WHAT'S THE BIG EEL: HIGHLIGHTING THE EFFORTS OF SCIENTISTS TO EXPLORE THE SCIENTIFIC PROCESS

by

Amanda Katherine Grunder

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Fine Arts

in

Science and Natural History Filmmaking

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2023

ACKNOWLEDGEMENTS

Throughout my time at Montana State, I have been supported and assisted by more people than I could ever name here.

My advisor, Dennis Aig, is the heart and soul of our department. I cannot overexpress how much his knowledge, passion, and creativity have impacted my education and career. I also want to express my appreciation for my committee, Alexis Pike and Hugo Sindelar. Your patience and guidance have gotten me where I am today.

Thank you to the faculty, staff, students, and alumni of the SNHF program who have assisted me throughout these years. The work each of you do is so incredibly important.

I would like to thank my family for supporting me every step of the way. To my educator mother and my scientist father, you have made me into the person I am today: someone who cannot stop talking about eels. To my sisters, thank you for your constant help and humor. To Cohort 18, I never would have made it this far without each and everyone of you.

TABLE OF CONTENTS

ABSTRACT

By highlighting the devoted efforts that science requires, science films can create a long-term impression on their audiences. This thesis showcases how the scientific process can create a more trustworthy and believable documentary, even with an audience having an increasing rate of science denial. By highlighting the passionate dedication it takes to conduct the scientific process, documentaries can create an interest in audiences and retain a sense of trust. This method's success is discussed in a variety of different documentaries, including *My Octopus Teacher*, *Particle Fever*, *The Thin Blue Line*, and my related thesis film "The Eel Problem."

CHAPTER ONE

INTRODUCTION

Films highlighting processes are not uncommon in the documentary field. From the very beginning, Robert Flaherty's *Nanook of the North* includes the process of building an igloo. Dziga Vertov's *Man with a Movie Camera* uses the process of manual film editing to connect a variety of avant-garde sections. The attention to detail in each of these sections allows the audience to understand these processes and, therefore, have a stronger conception of the respective films. Flaherty presents the lifestyle of the Inuit people while Vertov shows the inherent artificiality of filmmaking. Instead of just announcing the final outcome to the audience, demonstrating these processes allows the viewer to create his or her own understanding.

At the center of each of these practices is a human subject with which the audience is able to relate. The titular Nanook – whose real name was Allakariallak – shows a tireless and universal need for shelter with every stacked block of ice. The unnamed film editor's attention to detail is clear with each precise cut. Even with the knowledge that each of these scenes was – to a varying degree – fabricated, the audience is able to empathize with the subject throughout these processes. The subjects efforts are something with which we can empathize, despite never having been a part of the process.

In the Atlantic Ocean, living halfway between Flaherty and Vertov, the European Eel, Anguilla anguilla, has long represented the ongoing mysteries and questions within the scientific community. They have played a key role throughout Western history including being mummified in Ancient Egypt and used as currency throughout Medieval Europe. Their habitats have shaped the dispersal of humans in Sweden, Ireland, and Spain. They have been studied by

famous scientists in history, including Aristotle, Pliny the Elder, Sigmund Freud, and Rachel Carson (Prosek, 1-9). Despite this, much of the European eel remains a mystery.

Through thousands of years of research, we have learned most of the lifecycle of the eel. They come from the Sargasso Sea in the Atlantic Ocean, swimming to Europe's coastline while only a few centimeters long over the course of 3 years. They metamorphize, swim upstream in fresh water, metamorphize again, and then spend more than a decade in their chosen river or pond. They metamorphize again, swimming back to their birthplace, where they reproduce and die (Svensson). Despite the years of research, we still have never seen a European eel egg, we don't know why they travel such great lengths, and we do not have an accurate population count of young eels.

The "eel question," as it is often referred to, has been one of the longest ongoing scientific questions in Western history. While many aspects have been revealed, many remain unknown. Discoveries added new mysteries to the question. As the number of European eels has sharply dropped, the question is now facing a deadline for the first time. Thousands of years of observations and experimentation may go unanswered.

The eel question is a clear example of the ongoing, long-term nature of the scientific endeavor. It doesn't have a final conclusion or a naturally appealing subject. It does, however, have a long list of intensely devoted scientists and a small species that needs wider attention. My film, *The Eel Problem*, tells the story of this scientific process by focusing on the people who studied it. Showing the dedicated efforts of these scientists creates a connection with the viewers, allowing them to gain a more complete perspective on one of science's most intriguing fish.

Highlighting the passion that drives the tireless effort of scientists throughout the scientific process can lead to a deeper understanding and interest in viewers. In this work, I explain the importance of revealing the entire scientific process to the public and the challenges that creates. I will show how three critically-acclaimed documentaries have successfully implemented aspects of this theory in three different manifestations of the scientific method. *My Octopus Teacher*, *Particle Fever*, and *The Thin Blue Line* all highlight the scientific endeavor. I will show how my own thesis film *The Eel Problem* is built off this concept itself, concluding with discussing the importance of this aspect of science communication in the documentary genre as a whole.

CHAPTER TWO

SCIENCE AS A PROCESS

Science is often presented to the public as a series of irrefutable facts. This tendency can be seen both within the classrooms of our youth and the science news stories presented to the public (Wilson and Howitt). This recurring appraoch, however, goes against the very nature of science itself. Instead, science is a constantly growing and changing process. Early hypotheses are found to be flawed. Debate and arguments are central to the scientific process. Findings are reviewed and challenged by other experts (Öberg et al.). Presenting only final results of the scientific process may create a sense of authority, but it disconnects the public from the true nature of science itself.

As the rate of science denial continues to grow throughout American culture, this method becomes even more concerning (Öberg et al.). Contradictory findings can be presented as an indication, not of the ever-changing nature of science, but as clear proof that science is not a trustworthy endeavor (Björnberg et al.).. This can add to an increased level of tribalism, disconnecting the public from scientists based on their perceived elitism (Öberg et al.). Recent examples include climate change, evolution, vaccinations (Fackler). Science “has become something like a new mysterious religion, with a priesthood and an occult doctrine that is understood by only a small and select group.” (Bohm). This impression will only decrease a belief in science. Allowing the public to view the process of scientific experimentation can build a trust between the two entities, limiting the growth of science denial.

The presentation of science as facts also does not allow space for unresolved issues. While scientific knowledge has progressed significantly throughout the last century, there are

still immense numbers of unanswered questions remaining within every field. For example, the existence of dark matter, the emergence of consciousness, and the possible pattern within prime numbers are all widely debated unanswered scientific questions. If the public is only presented with the final results, huge expanses of the science community's contributions will be left unseen. Mysteries can also be a key factor in inspiring a new generation of scientists. If we are attempting to create science documentaries, we should be willing to challenge ourselves with unanswered subjects.

Science, therefore, must be presented as it is — an ongoing process. We must be able to build strong narratives that do not rely on hard answers and solutions, but instead reveal the long-term efforts of scientists. Otherwise, we will be unable to tell important stories, and we will increase the disconnect between the public and scientists.

Creating a documentary that focuses on science as a process — and an unanswered process, as well– can create a new series of challenges. Expository documentaries, as described by Bill Nichols, have relied on creating a sense of authority in their narrator (121-122). Scientific process films, however, require the film to admit a limited knowledge of a subject, at a minimum at the beginning of the documentary. Their authority cannot come from the perceived knowledge of a single person, but in the filmmaker's clear compilation of the steps the scientists have gone through to reach their results and their dedication to discovering the truth. Films that highlight science as a process must be able to balance an admittance of lack of knowledge with a need to build the audiences' confidence in the abilities of the scientists to add to what is known.

This challenge can be further complicated by a lack of public awareness or interest in a subject. While the public's interest in science is at an all-time high (Burns), that interest varies

strongly in different fields. Biology, psychology, and medicine are generally more popular than geography or material science, for example (Yin). This range is also clearly shown by topics within fields. Documentary films' first obstacle, then, is in the creation of interest in their specific topics.

Scientific processes, however, inherently come with a group of people who are deeply interested in a topic. Scientists dedicate themselves to complicated and difficult subjects, typically spending years focused on a singular aspect of research. Their focus can serve as the connection for the audience by showcasing an individual scientist or team to create a similar drive in the viewer themselves. Highlighting that dedication and enthusiasm with an empathetic approach can build trust, explore the unknown, and create interest where there is little.

CHAPTER THREE

CASE STUDIES

Swimming with Octopuses

Wildlife documentaries, from their earliest conception, have primarily focused on large and aesthetically pleasing species. From 1912's *African Hunt* to Disney's *Seal Island* to 2005's *March of the Penguins*, wildlife films have used the spectacle of impressively sized species to draw in audiences (Malloy 165-176). These species, often referred to as charismatic megafauna, are already favored by the audience; viewers may watch the film because of their already-present love of the species. Charismtaic megafauna are relatively large species with widespread appeal, such as the giant panda, koala, and African elephant (Barney, Mintzes, and Yen). Whether innate or culturally based, the likability of a species has played a key role in its likelihood of being showcased (Ducarme et al.).

This overrepresentation can lead to a lack of stories about uncharismatic species. Unpopular species are harder to sell to an audience and are often left out of the spotlight. The range of coverage between species can have serious conservation impacts. Public interest often directly relates to conservation funding, "creating a sort of class struggle between 'wealthy', successful animals and poor, doomed castoff animals: it is just like if humans could decide on the right to exist or not for the animals they like or dislike, irrespective of ecological concerns and sustainability" (Ducarme et al.). This is especially concerning, as successful conservation efforts require the preservation of biodiversity on multiple ecological levels (Zhang). There is a

need for uncharismatic species to be highlighted and to create an interest in audiences where little was before.

Like the eel, the octopus is not regarded as charismatic by most audiences (Linden). Its behavior and life-cycle is vastly different from our own and between the tentacles and the beak, cute is not a likely descriptor. This makes the success of the 2020 documentary *My Octopus Teacher* all the more impressive. The film follows the relationship between filmmaker Craig Foster and a common octopus. Foster and the titular octopus's first encounter is while he is free-diving near Cape Town. She quickly becomes habituated to his presence, eventually playing with him and allowing him to see her natural behaviors. The film follows the two for just over a year, until the octopus's death. The film became a massive success; it was a streaming hit and critically praised-before winning the Oscar for Best Documentary Feature.

My Octopus Teacher's success stems from its use of Foster as the emotional connection between the audience and the octopus. This begins with our connection to Foster. As one critic wrote, "It's presented as the story of the octopus, but really it's about [Foster], and it's through his lens" (Williams). Within their relationship, the octopus and Foster take on roles similar to a film's subject and its audience. The octopus's daily life becomes her performance and Foster becomes the enamored viewer. The roles within the film are clear; as viewers, we then can easily find our place alongside Foster.

The film introduces us to Foster first, before we have time underwater. When we are first introduced to Foster, he speaks frankly about his declining mental health and his desire to be a more engaged father for his son. He begins free-diving as a form of stress-relief. Later, his son begins diving alongside him. His excitement for each dive feels genuine to the audience.

Unsurprisingly, it doesn't take much for us to relate to the film's human subject. Our connection with Foster is quickly settled.

The film then extends this connection when we initially meet the octopus alongside Foster. *The Hollywood Reporter* describes this relationship as a "Spielbergian human-alien connection" (Linden). The film never shies away from the strange nature of the octopus; instead it highlights how foreign it is to Foster. His curiosity about the octopus's behavior builds a matched curiosity in audiences. "A lot of people say an octopus is like an alien," Foster says in the film, "but the strange thing is, as you get closer to them, you realize that we're very similar in a lot of ways." His initial curiosity about this new species sparks our own interest.

As he fosters a relationship with the octopus, we also begin to connect more deeply with the animal. When she learns new ways to be more successful on her hunts, both Foster and the audience celebrate and admire her intelligence. After a shark attack leaves her injured, we worry for her well-being too. When she dies, we mourn her alongside Foster. This connection takes the audience from uninterested – or even potentially disgusted – to amazed and empathetic. The audience can connect with a seemingly uncharismatic species because we can relate with the human subject and his admiration.

This relationship is central to the emotional weight of this film. Their year together and our more than an hour alongside them creates an overarching view of the importance of this individual and her species. *My Octopus Teacher* is able to create a compelling connection between the audience and an uncharismatic species by highlighting the full process of the subjects' relationships with one another and the observer's perspective on their subject.

Mountaineering Model

Building off of the work of Koballa, Kemp, and Evans, Burns, et al., describes science communication with an analogy to mountaineering. In it, each scientific field and domain is described as a separate mountain within a range. Each person is a climber. As one becomes more literate in a subject, he or she make the way higher up the mountainside. Skills and activities are the equipment that bring the climber closer to the summit of full understanding.

This model highlights the continuous learning of scientists. Scientists may not be on the summit of their own subject, let alone any of the other scientific domains. Everyone, from the layperson to the scientist, is somewhere along the way of his or her own climb of each mountain. Scientists are not set apart from the audience, just higher up the mountain.

The Mountaineering Model casts science communicators as mountain guides. They are able to teach new climbing techniques, provide ladders, and report conditions by teaching skills, creating texts and films, and speaking directly with the public, respectively. Scientists can help lead the public through their own individual climb. Like professional mountaineers, they are creating routes that the public can follow.

In *My Octopus Teacher*, we see Foster's entire mountain climb. When the film begins, his knowledge of the octopus is very limited; he is at the base of the mountain staring up. As he climbs, we are taken with him. We are with him when the octopus's initial hesitation slows his progress. When she shows her ability to learn from a shark attack, we take the same leap as Foster: a sudden jump in the amount of knowledge we have about her cognition. As the film reaches its end, we even see Foster teaching his son, guiding his climb. Neither we nor Foster

may end up at the summit of the octopus behavior mountain, but the audience is able to advance quickly because we see the climb itself.

Particles and People

Creating an interest and enjoyment within the audience becomes even more difficult in non-biological sciences. Even an octopus is at least visible to the audience. Hard sciences often focus on invisible concepts, ones that can be difficult for the general public to even conceptualize. A documentary doesn't only have to explain the findings of their research; it also has to explain the fundamental concepts with which they are working. Interest is necessarily low if the audience is not aware of the existence of the topic. In these cases, appealing to the human element of a film is even more crucial.

The 2013 documentary *Particle Fever* is tasked with highlighting the appeal of the Higgs boson, a rapidly decaying, non-charged subatomic particle, arguably one of the least charismatic film subjects possible. The film follows the confirmation of the particle's existence at the CERN, the experiments leading up to it, the debates between experimental and theoretical physicists, and the importance of its discovery. Even when the physics may be difficult to comprehend, the audience is able to recognize the importance of this work as each failure or success is shown and explained.

Particle Fever has a subject that most of the audience cannot fully conceptualize. Instead, it relies on the enthusiasm and passion of six scientists to inspire a similar interest in the viewer. As David Kaplan, a producer and a theoretical physicist, describes the film, "Once the story was there, we put in just enough physics to explain the emotional content of the film" (Charley). The highlighted scientists are all humanized for the audience: Dr. Monica Dunford, an experimental

physicist, spends her free-time riding her bike throughout Geneva, theorist Nima Ankani-Hamed is seen playing a game of table tennis, and Savas Dimopoulos describes his childhood as a refugee. Within the first minutes of the film, Kaplan is shown accidentally hitting his head on a metal beam. These scientists are not presented as merely their career choices; the viewer is introduced to each of them as empathetic and relatable humans.

This approach culminates in the climax of the film: the announcement of the confirmation of a Higgs-like particle. The impact of this scene does not stem from the announcement itself, but from the reactions of the scientists. The focus is on the standing ovation, the tears, and thecamaraderie. The approximate weight of the particle is important in the context of whose hypothesis was closer. Dunford's description of the excitement is far from scientific: "The entire control room is like a group of six-year-olds whose birthday is next week."By the end of the film, the audience is excited and emotional about the discovery that has been made, even if it does not comprehend each tenet of it.

Within a given society, there are scientific topics that hold less general interest than others, whether due to their complex nature or their unattractive appearance. This does not negate their importance; if anything, it highlights the need for their stories to be told. *Particle Fever* succeeds by highlighting the known within a story about the esoteric. The passion that these scientists feel is the focal point.

AEIOU

In their previously mentioned report on the state of science communication, Burns et al., also describe the AEIOU definition. The initialism lists the five potential audience's responses that define an act of science communication as successful: "A" for growing awareness, "E" for

increased enjoyment, “I” for new interest, “O” for shifted opinion, and “U” for a stronger understanding. Within this definition, science communication has success when any of these five aspects are affected in its audience. In *Particle Fever*, all five aspects are developed as the viewer watches the scientists.

Awareness is the first step, one that “broadens the mind and opens up personal and public opportunities” (Burns). *Particle Fever* reveals complex subatomical physics to the layperson. The film begins with Kaplan summarizing:

> The Large Hadron Collider, the biggest machine ever built by human beings, is finally going to turn on. And after many, many years of waiting and theorizing about how matter got created and about what the deep fundamental theory of nature is, all those theories are finally going to be tested. And we’re going to know something. And we don’t know what it’s going to be now, but we will know and it’s going to change everything. (*Particle Fever*)

From the start, this film was created with a broad audience in mind. Each scientist acts as our connection with the subject on the most basic level.

Enjoyment is also highlighted by the researchers. Burns, et al., describe two levels of enjoyment. The first is on a superficial level, with science as a form of entertainment. As an audience, we can experience this through the comedic moments we share with the scientists. The second is through personal involvement and satisfaction. The empathy we have developed with the scientists allows us to experience this in the moment as the discovery is announced and their work is proven fruitful.

Interest is shown through the viewer’s future involvement with science. *Particle Fever* creates new questions for the audience by allowing the open-ended nature to inspire the scientists themselves. The film ends with more questions for the scientists to investigate and so our interest continues. Anecdotally, this approach has been successful, as years later, Kaplan said, “People

will still come up to me at conferences to say that they saw *Particle Fever* in high school and it inspired them to do physics" (Charley). The promise of continuing research connects the scientists with the new, budding scientists in the audience.

Opinions and debate are highlighted within the film. Two sides are presented to the audience, theoretical and experimental physics. Each presents its own hypothesis and the ramifications of them. The audience is allowed to form their own thoughts. The film gives the viewer space to make their own opinion. "Science communication," as Burns, et al. describes it, "is most powerful when it causes participants to reflect on, and form, reform, or affirm their attitudes". In the end, neither is proven correct or incorrect. The scientists, and the audience, are left to continue the debate.

Understanding is the comprehension of scientific concepts. *Particle Fever* does not presume the audience will have a full understanding of these topics. We are, however, still able to understand the concepts themselves. The audience also has an appreciation of the implications of this research. We see what the research means to each scientist and how their work is now being changed.

Through the craftsmanship of *Particle Fever*, we can see how a focus on scientific endeavors can successfully produce each of the personal responses described by the AEIOU definition. The six scientists act as inspiration, empathetic connection, and teachers, allowing for a variety of reactions to the film. Each viewer will experience these personal responses differently, from a more basic awareness to a deeper understanding. The success of each aspect, however, can be created with scientists as the example.

Suspects and Investigators

Errol Morris's *The Thin Blue Line* is not a science film; it's a crime documentary. It focuses on a mystery and interprets events with the method of scientific experience. The film explores the murder of a police officer, the detectives who investigated the crime, and the suspect who has been accused. Heavily based on interviews and dramatic re-enactments, the film shows each perspective of the night of the murder itself.

Errol Morris's career has been built on solving mysteries. He engaged in a meandering education by studying history, then the history of physics, before joining a doctoral program in philosophy. As his focus shifted to filmmaking, he was still focused on the unknown. About his films, Morris said, "Almost everything I do now in my work is about epistemic concerns: how do we come by certain kinds of knowledge?" (Singer). A lack of knowledge became central to his films. Instead of focusing on answered questions, the mystery itself is highlighted. At its center, *The Thin Blue Line* is about the process of solving a mystery.

Like a scientific experiment, Morris begins with a question: who killed Robert Wood? This mystery remains central throughout the film. The film begins with an initial re-creation of the shooting, unexamined evidence from the scene, and the basic facts as reported by the media. Within a few minutes, a hypothesis is presented: Randall Dale Adams is the killer. The rest of the film serves as a testing of this hypothesis.

The film then presents the method: a survey of those involved. The suspected killer is interviewed, alongside police officers, potential witnesses, the judge, and his lawyers. Morris creates a strong connection between the audience and the subjects of the film. He does not use use this solely to build empathy, but to keep the viewer questioning the mystery itself. Interviews

are filmed directly facing the camera, forcing a connection with the audience. We are unable to separate ourselves from the subjects as they speak directly to us, a perspective that he would continue to build upon in his future works. These interviews disprove each other; the audience cannot trust each individual, so we constantly consider what the truth may actually be, deciding for ourselves whom we trust and what evidence is believable.

The results are very clear. Morris presents an audio recording of himself and witness David Harris. In it, Harris essentially admits to the murder, heavily implying his guilt. This is not presented as a re-creation; it is not a part of the investigation but its conclusion. This is our final evidence. The implication Adams was convicted for a crime he did not commit is never spelled out for the audience. When written text appears on screen, showing that Adams is still in prison, Morris never explicitly tells us he is innocent. This becomes our discussion, the call for further work that still needs to be completed.

While the audience is left to develop their own beliefs, Morris is far from objective. Adams and Harris's interviews are deisgned to give a sense of weight to the audience, using dramatic lighting and a clean background. The sheriffs and district attorneys are filmed from uncomplimentary angles, along with low-income witnesses (Dieckmann, 35). The film uses the visuals of interviews to imply Morris's views (Curry, 155-156). Morris is lacking in the objectivity that would be needed in a scientific experiment.

The Thin Blue Line is not a science film but interpreting it in the context of a scientific experiment allows us to see another example of how one can be created. Morris focuses on the process itself. While a conclusion is found, that was never his focus. Instead, he shows how

showing a process leads to the audience finding the truth ourselves with, of course, significant assistance from the filmmaker.

> Maybe in getting at the truth, the best thing is to show how you got at it, or how you tried to get at it--to leave your investigation available to others, the process by which you arrived at certain kinds of conclusions or accepted certain kinds of beliefs. ("Truth is Not")

The Thin Blue Line, while not a science film, is one of the clearest examples of why showing the entire process can allow audience to come to their own conclusions.

Autonomy

Recent science communication techniques have relied heavily on the deficit model. This model connects public distrust of science with a lack of understanding. The public's understanding of science has increased, however, even as science denial has risen (Bubela 514-517). Instead, new models call for a stronger interactivity between scientists and the public. As Alan Leshner writes, "there needs to be a conversation, not a lecture." (459). This becomes more difficult while discussing documentaries, a medium that naturally has less room for interactivity. Instead, documentaries often try to appeal to the root of interactivity: the learner's agency.

Within education, the concept of agency has recently become a popular way of highlighting a learner's choice and interest. Agency places learning under the individual's own control, instead of the will of the educator. By increasing the learner's choice, their intrinsic motivation leads to deeper understanding of topics and higher enjoyment of the subject matter ("Agency"). Implementing viewer agency can lead to a stronger interest and knowledge of our subject.

The Thin Blue Line provides a clear example of this. The audience is allowed to continuously question the evidence presented. Even the conclusion, while clear, is not directly

given. In this sense, this film makes the viewer into the investigators, the scientists themselves. Without featuring a human subject, Morris is still able to use the dedication of scientists to create a compelling story; the dedication, however, is the audience's own.

Learner agency within education is a complex idea that is still being defined and studied ("Agency"). Its place in documentaries is also worthy of continued exploration. Creating a sense of scientific questioning within audiences is one possible opportunity alongside various interactive documentaries (Nichols 108). As future films explore the use of agency, its reach will become a more researched concept.

Morris's film is one of the most critically acclaimed crime documentaries of all time. Adams's conviction was overturned and he was released from prison as a direct result. The film's impact on the documentary genre is unquestionable and could be spoken about at length. Its use of reenactments, music, and pacing can be seen replicated in many films that followed. It has the ability, however, to impact how science documentaries are crafted. Like *The Thin Blue Line*, scientific films can create processes that turn audiences into scientists themselves.

CHAPTER FOUR

THE EEL QUESTION

The European eel, at first glance, is not a very exciting animal. It is rather alien, often hidden from sight, and generally unpleasant when it is seen. When talking about my thesis film, I was often met with slight revulsion at the mere thought its subject. Perspectives changed when the enormity of the eel question was explained. The fascinating thing about the eel is the mystery surrounding it and humanity's continuing fascination with it.

"The Eel Problem" is primarily an animated film with the design modeled after paper cut-outs. It explains the central question of the European eel – how does anything about it make sense. The film then describes what we currently know about the lifecycle of the eel. With the framework of the scientific process, most of the film follows different scientists throughout time and their own work trying to determine even a fraction of the question. At the film's conclusion, the rapidly decreasing number of eels is shown while the eel question is still unanswered.

At the onset, this film presents a mystery for audiences. The viewer is given a clear question, one that has been the focus of thousands of years of research efforts. Like *The Thin Blue Line*, I wanted audiences to be able to part of the mystery from the onset. The short time frame and the more unfamiliar subject matter meant that some of the answers needed to be revealed early on. There were simply too many minor questions about the eel to engage them all. With some mysteries exposed, the film focuses on how we gained this understanding, using that knowledge search as the driving process.

The scientific method was used to increase viewer comprehension. The vast length of this research and the number of people involved could quickly become overwhelming and confusing.

By including the steps of the scientific method, viewers had a clear idea of the progression of the film and the research as well. Each scientist's work is placed in the context of the overall process. It also emphasizes the ongoing efforts even over such long periods.

Despite the fact that none of the scientists are still living, the film highlights the scientists' enthusiasm for their work through what we know of their emotional states. *Particle Fever* served as an example for connecting scientists with audiences. The writings of each created a clear portrayal of how they felt about their efforts. Aristotle is shown disregarding the more common conceptions of his time, despite being incorrect. Sigmund Freud is clearly infuriated by his failed attempts, but his future work will still be influenced by it. Johann Schmidt's dedication is apparent from the sheer amount of time spent searching. Rachel Carson's intense appreciation for the species elicits an appeal to the audience. Each scientist is an example of the ongoing connection between researcher and subject: interest, frustration, passion, and appreciation.

The need for a narrator is an additional challenge. The narrator of "The Eel Problem" has to act as a stand-in for each of scientists while not distracting from the information presented. Each section requires the narrator to convey its tone without becoming too exaggerated. The ending, for example, needs to carry the weight of potential extinction without becoming overly sentimental. I used the scientist's words where possible to make a clear connection between the subjects and the narrator, quoting both Freud and Carson. This was not possible for some of the lesser known or older scientists. The narrator, however, was still able to act as an emotional connection for each scientist.

While musical score was not discussed in the earlier analyses of influential films, I paid considerable attention to this issue in my film. Each of the three previously discussed films have used music to great success. *My Octopus Teacher* creates a quiet and meditative state to show the same peace that Foster feels. Phillip Glass's famous score in *The Thin Blue Line* adds to the film noir elements in each narration. *Particle Fever*'s staccato music builds tension throughout its climax. In my own film, I used the score to create the tone in each sections. The section on Freud's research takes on a lighter mood, while Carson's section relies on more inspirational moods. The music that I used throughout the film has light instrumentation as narration is used heavily. As each of the case studies have done before me, I used the film's score to add to its emotional weight.

Extinction can be a difficult topic. The weight of the loss of a species is often not fully felt, especially as it becomes more common. Uncharismatic species may be lost quietly with the public unaware. As the film continues, the animated papers build upon themselves until extinction is mentioned. The papers fall away and the eel itself is shown for the first time. The audience sees the eel, living in its habitat for the first time. The narration highlights the weight of this ecologically, but within the context of the mystery as well. As the viewer connects with the scientists and empathizes with their passion, the knowledge that the answers may never be discovered becomes clear. While it only dealt with the death of an individual animal, I used a similar connection to what was created in *My Octopus Teacher* to give more weight to a possible extinction. The long scientific process may not amount to anything; the question that they have come to connect with may go unanswered.

"The Eel Problem" uses the dedication of many different subjects over multiple time periods to create an emotional connection with the audience. It builds trust with the viewer by giving each one an insight into the scientific processes. The film creates a mystery that audiences want to be able to solve themselves. With each of these steps, the film builds a strong interest where there was little and –it is hoped – creates a dedication to protecting the European eel.

CHAPTER FIVE

CONCLUSION

Empathy is a strong driving force. Our ability to recognize and connect with the emotional state of another person is a crucial aspect of relationships and community. It can be a powerful educational tool, creating interest where there was little. It can be a motivator for conservation, promoting internal and external change. The significance of empathy in documentaries cannot be overstated.

The scientific process is often presented as cold and emotionless. The passion of scientists is clear evidence that this is not the case. They spend decades studying, followed by years of research in their field. Many are actively arguing for funding; others are pushing for the media to tell their story. This dedication is powerful, and it can be deeply moving if it is presented properly.

Documentaries have the ability to harness empathy and create strong emotions in their viewers. A scientist's relationships with species can trigger our own concern, their dedication can inspire new passions in the unknown, or their zeal can be created within ourselves. By highlighting the intense emotions that lead to fervent exploration, we can inspire that same enthusiasm and love.

REFERENCES CITED

"Agency." *The Education Hub*. 20 January 2020, https://theeducationhub.org.nz/agency/

Barney, Erin C., Joel J. Mintzes, and Chiung-Fen Yen. "Assessing Knowledge, Attitudes, and Behavior Toward Charismatic Megafauna: The Case of Dolphins." *The Journal of Environmental Education*, vol. 36, no. 2, 2005, pp. 41-55. ProQuest,

Burns, Terry. W., et al. "Science Communication: A Contemporary Definition." Public Understanding of Science, vol. 12, no. 2, 2003, pp. 183–202, https://doi.org/10.1177/09636625030122004.

Burns, Terry. W., et al. "Science Communication: A Contemporary Definition." *Public Understanding of Science*, vol. 12, no. 2, 2003, pp. 183–202, https://doi.org/10.1177/09636625030122004.

Bubela, Tania et al. "Science Communication Reconsidered," *Nature Biotechnology*, pp 514-517. 2009.

Björnberg, Karin Edvardsson, et al. "Climate and Environmental Science Denial: A Review of the Scientific Literature Published in 1990–2015." *Journal of Cleaner Production*, vol. 167, 2017, pp. 229–241, https://doi.org/10.1016/j.jclepro.2017.08.066.

Charley, Sarah. "Particle Fever: Where Are They Now?" *Symmetry Magazine*. 30 June 2022, https://www.symmetrymagazine.org/article/particle-fever-where-are-they-now?language_content_entity=und

Curry, Renée R. "Errol Morris' Construction of Innocence in 'The Thin Blue Line.'" *Rocky Mountain Review of Language and Literature*, vol. 49, no. 2, 1995, pp. 153–67. JSTOR, https://doi.org/10.2307/1347983. Accessed 24 July 2023.

Dahlstrom, Michael F. "Using narratives and storytelling to communicate science with nonexpert audiences." *Proceedings of the National Academy of Sciences*, vol. 111, no. 4, pp. 13614–13620, https://doi.org/10.1073/pnas.1320645111

Dieckmann, Katherine. "Private Eye." *American Film*, vol. 13, no. 4, 01, 1988, pp. 32. ProQuest, https://www.proquest.com/magazines/private-eye/docview/196363263/se-2.

Ducarme, Frédéric, et al. "What are 'Charismatic Species' for Conservation Biologists?" *BioSciences Master Reviews*, 01 October 2012.

"Errol Morris, Documentarian: Errol Morris on His Breakthrough Moment." New York, Jan 11, 2016. ProQuest, https://www.proquest.com/magazines/errol-morris-documentarian/docview/1756195529/se-2.

Fackler, A. When Science Denial Meets Epistemic Understanding. *Sci & Educ* 30, 445–461 (2021). https://doi-org.proxybz.lib.montana.edu/10.1007/s11191-021-00198-y

Fallon, Kris. “Several Sides of Errol Morris.” *Film Quarterly*, vol. 65, no. 4, 2012, pp. 48–52. JSTOR, https://doi.org/10.1525/fq.2012.65.4.48.

Morris, Errol. "'Truth is not about what the Majority Believes': Documentary Filmmaker and Author Errol Morris on how we are all Error-generating Machines." *Nieman Reports*, vol. 66, no. 4, winter 2013, pp. 4+. Gale Academic OneFile.

Morris, Errol and Bates, Peter. “Truth Not Guaranteed: An Interview with Errol Morris.” *Cinéaste*, vol. 17, no. 1, 1989, pp. 16–17. JSTOR, http://www.jstor.org/stable/23803048. Accessed 14 July 2023.

Leshner, Alan. “Bridging the Opinion Gap.” *Science Magazine*, vol 347, issue 6221.

Linden, Sheri. “‘My Octopus Teacher’: Film Review.” *The Hollywood Reporter*, 15 Mar. 2021, www.hollywoodreporter.com/movies/movie-reviews/my-octopus-teacher-film-review-4136577/.

Malloy, Claire. “Independent Nature: Wildlife Films between Hollywood and Indiewood.” *American Independent Cinema*, pp. 165-176.

Man with a Movie Camera. Directed by Dziga Vertov. 1929.

My Octopus Teacher. Directed by James Reed and Pippa Ehrlich. Netflix Studios, 2020.

Nanook of the North. Directed by Robert Flaherty. 1922.

Nichols, Bill. *Introduction to Documentary.* Indiana University Press, 2017.

Öberg, Gunilla, et al. “Teaching Science as a Process, Not a Set of Facts.” *Science & Education*, vol. 31, no. 3, 2021, pp. 787–817, https://doi.org/10.1007/s11191-021-00253

Particle Fever. Directed by Mark Levinson. Netflix Studios, 2014.

Pouliot, Chantal, and Julie Godbout. “Thinking Outside the ‘Knowledge Deficit’ Box.” *EMBO Reports*, vol. 15, no. 8, 2014, pp. 833–835., https://doi.org/10.15252/embr.201438590.

Prosek, James. *Eels: An Exploration, from New Zealand to the Sargasso, of the World’s Most Mysterious Fish*. Harper, 2011.

Saini, Angela. “The Code for Cuteness.” *BBC Earth*, www.bbcearth.com/news/the-code-for-cuteness. Accessed 14 July 2023.

"Science Is a Process - Understanding Evolution." *Understanding Evolution*, 29 Sept. 2021, evolution.berkeley.edu/nature-of-science/science-is-a-process/.

Singer, Mark. "Predilections." *The New Yorker*. 6 February 1989, https://www.errolmorris.com/content/profile/singer_predilections.html

Svensson, Patrick. *The Book of Eels: Our Enduring Fascination with the Most Mysterious Creature in the Natural World*. Harper Collins, 2021.

The Thin Blue Line. Directed by Errol Morris. 1988.

Rutkowski, Ed. "Talking about Science: Goodbye-and Good Riddance-to the Deficit Model." *AIHA*, 17 Jan. 2017, https://www.aiha.org/blog/talking-about-science-goodbye-and-goodriddance-to-the-deficit-model.

Walsh, C. "Harvard panel discusses what made 'My Octopus Teacher' A Hit." *Harvard Gazette*. https://news.harvard.edu/gazette/story/2021/05/harvard-panel-discusses-what-made-my-octopus-teacher-a-hit/

Williams, Kathryn et al. "Empathy in conservation is hotly debated. Still, the world needs more stories like My Octopus Teacher." *The Conversation*. 23 November 2020, https://theconversation.com/empathy-in-conservation-is-hotly-debated-still-the-world-needs-more-stories-like-my-octopus-teacher-149975

Wilson, A., & Howitt, S. (2016). Developing critical being in an undergraduate science course. *Studies in Higher Education*, 1–12.

Yin, Y., Dong, Y., Wang, K. et al. "Public use and public funding of science". *Nat Hum Behav* 6, 1344–1350 (2022). https://doi.org/10.1038/s41562-022-01397-5

Zhang, Ruiyang, et al. "Critical Role of Multidimensional Biodiversity in Contributing to Ecosystem Sustainability under Global Change." *Geography and Sustainability*, vol. 4, no. 3, Sept. 2023, pp. 232–243, https://doi.org/10.1016/j.geosus.2023.05.002.