a position to critically analyse this knowledge base and investigate new ways to raise awareness about the species. The most logical step was to build on the most effective forms of communication which currently exist and take these into a new area. That is, I wanted to use the strength of visual communication and personal story contained in photographic books like Cupper and Cupper (1980) and Hollands (2003), combine these with some of the general biological information conveyed in 'science communication' books like Olsen (1995, 2005), and, in light of the above discussion about keeping in mind the sociological view of science in practice, expand into the filmmaking medium which I began using in 2008. The choice was to make a narrative film to do this, which would have several advantages: eliminate complicated language present in science papers, attract audiences using appealing visual images, and create a sense of engagement with an audience through the use of personal story (Ryan 2010).

In the next section, we will explore the topic of narrative theory, and use some examples to illustrate how narrative film has been used in the past to raise awareness and educate the public about other species.

### 4. Narrative and Film

#### 4.1 Introduction to Narrative Theory

Narrative is an integral part of everyday life. All of our interactions with the environment and other people can be relayed through story (Kercheval 1997). We describe experiences with people and animals though stories, we tell our friends and partners about what happened at the pub or on holidays overseas using narrative devices subconsciously. Humans habitually deal with each other through relations of giving and talking (Reid 1992). Yet story can easily be overlooked as a source of formal communication, often because of its ties to fiction (Cohan and Shires 1988). Despite this, it is still one of the most useful discourses to engage an audience and convey important facts. This chapter is focussed on investigating and explaining narrative theory, the advantages of story, and how this can be utilised in a fictional film to create meaningful educational resources. Firstly it is necessary to explain some definitions and principles of narrative.

A common definition of narrative is simply the organisation of a sequence of events into some form of order (Cohan and Shires 1988). Reid (1992) adds that there is a second component of narrative which most fail to recognise: that the sequence of events told in a story depends not only on their organisation, but also on the very *act* of their perception. The organisation of these events into a story can also be thought of as having two main aspects: story, which refers to the characters, actions and settings of the topic, and discourse, which relates to the means by which the story is communicated (Chatman 1975). In the context of this thesis we will eventually focus on film being the discourse used to convey narrative. Narrative theory has several terms which in non-theoretical writings are often used interchangeably to describe this procedure or to name the finished product (e.g. story, narrative, plot). These require early clarification in order to fully understand this topic.

#### 4.2 Elements of Narrative Theory

Narrative is best imagined as a structure composed of large components which are in turn made from smaller building blocks, and tied together with a variety of substances. Cohan and Shires (1988) state that the smallest of these building blocks is an *event*, defined as an occurrence to a being in a time or place. Events are of two different categories: either kernel, or satellite. Kernel events can be described as those

integral in progressing the story to its desired outcomes, or the main points which govern the story's process. In other words, kernel events define the narrative's macrostructure or skeleton. Satellite events are those which act to facilitate the meshing of kernel events, but which can be altered or reordered without any significant impact to the main message. Two or more events strung together to construct then alter a situation form a *sequence*. Assembling these sequences then creates a *story*, defined as an ordination of events which are arranged linearly (Cohan and Shires 1988). For example, "the man left the room and then the woman left the room." This is the simplest form of story, a chronological sequence, that we might convey to someone without considering its meaning.

An important point here is the distinction between story and narrative: we have already used these terms interchangeably but in narrative theory they have differences. According to Cohan and Shires (1988), narrative is a term which governs the process of storytelling, with *story* being a type of narrative, as defined above by having linear events, or events which unfold in a chronological order (Burroway 2003). The other type of narrative is *plot*, which refers to a narrative composed of a subordination of events, not simply a temporal order. That is, there is some meaning derived from the progression of these events; the plot serves to reveal the dramatic, thematic and emotional significance of such events (Burroway 2003). For example, "the man left the room and the woman chased him." This implies the man left the room because of something the woman said or did, and/or the woman had a reason for leaving the room. Here we have introduced characters and it is now necessary to elaborate on *character* in narrative.

A simple definition of a character is the person appearing in a particular narrative, and there is usually a main character or protagonist around whom much of the narrative is constructed. If we are imagining narrative as a journey driven in a car, then the protagonist would be described as the driver. While this is true, the character also serves a deeper purpose in that they appear in narrative structure to carry out important functions related to driving the narrative. That is, they are the agent that binds events together through action (Cohan and Shires 1988). While some define this protagonist as a person, Chatman (1978) more critically points out that a character is a "paradigm of traits." A character is not a closed set of conditions; rather they are composed of several traits or personal qualities which draw on existing beliefs and values in society. These traits may be changed or added to as the narrative progresses. In this way, character is a general term which can relate to a person, or to an animal or

item. It is also important to bear in mind that the interpretation of a character's traits will vary according to the relative ideologies of various readers (Prince 1982).

One important aspect of character in narrative is *change*. The protagonist's views and beliefs should be challenged or altered between the beginning and end of the narrative. That is, the main character needs to experience a single moment where they must make a decision that will determine their essential integrity, one where they will either live more in harmony or more add odds with themself (L'Heureux 2003). This change is an integral part of the narrative's success in engaging the audience and creating a sense of learning and enjoyment beyond the experience of simply reading a story (Burroway 2003). It gives the narrative the capability to have impact on the reader.

The final key element in narrative structure is *setting*, the place and collection of objects where the character's actions shape events as they unfold (Chatman 1978). It is a space which exists before any construction of narrative and occurs independently of other narrative elements. The setting can vary in its importance in different narratives, being either prominent or insignificant: Prince (1982) argues that settings are not essential to narrative but they play a vital role in many existing stories.

Finally, perhaps the most important term in narrative construction is *equilibrium*. This refers to a sense of stability which is inevitably disrupted, beginning a narrative and providing a set of conditions for which the unfolding of events in the narrative are striving to restore (Cohan and Shires 2008).

Now we have laid the basic foundations of structure to the narrative's 'world,' and defined how events which shape it unfold. The reader then must be lead through this world by following the narrative form, or the *story arc*. This story arc can fall into certain categories: man vs. man; man vs. nature; man vs. society; man vs. machine; man vs. God; man vs. himself (Burroway 2003). While most writers do not select or construct a category before beginning a narrative as they would a character or plot, most finished stories do fall into one or another of these. Several analogies have been used to describe the arc a narrative follows from beginning to end. It can be defined as a 'battle' between two sides, each of which play their role until a crisis event is reached, this being the one which makes the outcome of the battle inevitable. In this way, a whole narrative can be thought of as one single resolving event (the ending) which all the other events serve to build up to (Burroway 2003). Alternatively, Cohan and Shires (1988) suggest a narrative is like a journey travelled by driving a car, with

the signals, signs, corner turns and pace changes encountered in such a journey akin to those we experience when reading a narrative. Both analogies serve to explain the process by which a reader follows the flow of a particular narrative. Importantly, the flow is initiated by the beginning of the battle; the start of the car journey; the disruption of the equilibrium. Burroway (2003) fits this disruption to a conflict – crisis – resolution model, where there is an emphasis on the need to apply some elements of trouble or conflict to create a different flow or pace change throughout the narrative. This relates to the different definitions of the terms *story* and *plot*: story would be considered a linear recount of events with no necessary conflict or crisis and, according to Burroway (2003), a dull narrative. On the other hand, a *plot* introduces elements of conflict which influence the dramatic, thematic and emotional significance of events and consequently shapes a interesting, engaging narrative with varied pace throughout.

However, the story arc does not rely solely on conflict, but also on a process of connection and disconnection (Burroway 2003). That is, throughout the course of the narrative the main character will engage and disengage with others and with aspects of himself to varying degrees. This is more an emotional process by which the reader engages with deeper human emotions and morals within themselves through characters, as they are influenced by various events in the narrative.

A final important consideration of narrative is its *truthfulness*. This is particularly relevant to our discussion of the role of narrative in portraying 'accurate scientific facts' (we have used the term 'fictional', here it is necessary to elaborate on its definition). Narratives can be broadly divided into two types: fiction or non-fiction. In simple terms we make quick assumptions that all narratives fit directly into one of these two categories. If a story is true, and describes, for example, an historical sequence of events, it must be non-fiction. And if it is written as a novel then it is assumed to be fictional. However, in reality all narratives have elements of both categories and it is more accurate to consider them as fitting on a scale, where at one end is absolute fact and at the other, absolute fiction (Cohan and Shires 1988). There is no narrative which fits exactly at one end of this scale. Narratives that contain 'fictional' characters still possess large elements of truth because, as Chatman (1978) explains, a character is set of qualities that are subject to change, and even created 'fictional' characters are made of qualities that exist in reality.

So we have established the key components of a narrative and how these components work to create a temporal and subordinal sequence of events. But how does this relate to the communication of science, and more specifically, conveyance of knowledge about wedge-tailed eagles? Primarily it creates a template to which we can apply any people and circumstances to build a narrative that is easy to follow. We can then use this template across different forms of media. There is a diverse range of means to convey narrative, including novels, short stories, music, paintings, photographs, plays, television shows and films. Human culture depends on the conveyance of narrative using these devices, as they have strong influence on the way society functions (Cohan and Shires 1988). We have the opportunity to use various media to convey facts through narrative, but is it worth it? In order to demonstrate this it is necessary to look at case studies which confirm its effectiveness.

#### 4.3 Effectiveness of Narrative

The most obvious advantage of narrative as a means of communication is that the arrangement of events in a linear and subordinal fashion is easy for anyone to follow. All of us can relate to these types of stories as we each experience them daily. It is becoming more popular to use narrative as a means of teaching children, both at the primary (Storey 1982) and secondary level (Hoffmaster 1986). Numerous studies have demonstrated that using fictional discourses which contain factual material can indeed help with the learning process. In several controlled experiments, Marsh et al. (2003) conducted general knowledge tests on people who had read certain facts presented in stories. These people were shown to use the facts from stories and incorporate them with their existing knowledge to answer general knowledge questions correctly. Science fiction films have also been valued as an educational device. A collaboration of teachers used science fiction films to investigate their effectiveness at increasing appreciation of science topics such as physics, astronomy and biology (Dubeck et al. 1990). Eighty percent of 398 test students found that these films enhanced at least one of three categories: attitude toward science, knowledge of science, and cognitive development. Therefore, the application of certain facts to a structured narrative seems to be an effective means to communicate information, including scientific knowledge and the studies used to acquire it.

#### 4.4 Use of Narrative in Film

Film is one of the most useful means to convey fictional narrative because of its broad outreach. This is particularly relevant in today's world where the internet has the capability to make films accessible to a wide global audience (Holliman *et al.* 2009). It also has the ability to engage the audience because of its audio and visual effects. Recent films from the Master in Science Communication have successfully conveyed meaningful environmental messages using narrative. In *The Fall of Jatayu* (2009), the narrative of an historic Indian myth is used to tell the story of vulture decline in India, which resulted from widespread poisoning by the drug diclofenac (Puthiyavalappil 2009). Stories of young leaders engaging with their community through public events and school workshops were used to inspire individual and community action towards climate change in the film *Carving the Future* (2010).

More recently, well known wildlife films such as BBC's *Life* (2010) have become incredibly advanced, and with improved technology increased their capability to bring elements of the natural world into people's lounge rooms. This has made natural history an increasingly popular film subject. One problem with wildlife film is it is often automatically dubbed 'documentary,' which implies it is a truthful representation of reality. Bousé (2003) argues that filmmaking devices such as camera angles, the use of long lenses, editing techniques, asynchronous sound and other elements used to construct believable sequences detract from a wildlife film's legitimacy. The use of narrative further enhances the portrayal of a false reality, and the filmmaker is therefore enforcing a story onto animals which do not live their life according to narrative, as Bousé (2003) also points out. Therefore, when referring to wildlife film, the term 'documentary' must be used cautiously. Consequently, some modern wildlife films purposely include human elements to justify the use of narrative.

One such film is *Eagle Island: A Year on the Isle of Mull* (2005). After watching this film several years ago I was interested in the way in which it engaged the audience. It provides a good example on which to elaborate as it was similar to my intentions with this thesis and future filmmaking ambitions. We will now examine a case study of the white-tailed sea eagle and a 'fictional' narrative film about this bird, which provides further evidence of the effectiveness of narrative to communicate information.

#### 4.5 The White-tailed Sea Eagle: A Case Study

Often described as 'a flying barn door,' the white-tailed sea eagle *Haliaeetus albicilla* is a large raptor distributed across the northern hemisphere (Dementavicius and Treinys 2009)). Its wingspan averages over 2m and females, the larger of the sexes, can reach 7.2kg (Tingay and Katzner 2010). In Britain it was once a common bird of

coastal habitats, but like the wedge-tailed eagle, it suffered extensive persecution by egg collectors, pastoralists and game keepers and became extinct in the country by the 1920s (Love and Ball 1979). In an effort to re-establish the species, 82 birds were reintroduced to western Scotland during the 1970s, with continued additions throughout the 1990s (Green *et al.* 1996). Several years after reintroductions, pairs began breeding on the island of Mull, Scotland, resulting in the establishment of a viable breeding population which has continued to grow during the 2000s (Evans *et al.* 2009). Part of the success of this program was due to engagement of the wider community through the Royal Society for the Protection of Birds (RSPB), which recruited numerous volunteers to keep 24-hour watch at nest sites to deter egg collectors. This strongly enhanced breeding success and population growth.

In order to raise awareness about its situation in Britain, BBC has featured the whitetailed sea eagle in several Natural History films during the last decade. It appeared briefly in *Living Britain* (1999) but this was only a short segment that provided limited information on the species. One of the more detailed films is *Eagle Island: A Year on the Isle of Mull* (2005), a wildlife film which shows the various animals and seasonal changes on the island of Mull off the Scottish coast. The film stars Gordon Buchanan, a wildlife filmmaker who was born and raised on Mull and has a special interest to return to his home and rediscover the wildlife here. In particular, Gordon is focussed on filming three animals: the otter, the golden eagle, and the white-tailed sea eagle. Because of its history and the significance of the establishment of this species on Mull, the sea eagle dominates the feature and Gordon spends much of his time attempting to film behaviour at one nest, show the majesty of these birds, and give information about efforts involved in the conservation project.

There are few characters in the film, with Gordon being the protagonist and the sea eagles being the other important 'character'. The otters and golden eagles are less significant characters which help drive the narrative. The main character acts as an interface between the wildlife and the audience, leading them on his quest to obtain footage of these animals. In doing so, Gordon relates some information about these animals to the audience. By using a main character to engage the audience with the island and its creatures, the filmmakers are able to tell the sea eagle story in a logical fashion which is easy to follow. As Storey (1982) points out, narratives related in first person viewpoint help create a real sense of history on a personal level, and are effective at generating and maintaining interest in a subject matter. This is especially applicable to first person narrative relayed in a conversational way (Quasthoff and Nikolaus 1982). The film is also made more visually engaging by the inclusion of images of other wildlife (e.g. a variety of smaller birds, sea birds, whales, mink, rabbits), which help to flesh out the environment of the film. This is one aspect of filmmaking that appealed to me when forming the idea for "A Wedged Tale."

The film's narrative arc is relatively simple as it follows the chronological order of a calendar year; that is, it is structured as a story, with events arranged temporally according to seasons. The macrostructure involves three main sections or kernel events, each of which is divided into 'man vs. nature' quests, defined by the goal of filming each of the three main animals. The equilibrium is shifted, or the 'battle/driving journey' commenced, in the introduction of the film when Gordon shares his fascination and goal of obtaining footage of each of the three animals. This simple idea hooks the audience in and holds their attention to see if Gordon will reach his goal.

In order to apply a *plot* to these temporal events, there is a slight rearrangement to create more of an interesting and less predictable narrative. That is, the narrative is not as simple as Gordon checking off his subjects one by one in a chronological order, as it would be in a *story*. (However, their arrangement in the film may indeed be factual representation of the actual order Gordon films the animals, as the actual truth is unclear to the audience). To help explain how this rearrangement works to serve the narrative arc and add a conflict – crisis – resolution to the narrative (Burroway 2003; see **Section 4.2 "Elements of Narrative Theory"** for more detail), I have listed the main kernel events in their *plot* order below:

- Gordon introduces his aims: to film otters, golden eagles and sea eagles. {the audience becomes hooked}
- He tries to film otters but is unsuccessful as they are too quick. {the audience wonders if he has now given up on this animal}
- Sea eagle breeding commences and his attention turns to filming them.
- He gets some nesting footage from a distance but would like to get closer.
- Rain prevents him moving closer as he can't disturb the nest in bad weather.
- He walks into the mountains and films golden eagles.
   {the audience is satisfied to see golden eagles, but at the same time in suspense about whether he will film sea eagles again}
- The weather fines up and he obtains fantastic sea eagle footage.

{the audience is satisfied he has now achieved two goals but is still curious about the third}

- He spends time in the coastal areas in search of otters again.
- He ventures to sea to film basking sharks and minke whales.
- While looking for otters, he finds and films dolphins near a fishing village. {the audience is satisfied but there is still mystery about the final species}
- Time is running out and he hasn't found any otters.
- Finally he locates a female otter with pups and gets great footage.
   {the audience leaves Gordon with a sense of satisfaction and fulfilment}

It is unclear whether the order of this sequence of events appears is as it actually happened in real life, or if it was reordered to serve a better narrative. Whichever the case, the narrative is scripted in such a way that it creates an interesting narrative arc and engages the audience throughout. We have a hooking beginning and a satisfying ending, two important parts of any narrative (Quasthoff and Nikolaus 1982). More importantly, we are given a variety of information about the white-tailed sea eagle. During his attempts to film nesting eagles. Gordon explains (and his footage clearly shows) basic ecological facts including how eagles nest, clutch size, reproductive challenges and diet. He also emphasises the importance of his home Mull in providing undisturbed habitat for some of the first nesting pairs. Furthermore, by meeting with field biologists who are monitoring the eagle population and filming them in the field weighing and tagging eagle chicks, Gordon relates important information about sea eagle extinction and subsequent reintroduction, emphasising the role that RSPB, community volunteers and government departments have played in this conservation program. This information is clearly portraved while at the same time the audience is engaged in the narrative arc that is both satisfying and rewarding.

For these reasons it provided a great example of a 'template film,' an idea on which to base a new film about wedge-tailed eagles in Western Australia. Now we will explore the final area of the thesis by looking at the creation of this film.

### 5. The Film: "A Wedged Tale"

#### 5.1 Introduction to and Aims

So far we have established that a vast amount of knowledge about the wedge-tailed eagle exists in various resources, but much of the detailed information is 'locked away' in the science literature. We then explored the area of communicating information via the scientific method and some of the associated problems, and looked at the narrative as an alternative means to communicate facts. This brings us to the story of the film which forms the major component of this thesis: "A Wedged Tale." This story was originally scripted in late 2009 as part of the first year coursework for the Master in Science Communication (Natural History Filmmaking) course. The script evolved during the course of shooting in 2010 although by the final stages of the film the main narrative idea remained unchanged.

This chapter presents a detailed description of the process of crafting the final film, taking into account the use of narrative theory devices, and includes some of the problems encountered and the ways these were overcome. Because I appear in this film it has been difficult to write this section from the 'outside,' and also because the scripting process involved both myself and a fellow filmmaker Adam Hermans, so as a team we could more easily look at this story from 'outside'. To make this section more objective and easier to follow, I will refer to myself in the third person from **Section 5.2** onwards.

In order to convey some information about the biology and distribution of the wedgetailed eagle in Western Australia, and take the existing knowledge base on the species to a new area, I decided to relate facts in the form of a narrative film. The reason for the use of 'fictional' narrative film was to convey eagle knowledge through a discourse which has not yet been used. I wanted to take advantage of the strength of visual communication and personal story contained in photographic books like Cupper and Cupper (1980) and Hollands (1983; 2003), and combine these with some of the effective interpretation conveyed in 'science communication' books like Olsen (1995, 2005). The only two other films on wedge-tailed eagles (see **Chapter 2**, **"Eagle Discourses"**) convey 'scientific' facts to the audience in a documentary rather than a narrative film form. With "A Wedged Tale" we attempted to complement the information shown in these existing films and present other facts in a different format. In scripting "A Wedged Tale" we quickly established our aims. These were, to:

- 1. Show a variety of wedge-tailed eagle behaviour and ecology, thereby generating interest in and appreciation for the species.
- 2. Show that eagles live in a broad range of habitats and feed on a variety of animals.
- 3. Include some aspects of scientific research by showing how eagle diet is studied.
- 4. Engage a wider audience by telling a personal human story rather than just a story about animals.
- 5. Include in the main story 'behind the scenes' footage and give insight into the making of a wildlife film.
- 6. Emphasise, through the inclusion of a human character in a wildlife film, how humans are a part of nature and the nature/culture blend is always present.
- 7. Celebrate biodiversity in Western Australia and increase appreciation for the natural environment.

#### 5.2 What Facts to Include?

After establishing the aims we then had to decide what eagle information we could include. The first problem was that our film was constrained by a time limit of 25:00 minutes exactly. As the aims above outline, we were not focused entirely on communicating information about eagles, though this would obviously form a large part of the film. It was clear that we would only be able to include some scientific facts about eagles in this timeframe, so we decided the most important aspects were:

- the size of wedge-tailed eagles, their keen eyesight, nesting and young, the size of nests, and importantly how hard they are to *film* (these facts help to emphasise the beauty and charisma of the species).
- what eagles feed on, how people study diet and know what they feed on, that they feed on carrion as well as live prey (these facts help connect the eagle to their habitat, connect humans to eagles through research, and emphasise their diet is *varied*, includes feral and native animals, and is not all lambs).
- The range of habitats they occupy and their broad distribution (these reinforce their presence right across the state).

An advantage of film is the ability to use a few simple shots to convey some information in a concise manner, which other discourses such as written stories place constraints on. Firstly, we thought it necessary to flesh out the character of the wedgetailed eagle by providing key background information on the species, so we decided to introduce physical characteristics like size and wingspan, and include breeding biology by constructing a nesting sequence. This would be placed at the beginning of the film to shape the eagle's character early on, but would be reinforced with the inclusion of more eagle footage throughout the film.

No ecological aspect shows an animal's interaction with its environment better than diet. The eagle's maligned reputation has created great interest with regard to its diet, this has been studied extensively for over four decades, and as we saw in **Chapter 2 "Eagle Discourses"**, is the most common type of research published. We therefore saw it as an integral part of the story. Because Simon has also studied eagle diet it would be easier to use existing information and collections of prey remains to incorporate a truthful aspect into the narrative.

We then had to apply some techniques of narrative to our idea of conveying these main facts in order to incorporate them into a narrative arc. Initially, we had to decide the key components: character and setting.

Each of the following sections is written with the attempt to illustrate individual components of the narrative for "A Wedged Tale," before then describing the blending of these into the final product. However, as narrative is a dynamic process, and as Reid (1992) notes, a narrative depends on the *act* of its perception before becoming a closed entity, no single one of these components can exist on its own. The description of character or setting alone is meaningless unless the narrative arc is explained, and the narrative arc is meaningless without knowledge of the characters. Therefore, it may be helpful to watch the final film before reading on.

#### **5.3 Character**

It was obvious that the wedge-tailed eagle would be an important character in the film. The prime aim of portraying eagles was to give information about the species in an educational format, but there are also deeper connotations to the eagle character. If we consider character according to Chatman's (1978) definition, it is not a person or closed set of conditions but rather an assemblage of human qualities. It would therefore be important that 'the eagle' in the general sense represented certain traits; to much of society eagles represent strength, freedom and, because of their monogamy, loyalty. By using eagles, we were indirectly introducing these traits as

'character qualities' within the film. To us, the most important of these was freedom, because this linked in with our interest to explore the nature/culture 'boundaries' and emphasise that people are free to cross these boundaries and contact nature as free individuals. Nature is everywhere. Other traits like power and strength help to build the eagles as charismatic icons with the hope that this will inspire interest in them and encourage others to delve into nature.

Simon was also a necessary inclusion because of his life interest in eagles. The set of qualities in Simon's character link to value of nature and adventure, and these also tied in with our aims. During scripting process we were advised early on that "you can't make a film about eagles and not have Simon in it." With this in mind it was necessary to consider the role the two characters could play in the narrative and how this might help us achieve our aims. We had two choices about which character would be the protagonist: Simon or a wedge-tailed eagle. Initially we thought to include only an eagle in the story, and have Simon appearing subtly as the narrator. We would construct a traditional wildlife film with a story driven by one animal and through this animal the audience could be exposed to settings and other animals. This posed several problems and we realised it would be difficult to address all our aims. There was also the problem with portraying one 'protagonist eagle' consistently across locations. We then decided that to explore the boundaries of the nature filmmaking genre, we could include a rarely seen wild animal: the wildlife filmmaker (Simon). Most documentaries, especially well known BBC Series such as Life (2010), construct their main story with no evidence of humans being present in the habitats shown. They deliberately exclude humans and by doing so, create a false portrayal of a world where people do not exist. Occasionally, a 'making of' section is shown at the end which then reveals where the filmmakers fit into the habitats they film. But our goal was to make a film which showed this throughout. We therefore decided we would more efficiently achieve our goals by having Simon as the protagonist to drive the narrative. This would 1) make the inclusion of behind the scenes footage easier, 2) emphasise the human context in nature more effectively, and 3) engage a wide audience by having a human tell the story (Aims 4, 5 and 6). It also allowed us to bring a 'science' aspect into the film by including some element of how diet research is conducted (Aim 3).

In this way we constructed two characters, or two separate sets of traits, to set up the 'battle' between these traits which would flow as the narrative arc progressed. A third important character was 'the goat', which does not appear until the end of the film. As

the film demonstrates, the goat is representative of conscience, and Simon's interaction with it symbolises him pushing existing elements of his character in desperation to achieve his goal (see Section 5.5 "Deciding Level of Fiction" for more detail). There would also be other minor characters in the form of various fauna species placed throughout the film (this was integral in emphasising biodiversity), but these would all have minor roles in the actual narrative arc. Like the goat, however, they would play a very important role at the narrative's conclusion.

#### 5.4 Setting

"A Wedged Tale" is set in Western Australia. In order to show how the wedge-tailed eagle lives in a broad range of habitats over a wide area, four different areas of this state were chosen: a city, a 'pristine' forest, a mountain range, and a desert. Each of these has differing degrees of human activity and impacts. Descriptions of the locations are presented below.

#### Perth Hills

Perth is Australia's fourth-largest capital city. The metropolitan region covers a broad area which includes much 'concrete jungle' typical of most cities. One part of it, the Perth Hills, consists of a suburban landscape of houses intertwined with natural bushland of jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) trees. There are also large areas of natural bushland in National Parks or State Forest with few direct human impacts. The wildlife in this region is surprisingly diverse and many species thrive in backyards. This location was chosen as it presents a great example of a place with a high degree of human activity.

#### Dryandra Woodland

Dryandra is a remnant of the native wandoo (*E. wandoo*) and powderbark (*E. accedens*) woodland, once widespread in an area of Western Australia that has now been largely cleared for extensive agriculture. It is situated about 200km south of Perth. Often described as 'an island in a sea of wheat and sheep,' Dryandra is a stronghold for some of the region's most unique animals, many of which live almost nowhere else. For this reason it was chosen to show in the film a 'pristine' forest, although few places in Australia fit the true definition of this word.

#### Porongurups

This small range of granite boulders is located nearly 400 km south of Perth. Like Dryandra, it is also surrounded by a highly altered landscape of pastoral land and vineyards. In a largely flat landscape like that of Western Australia, this is one of the few places with any significant topographic elevation. The range essentially creates its own climate and a relatively high amount of annual rainfall together with deep loam soils here gives rise to enormous karri (*E. diversicolor*) trees. We chose to include this location in our film because its represents a 'mountain' habitat where eagles live.

#### Milerua Station

Situated about 800km north of Perth, this enormous tract of land in Western Australia's arid zone is managed as a cattle station. Cows and some sheep roam over the 250 000ha property which consists of remnant mulga (*Acacia aneura*) plains, punctuated by rocky breakaways and small boulder outcrops. It provided a perfect example of a 'desert' habitat where eagles thrive, along with the array of other unique fauna.

The reason for choosing such a variety of environments in the film was to help achieve our aims in the most effective way and convey several messages. Firstly, it was important to show how the wedge-tailed eagle is an adaptable predator which is able to live in a variety of habitats, and survive on different foods in those habitats. We chose four places whose topography, vegetation and fauna contrasted strongly with each other in order to emphasise this. Secondly, we wanted to celebrate the biodiversity in this unique part of Australia by 'filling the forest' with as many species as possible, and it made sense to visit different habitats to maximise the number of animals we could film. Thirdly, we wanted to show the true context of wild animals in relation to humans (Low 2003). We aimed to deconstruct barriers that are often created in true 'blue chip' natural history documentaries, which deliberately exclude cultural elements from their pictures and stories, and portray 'nature' or 'wilderness' as something which occurs separately from human existence. By shooting in four very different places, all of which have evidence of humans and their impacts, we could clearly show that people are not absent from any habitat, even though some of our locations were very remote and could easily have been depicted as 'pristine wilderness.'

Having four locations in our story also aided with development of the plot. Before we discuss this any further, it is necessary to discuss the plot structure.

#### 5.5 Plot

Having established the characters and setting for "A Wedged Tale," we had to bind them together and construct the narrative arc. This was the most difficult aspect as we needed to create a 'battle' between Simon and 'the eagle,' and create a reason for visiting each of the four main locations described above. We decided a 'quest' narrative arc would suit our situation the best as it created an obvious drive for the story. As wildlife filmmakers we had also discussed the idea of 'predation shots' (footage of a predator capturing its prey) and the difficulty in obtaining legitimate ones. It made sense to use this as the main plot, introducing the 'equilibrium disruption' by having Simon decide that he must obtain this holy grail of filmmaking at all costs. Such a quest to obtain footage is similar to the narrative arc of *Eagle Island* (2005). The 'equilibrium' can therefore be thought of as a swaying of emphasis between the two main characters: Simon, who needs the predation shot, pursues eagles to win his battle; 'the eagle', who exists freely in nature proves more difficult to simply follow and film, increasing Simon's challenge in obtaining his goal. The narrative is thus:

Simon begins a mission to obtain on film 'the predation shot,' footage of a wedgetailed eagle killing its prey. Beginning in Perth, the journey continues to the three other locations in Western Australia (described above) as the quest for the predation shot continues. At each location Simon films resident wildlife, investigates the presence of eagles and establishes what their favoured prey is, then attempts to spend time with that prey species hoping he will film an eagle killing an individual animal. The prospect of Simon leaving for a new location provided several key kernel events or 'corner turns' to the story, when the various challenges at each location prevent him from obtaining the footage and force him to move onto another location. With each move Simon becomes more desperate to get the predation shot until he is driven to tying up a live goat, something which does not feel right to him. After a short but uncomfortable situation Simon has a sudden moment of reflection, learns there has been much more value in the journey of his quest than the destination, and realises he no longer needs the predation shot so unties and releases the goat. Simon's journey is emphasised by the diversity of wildlife encountered across the state, despite the presence of varying degrees of human activity, from highly populated city to nearly unpopulated forest.

#### 5.6 Character Change and "Level of Fiction"

As L'Heureux (1990) and Burroway (2003) suggest, it is important for the protagonist's persona to change during the course of the narrative. That is, he/she acquires or challenges certain existing traits and tests their strength. As Simon was the protagonist, we knew that he would have to undergo a change in persona to really move the audience and give the narrative integrity. The set of qualities in Simon's character link to value of nature and adventure, but the challenge was to craft the narrative in such a way that existing qualities were challenged. Simon is already a naturalist and keen wildlife filmmaker who appreciates and has a connection with the natural world, so it would be difficult to coerce the 'truthful' Simon to experience a change in character if we were unaware of a certain event which caused this. This was especially true because we aimed to film an actual journey and create as much truth as possible. We would therefore have to craft the film too incorporate some (fictional) event which would guarantee this character change. So we decided during the initial scripting process that Simon would fail at achieving his goal and not get the predation shot. Whether in reality he did or not was irrelevant, the act of failing or failure would create a situation (tying up a goat in desperation) that conflicts with Simon's values of freedom and love of nature/wild animals. This would be the 'one single resolving event' (Burroway 2003) that the narrative builds towards.

As we discussed in Section 4.2 "Elements of Narrative", fictional and non-fiction occur at opposite ends of a scale and all narrative fits somewhere on this scale, depending on the degree of each present. Our aim was to tell a true story, show real wildlife in Western Australia, and obviously convey accurate information about wedge-tailed eagles. The film would be a portrayal of the true situation of Simon's pursuits to study, photograph and film wedge-tailed eagles. All wildlife that would appear in the film occurs naturally in Western Australia, each individual would represent accurately the type of animals that are likely to be encountered at each location. So almost all elements of the film would be portraying reality. The one exception is the concluding scene of the film: Simon tying up a goat in desperation to obtain a predation shot. Contriving this moment gave our film the narrative arc an interesting and engaging conclusion, and essentially all other events serve to build up to this pivotal moment.

# 6. Conclusion

We have explored a vast range of literature on the wedge-tailed eagle, and established the importance of environmental science communicators in unlocking this information from the scientific literature and making it widely accessible to the public. The use of narrative theory and 'fictional' narrative film has been shown as an effective device as a step towards reaching this goal. "A Wedged Tale" provides an opportunity to continue with education and environmental engagement using the wedge-tailed eagle as an icon in Western Australia. The premiere of the film occurred on 19<sup>th</sup> November 2010 in Dunedin, New Zealand, which involved two screenings on two separate nights and an audience of more than 800 people. The film was well received and anecdotal feedback suggests the film has been positive in achieving some of its goals. There has been a great deal of interest in the film in Western Australia and screening events will be organised here for 2011. The film also provides a reference for future films with similar objectives.

## **6.** References

- A King on Outstretched Wings. (2008) [Documentary DVD], Insight Ornithology, Perth, Western Australia.
- Allott, M., Allott, M. and Hatchett, N. (2006). The breeding cycle of a pair of wedgetailed eagles *Aquila audax* in south-east Queensland. *Sunbird* **36**, 37-41.
- Anon. (1944). Wedge-tailed eagle takes piglets. Victorian Naturalist 61, 24.
- Anon. (1995). Wedge-tailed eagle takes deer calf. Australian Raptor Association News 16, 28.
- Australian Bureau of Statistics (2010). National Regional Profile: Western Australia, viewed online at < <u>http://www.abs.gov.au/</u> >
- Beckman, R. (1988). Where Wedgies Dare. Ecos, 57, 9-13.
- Berney, F. L. (1906). Eagles and rats. *Emu*, 6 (1), 13.
- Bousé, D. (2000). Wildlife Film. University of Pennsylvania Press, Philadelphia.
- Brooker, M. G. (1974). Field observations of the behaviour of the wedge-tailed eagle. *Emu*, **74**, 39-42.
- Brooker, M. G. (1983). Further food items of the wedge-tailed eagle. *Australian Birds*, **17**, 63.
- Brooker, M. G. (1996). Morphometrics of the wedge-tailed eagle *Aquila audax*. *Corella*, **20** (4), 129-135.
- Brooker, M. G. and Ridpath, M. G. (1980). The diet of the wedge-tailed eagle, *Aquila audax*, in Western Australia. *Australian Wildlife Research*, 7, 433-452.
- Burroway, J. (2003). *Writing fiction: a guide to narrative craft*. Harper-Collins, New York.
- Burton, A. C. G. and Morris, A. K. (1993). New South Wales annual bird report 1990. *Australian Birds*, **26**, 89-97.
- Carr. E. (2008). Feathers, fame and football. Landscope, 23 (3), 59-61.
- Cain, C. (1936). Notes on the wedge-tailed eagle in the Farina district, S.A., during 1934-1935. *South Australian Ornithologist*, **13**, 169-170.
- *Carving the Future* (2009). [DVD] Centre for Science Communication, Produced by Guy Ryan and Nick Holmes.
- Chatman, S. B. (1975). Towards a Theory of Narrative. *New Literary History*, **6** (2), 295-318.
- Chatman, S. B. (1978). *Story and Discourse: narrative structure in fiction and film*. Cornell University Press, USA.
- Cherriman, S. C. (2004). The diet of the wedge-tailed eagle *Aquila audax* during the breeding season in the jarrah forest and on the Swan Coastal Plain, Western Australia. Third Year Biology Project, Curtin University, Perth.

- Cherriman, S. C. (2007). Territory size and diet throughout the year of the wedgetailed eagle *Aquila audax* in the Perth region, Western Australia. BSc Honours Thesis, Curtin University, Perth.
- Cherriman, S. C. (2008). Wedge-tailed eagle *Aquila audax* predation in south-west Western Australia: Implication of eagle predation on mammal reintroduction programs. [Abstract] Australian Raptor Association Conference, Coffs Harbour.
- Cohan, S. and Shires, L. M. (1988). *Telling stories: a theoretical analysis of narrative fiction*. Routledge, New York.
- Collins, H. M. (2007). The Use of Sociology of Science for Scientists and Science Educators. *Science and Education*, **16**, 217-230.

Collins, H. M. and Evans, R. (2002). The Third Wave of Science Studies: Studies of Expertise and Experience. *Social Studies of Science*, **32** (2), 235-296.

- Collopy, M. W. and Edwards, T. C. (Jr.) (1989). Territory size, activity budget and role of undulating flight in nesting golden eagles. *Journal of Field Ornithology*, 60, 43-51.
- Cribb, J. and Hartomo, T. S. (2002). *Sharing Knowledge, A Guide to Effective Science Communication*. CSIRO Publishing, Australia.
- Debus, S. J. S. (1978). Notes on wedge-tailed eagle behaviour. Corella, 2, 54-55.
- Debus, S. J. S. and Rose, A. B. (1999). Notes on the diet of the wedge-tailed eagle *Aquila audax. Australian Bird Watcher*, **18**, 38-41.
- Dementavicius, D. and Treinys, R. (2009). Nest-site attendance of the resident whitetailed sea eagle (*Haliaeetus albicilla*) outside the breeding season. *Acta Zoologica Lituiania*, **19** (1), 10-17.
- Dennis, T. E. (2006). Status and distribution of the wedge-tailed eagle on the Fleurieu Peninsula, South Australia, in 2005. *South Australian Ornithologist*, **35**, 38-46.
- Department of Environment and Conservation (2005). Fauna Note No. 17: Wedgetailed eagle. Department of Environment and Conservation, Western Australia.
- Dixon, J. B. (1937). The golden eagle in San Diego country, California. *Condor*, **39**, 49-56.
- Dubeck, L. W., Bruce, M. H., Schmuckler, J. S., Moshier, S. E., and Boss, J. E. (1990). Science fiction aids science teaching. *The Physics Teacher*, 316–318.
- Dutton, G. (1980). The Wedge-tailed Eagle: stories. Sun Books, South Melbourne.
- *Eagle Island: A Year on the Isle of Mull* (2005). [Video: VHS] Producer Mike Birkhead, BBC, London.
- Evans, R. J., Wilson, J. D., Amar, A., Douse, A. MacLennan, A., Ratcliffe, N. and Whitfield, D. P. (2009). Growth and demography of a re-introduced population of white-tailed eagles *Haliaeetus albicilla*. *Ibis*, **151**, 244-254.
- Fleay-Thompson, R. (2002). David Fleay's World of Wedge-tails: the writings of David Fleay on the Wedge-tailed Eagle. Petaurus Publishing, Queensland.

- Foster, A. and Wallis, R. (2010*a*). Nest site characteristics of the wedge-tailed eagle *Aquila audax* in southern Victoria. *Corella*, **34** (2), 36-44.
- Foster, A. and Wallis, R. (2010b). Breeding diet of the Wedge-tailed Eagle Aquila audax in southern Victoria. Corella, **34** (2), 45-48.
- Friend, T. and Beecham, B. (2004). Return to Dryandra: Western Shield review February 2003. *Conservation Science Western Australia*, **5** (2), 174-193.
- Fuentes, E., Olsen, J. and Rose, A. B. (2007). Diet, occupancy and breeding performance of wedge-tailed eagles *Aquila audax* near Canberra: four decades after Leopold and Wolfe. *Corella*, **31** (3/4), 65-72.
- Fulton, G. R. (2006). Observations of predation, nest-predation and other disturbance events at Dryandra, south-western Australia: I Birds as Predators. *Australian Field Ornithology*, 23, 144-151.
- Gaukrodger, D. W. (1924). The Way of an Eagle. Emu, 24, 3-12.
- Geary, N. (1932). Notes on the wedge-tailed eagle. Emu, 31, 288-289.
- González-Espada, W. J. (2009). Authoring Newspaper Science Articles: A Rewarding Experience. *The Clearing House*, **82** (3), 131-134.
- Greeen, R. E., Pienkowski, M. W. and Love, J. A. (1996). Long-term viability of the re-introduced population of the white-tailed eagle *Haliaeetus albicilla* in Scotland. *Journal of Applied Ecology*, **33**, 357-368.
- Haby, M. (1997). Eagle takes black cockatoo. The Bird Observer, 775, 4.
- Hickey, J. J. and Anderson, D. W. (1968). Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. *Science*, **162**, 271-3.
- Hobbs, J. N. (1962). Food of the wedge-tailed eagle. Emu, 62, 180.
- Hoffmaster, S. (1986). Pseudoscience teaching by counterexample. *Journal of College Science Teaching*, **16**, 432-436.
- Hollands, D. (1984). *Eagles, Hawks and Falcons of Australia*, First Edition. Thomas Nelson, Melbourne.
- Hollands, D. (2003). *Eagles, Hawks and Falcons of Australia*, Second Edition. Blooming Books, Melbourne.
- Holliman, R., Whitelegg, E., Scanlon, E., Smidt, S., and Thomas, J. (2009). *Investigating Science Communication in the Information Age*. Oxford University Press, New York.
- Hull, C. (1986). The diet of the wedge-tailed eagle, *Aquila audax*, breeding near Melbourne. *Corella*, **10**, 21-24.
- Jensen, R. W. (2005). Understanding how the pubic perceives the importance of University Research in the United States. *Journal of Science Communication*, **4** (1), 1-6.
- Johnston, K. A. (2008). Community engagement: A relational perspective. In Tebbutt, J. and Cregan, Ka. (eds.) Proceedings of the Australian and New Zealand

Communication Association Annual Conference, 2007: Communication, Civics, Industry. La Trobe University, Melbourne Australia.

- Kercheval, J. L. (1997). *Building Fiction: how to develop plot and structure*. Story Press, Cincinnati, Ohio.
- Kim, H. (2007). A new model for communicative effectiveness of science. *Science Communication*, **28** (3), 287-313.
- Kuhn, T. S. (1962). *The Structure of Scientific Revolutions*. University of Chicago Press, Chicago.
- Laszlo, P. (2006). Communicating Science: A Practical Guide. Springer Verlag, Berlin.
- Latour, B. and Woolgar, S (1979). *Laboratory Life: The Social Construction of Scientific Facts*. Sage, London and Beverly Hills.
- Leopold, A. S. and Wolfe, T. O. (1970). Food habits of nesting wedge-tailed eagles, *Aquila audax*, in south-eastern Australia. *CSIRO Wildlife Research*, **15**, 1-17.
- Le Souef, L. (1905). Western notes. Emu, 4, 169-170.

L'Heureux, J. (1990). Comedians. Penguin, USA.

Life 2010. [DVD] Series Producer Martha Holmes, BBC London.

Living Britain (1999) Series Producer Peter Crawford, BBC London.

- Love, J. A. and Ball, M. E. (1979). White-tailed sea eagle *Haliaeetus albicilla* reintroduction to the isle of Rum, Scotland, 1975-1977. *Biological Conservation*, 16, 23-30.
- Low, T. (2003). The New Nature, Penguin Books, Australia.
- McGilp, J. N. (1936). Wedge-tailed eagles. Emu, 36, 99-102.
- Marsh, E. J, Meade, M. L, Roediger III, H. L. (2003). Learning facts from fiction. *Journal of Memory and Language*, **49**, 519-536.
- Meyer, W. B, and Turner II, B. L. (1992). Human Population Growth and Global Land Use/Cover Change. *Annual Review of Ecology and Systematics*, **23**, 39-61.
- Mooney, N. and Holdsworth, M. (1991). The effects of disturbance on nesting wedgetailed eagles *Aquila audax fleayi* in Tasmania. *Tasforests*, **3**, 15-31.
- Moore, J. A. (1980). "The Structure of Scientific Revolutions" revisited. *The American Biology Teacher*, **42** (5), 298-304.
- Murray, R. W. (2006). The Sociology of Scientific Creativity. *Analytical Chemistry* **78** (11), 3479.
- Nevard, T. D. and Penfold, J. B. (1978). Wildlife Conservation in Britain: the unsatisfied demand. *Biological Conservation*, 14, 25-44.
- Olsen, J., Feuentes, E. and Rose, A. B. (2006). Trophic relationships between neighbouring white-bellied sea eagles *Haliaeetus leucogaster* and wedge-tailed eagles *Aquila audax* breeding on rivers and dams near Canberra. *Emu*, **106**, 193-201.

- Olsen, P. (1995). *Australian Birds of Prey: The Biology and Ecology of Raptors*. The John Hopkins University Press, Baltimore, Maryland.
- Olsen, P. (2005). Wedge-tailed Eagle. CSIRO Publishing, Australia.
- Olsen, P. and Price-Jones, H. (2007). Spirit of the Wedge-tailed Eagle: the artwork of *Humphrey Price-Jones*. CSIRO Publishing, Australia.
- Parker, B. D. (2000). Diet of breeding wedge-tailed eagles *Aquila audax* near Charleville, Southwest Queensland. BSc. Hons. Thesis, University of Sydney.
- Prince, G. (1982). Narratology: the form and functioning of narrative. Mouton, Berlin.
- Puthiyavalappil, S. M. (2009). Vultures in Old World Mythology. MSciComm Thesis, Otago University, Dunedin.
- Pyers, G. (2006). Wedge-tailed Eagle. Echidna Books, Victoria.
- Quasthoff, U. and K. Nikolaus (1982). What makes a good story? Towards the production of conversational narratives. *Discourse processing*, **8**, 16-28.
- Reid, I. (1992). Narrative Exchanges. Routledge, London.
- Reymond, L. and Wolfe, J. (1981). Behavioural determination of the contrast sensitivity function of the eagle *Aquila audax*. *Vision Research*, **21**, 263-271.
- Reymond, L. (1985). Spatial visual acuity of the eagle *Aquila audax*: a behavioural, optical and anatomical investigation. *Vision Research*, **25** (10), 1477-1491.
- Ridpath, M. G. and Brooker, M. G. (1986*a*). Age, movements and management of the wedge-tailed eagle *Aquila audax* in arid Western Australia. *Australian Wildlife Research*, **13**, 245-260.
- Ridpath, M. G. and Brooker, M. G. (1986b). The breeding of the wedge-tailed eagle *Aquila audax* in relation to its food supply in arid Western Australia. *Ibis*, **128**, 177-194.
- Ridpath, M. G. and Brooker, M. G. (1987). Sites and Spacing as Determinants of Wedge-tailed Eagle Breeding in Arid Western Australia. *Emu*, **87**, 143-149.
- Riley, P. and Traynor, K. (2001). Aquila the eagle. Bristlebird Books.
- Robertson, G. G. (1987). Effect of Drought on a Breeding Population of wedge-tailed eagles *Aquila audax*. *Emu*, **87**, 220-223.
- Ryan, G. J. (2010). Climate change and behaviour change: building community resilience through narrative. MSciComm Thesis, Otago University, Dunedin.
- Sankey, H. (2002). Books Reconsidered: The Structure of Scientific Revolutions. *Australian and New Zealand Journal of Psychiatry*, 36 (6), 821-824.
- Schallenberg, M. and Piña-Gasca, H. (2010). Complementary or Competing 'Ways of Knowing': Science, Social Sciences and Local Knowledge Systems. *Presented at the Centre for Science Communication, Otago University, Dunedin.*
- Serventy, D. L. and Whittell, H. M. (1976). Birds of Western Australia. University of Western Australia Press, Nedlands.

- Sharp, A., Norton, M. and Marks, A. (2001). Breeding activity, nest site selection and nest spacing of wedge-tailed eagles (*Aquila audax*) in western New South Wales. *Emu*, **101**, 323-328.
- Sharp, A., Gibson, L. and Norton, M. (2002a). The breeding season diet of wedgetailed eagles (*Aquila audax*) in western New South Wales and the influence of Rabbit Calicivirus Disease. *Australian Wildlife Research*, 29, 175-184.
- Sharp, A., Gibson, L. and Norton, M. (2002b). An evaluation of the use of regurgitated pellets and skeletal material to quantify the diet of wedge-tailed eagles, *Aquila audax. Emu*, **102**, 181-185.
- Sharp, A. (1997). Notes on the breeding season diet of the wedge-tailed eagle *Aquila audax* in Idalia National Park, south-central Queensland. *Sunbird*, **27**, 105-108.
- Shortland, M. and Gregory, J. (1991). *Communicating Science: A handbook*. Longman, New York.
- Storey, D. C. (1982). Reading in the Content Areas: Fictionalized Biographies and Diaries for Social Studies. *The Reading Teacher*, **35** (7), 796-798.
- *The Fall of Jatayu* (2009). [DVD] Centre for Science Communication, Produced by Siddharth Puthiyavalappil and Kyriakos Stylianopoulos.
- Thiele, C. (2003). Wedgetail. Lothian Books, South Melbourne.
- Thomas, A. (1999). Wedge-tailed Eagles. South Yarra, MacMillan Education.
- Thomas, J. E., Saxby, T. A., Jones, A. B., Carruthers, T. J. B., Abal, E. G. and Dennison, W. C. (2006). *Communicating Science Effectively*. IWA Publishing, London.
- Threatened Species Section (2006). *Threatened Tasmanian Eagles Recovery Plan* 2006-2010. Department of Primary Industries and Water, Hobart, Tasmania.
- Tingay, R. E. and Katzner, T. E. (eds.) (2010). *The Eagle Watchers*. Cornell University Press, New York.
- Treise, D. and Weigold, M. F. (2002). Advancing Science Communication. *Science Communication*, **23** (3), 310-322.
- Valenti, J. M. (1999). Commentary: how well do scientists communicate to media? Science Communication, 21 (2), 172-178.
- van Emden, J. (2001). *Effective communication for science and technology*. Palgrave, Basingstoke.
- Walters, D. E. and Walters, G. C. (2002). Scientists Must Speak. Routledge, London.
- Wilcove, D. and Eisner, T. (2000). The impending extinction of natural history. *Chronicle of Higher Education*, **47** (3), B24.

Wildlife Specials (2004). *Eagle*. [DVD] Series Producer Keith Scholey, BBC London.

Wild Tasmania (2007). [DVD] Digital Dimensions, Australia.