Florida Undergraduate Research Journal

Volume 1 | 2022

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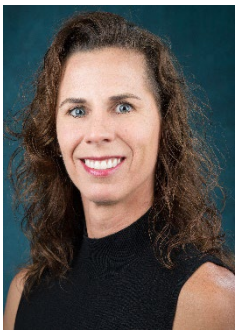
Meet the Editorial Board

Emmaline Blikstad

My name is Emmaline Blikstad, and I am a junior majoring in history at Florida Gulf Coast University. My research interests include holocaust history, world empires, and religion in history, particularly in Nazi Germany. I am currently pursuing an honors thesis on the intersection of different Christian denominations in their opposition of Nazism in Germany, and I aspire to continue this or similar research to a master's level. Though Covid has brought hinderances, I am still able to conduct research thanks to the availability of digital archives.

Dr. Melodie Eichbauer



My name is Dr. Melodie Eichbauer and I am the Executive Editor of FURJ as well as the Assistant Director of Scholarly Innovation and Student Research and a Professor of Medieval History at Florida Gulf Coast University. I am passionate about student research and the wide-ranging benefits it can bring. My own research specializes in legal and ecclesiastical history from c.1000 to c.1500. My research interests focus on legal pluralism and the evolution of legal principles. I am particularly interested in the dissemination of legal knowledge; the interpretation of law; and the ways in which social, political, and intellectual developments and trends shaped both during the height of the medieval period. By examining the larger processes linking law to the world in which it functions, my hope is to show new ways of thinking about current issues.

Camila Garcia

I am Camila Garcia, a senior majoring in biochemistry and minoring in Biology from Florida Gulf Coast University (FGCU). I am currently conducting research in the area of forensic biochemistry. My project focuses on optimizing amplification techniques for DNA found in fingerprints. However, my true passion is protein folding and structure research. During this busy year, I try to be in the lab at least once a week but some weeks it can be difficult to find the time, so I am most focused on writing the literature review for my Honor's Thesis throughout the week.

Anastasia Gregory

My name is Anastasia Gregory, I am a thesis student at New College of Florida, who is majoring in biochemistry. I have had the opportunity to do research across a variety of stem fields. My main research interests are diseases, disorders, and cancers. My most recent research was done through Moffitt Cancer Center to study the treatment of EGFR-mutant non-small cell lung cancer using CARM1 inhibitors. Performing research during a pandemic has been difficult, but it also allowed me to branch into some fields that are more virtually focused.

Jaia Hendrickson

Jaia Hendrickson is a fourth-year undergraduate student at Florida State University majoring in psychology with a minor in sociology. He is conducting an honors thesis project investigating whether subordinates prefer one of two leadership strategies (i.e., dominance or prestige) during times of intergroup competition. His research interests involve evolutionary psychology, close relationships, and mating behavior. Due to COVID, much of his current work has been through an online format. He still manages to conduct research in a lab setting when his other projects permit.

Paula Koppel

My name is Paula Koppel, I am a Senior at the Florida International University Honors College. I am majoring in Natural and Applied Sciences on the pre-med track. I am currently conducting research on autism and I am the treasurer of a pre-health honor society. On my free time, I enjoy cooking, baking, and going to the Disney parks!

Jess Moorefield

Jess Moorefield is a computer science and English major at Florida State University. Her current research is an intersection of her studies and focuses on using natural language (e.g. English) rather than a programming language to interact with databases. Jess hopes her research will be useful to non-technical users in the business world. Even while navigating the COVID-19 pandemic and a busy schedule, she continues to pursue research because it is an exciting chance to translate her knowledge into a practical tool that can benefit others.

Rabeea Rehman

Rabeea Summer Rehman is a recent graduate of the University of Central Florida Interdisciplinary Studies program (Biomedical Sciences and Physical Sciences Track) with a minor in Spanish. As an aspiring healthcare provider, Rabeea strives to gain insight into the various specialties in medicine. Rabeea has conducted clinical research at an Infectious Disease and Wound Center on the topic of Hyperbaric Oxygen Therapy. Under the mentorship of a board-certified Infectious Disease Physician and Nurse Practitioners, this hands-on opportunity provided a multidisciplinary experience to safely shadow the treatment of patients from varied demographics diagnosed with a multitude of diseases and wounds.

In addition to being a full-time student, conducting research, and serving on the student editing board of the Florida Undergraduate Research Journal, Rabeea has continued her service to humanity by spearheading local and national volunteer projects to assist those most affected by the pandemic. Projects organized include cooking weekly lunches for the homeless and holding donation drives for the less fortnate, sewing face masks for healthcare providers, fundraising for PPE, and more. The pandemic has resulted in many trials but has also given Rabeea the positive trajectory for personal & professional growth by providing countless opportunities to serve the community.

Elizabeth Saint

My name is Elizabeth Saint, and I am an Editing, Writing and Media major at Florida State University. I recently joined the editorial board for my university's literary journal, and this summer, I had the privilege of interning in the non-profit sector. These opportunities gave me insight into the professional world of writers and editors. I hope my skills will help other students pursue their research goals.

Faith Sauber

Faith Sauber is a Biomedical Sciences major from the University of Central Florida. She has been an undergraduate research assistant under multiple interdisciplinary research projects. Recently, she has been an undergraduate teaching assistant in a molecular biology laboratory course. She has also just published an undergraduate thesis paper investigating a topic in the areas of healthcare and computer science. She is thankful for the many incredible research opportunities available at the University of Central Florida, which have allowed her to continue her research journey abroad at a program in Geneva, Switzerland joining a neuroscience project in the spring of 2022.

Eve Vazquez

Hello! My name is Eve, and I'm majoring in I/O psychology at the University of Central Florida. My research interests include group interaction, decision-making, and motivation. During the COVID-19 pandemic, I engaged in three different remote research projects. My most notable remote experience was when I completed my honors thesis. I was conducting an experiment about memory retrieval and touch stimuli. I modified my project for the pandemic by recruiting my participants online and running trials through FaceTime!

Welcome from the Editorial Board

Student researchers are one of the most valuable assets any higher education institution can have. Their fascination and drive to dive into the subjects that interest them leads them to produce original research to present to their classes, schools, and at academic conferences. Yet, this research often ends there. The *Florida Undergraduate Research Journal* believes that student researchers should have the opportunity to publish their research to as wide of audience as possible, and it is devoted to the publication of undergraduate research.

We are so excited to share the research of six undergraduate students from Florida institutions in our first volume of the *Florida Undergraduate Research Journal*. All submissions have cleared a rigorous, tiered review process consisting of an Editorial Board and a disciplinary faculty reviewer. The Editorial Board consists of undergraduate student volunteers from across the state schools—public and private, two-year and four-year—who meet monthly to review submissions, provide feedback to the author, and help to facilitate a faculty reviewer. The diversity within the board offers student authors an interdisciplinary perspective and provides valuable experience for the Board to work together as colleagues in reviewing academic research. On a personal note, it has been a great experience to work with such a wonderful group so dedicated to helping other students.

The process of creating this journal has been a new experience for all involved, but the outstanding hard work of our student researchers, student editorial board, and faculty mentors has been essential in this publication. There are a few additional "thank yous", however, that are in order. First, the advice from many in the Florida Undergraduate Research Association and in the Office of Scholarly Innovation and Student Research at Florida Gulf Coast University has been instrumental. The care and input of the faculty reviewers to encourage and mentor students on their publication journey has been deeply appreciated. Finally, Shawn Brunelle, Hayley Sinnott, and David Blikstad deserve a special thank you for pitching in throughout the process to get the journal published.

—Emmaline Blikstad, Assistant Editor

—Dr. Melodie H. Eichbauer, Executive Editor

Welcome from the Florida Undergraduate Research Association (FURA)

The Florida Undergraduate Research Association (FURA) is thrilled to partner with Florida Gulf Coast University to launch the inaugural edition of the Florida Undergraduate Research Journal! Helmed by Dr. Melodie Eichbauer along with a talented and committed Student Editorial Board, this is the first peer-reviewed undergraduate research journal composed of submissions from students across the state. FURA would like to offer special recognition to the five authors whose research you will read about in the following pages, scholarship spanning across the disciplinary spectrum.

Dissemination, or the sharing of research, is a crucial component of the overall research process. It is not sufficient to conduct our research, if we are not sharing it in ways that benefit the wider public. FURA has long supported undergraduate research sharing through the Florida Undergraduate Research Conference, now in its first year. The addition of the Florida Undergraduate Research Journal provides another significant way for undergraduate researchers across Florida to share their research with this wider community, stretching beyond the boundaries of their individual institutions. We are especially delighted to be able to create a permanent DOI for the journal, so the incredible work of these undergraduate researchers will remain easily accessible moving into the future.

Again, congratulations to the student authors represented in our inaugural journal and a very special thank you to all those who volunteered their time to review submissions and craft this impressive feat. For those interested in joining the editorial board or submitting your own work in the coming year, please be sure to check out the FURJ page on our FURA website or follow FURA on any of our social media accounts.

Happy reading!

Florida Undergraduate Research Association

Abstracts

"Just" Utility? A Bioethical Analysis of COVID-19 Resource Allocation

Isabella Jacus, St. Leo University

COVID-19 has brought into focus the bioethical challenge of resource allocation by straining healthcare delivery in limiting the availability of healthcare resources. While the bioethical principle of autonomy has typically taken precedence for medical practices, with the struggle of resource allocation, the bioethical principles emerging as front-line and conflicting have been utility and justice. Balancing these ideals has been challenging because while utility has demanded that society make decisions maximizing good and minimizing harm, justice has emphasized all people getting their due, despite if most efficient. Looking at how these principles could work without compromising each other, the question how a "just" utility, or a utility well-balanced with justice, could be attained has emerged because while utility has encouraged policies that would save the most lives in dire situations, it has inadvertently allowed for the magnification of pre-pandemic inequities disproportionately impacting the marginalized, marking an issue of justice. The conversation has proven complex when considering the ventilator crisis, showing the importance of resource allocation for public health emergencies. To grasp the scope of resource allocation challenges during COVID-19, the role of bioethical principles in making decisions, the concept of "just" utility, and the implications of resource allocation (including questions of accountability and use of innovative technologies) will be evaluated. Advocated for will be the consistent discussion of resource allocation strategies by diverse community members who take responsibility together, health officials being transparent during crisis situations, and using bioethical principles to predict and combat inequities that might be amplified during crises.

An Analysis of Inoculation Rates Utilizing Statistical Learning to Validate the Significance of Predictors

Matthew V. Chin and Jordan M. C. Sanders, Embry-Riddle Aeronautical University

In a previous study, data analyzed from measuring cell phone signal movement showed that the most predictive factors of social distancing in response to the SARS-CoV-2 (COVID-19) pandemic were income and population. While a great deal of factors could be investigated to determine what the most predictive factors of inoculation rates are, this study is a continuation of the previous work by Smith, Boquet, and Chin (2020) and investigates if there is a significant difference between inoculation rates when separated by median income and population. Data is drawn from the State of Florida counties to remain consistent with the preceding work. The two-sample t-test performed revealed that there was a significant difference between the inoculation rates of counties with a high population when compared to those with a low population. A similar result was found for the inoculation rates of counties with high a median income when compared to those with a low median income. These results demonstrated that median county income and county population had impacts on both inoculation rates and social distancing.

Effect of Isolation on the Recognition of Context-Specific Alarm Calls in a Captive Vervet Monkey (*Chlorocebus pygerythrus*)

Ella G. Guedouar, Florida Gulf Coast University

In contrast to many animal signals that share limited information, context-specific signals communicate referential and/or situational information that is consistently interpreted by a group. Wild Vervet monkeys (*Chlorocebus pygerythrus*) use context-specific alarm calls to communicate predator type (e.g., eagle, leopard, snake), which causes receivers to respond in predator-specific ways. Captive Vervets use and respond to context-specific alarm calls, though these calls can be applied to novel stimuli such as when eagle calls signal an airplane, another flying entity. Context-specific calls may require a social structure to be produced and understood, where isolated individuals may not understand the information contained within calls. This experiment evaluated the response of a socially-isolated captive Vervet monkey to the context-specific calls that he presumably heard for the first time during the study. The subject, Ross, was exposed to three types of Vervet monkey predator-specific alarm calls, a Vervet monkey social signal, and a control signal (i.e., European Starling). Ross showed behavioral differences after the Vervet calls, suggesting he could recognize conspecific vocalizations. Ross demonstrated an ability to recognize the "alarm" nature of alarm calls with increased scanning behavior displayed after the calls. However, Ross was unable to distinguish between the predator type that the calls communicated. He failed to show the predator-specific responses to alarm calls. Ross' inability to recognize the information communicated within predator-specific alarm calls suggests the importance of social learning in understanding the context-specific nature of these signals. The overall interpretation of the results should be treated with caution because the study was based on the response of a single animal who lived in an extraordinary situation of social isolation.

The Use of Hyperbaric Oxygen Therapy to Treat Necrosis and Open Wound due to Ionizing Radiation

Rabeea Summer Rehman, with Dr. Haris Mirza, MD and Dr. Kersten Schroeder, PhD, University of Central Florida

Radiation is invaluable for the treatment of tumors but causes detrimental effects on surrounding healthy tissue because ionizing radiation is nonspecific to its target. Wounds may develop from radiation therapy for cancers growing close to or on the skin, like melanoma. Clinically approved approaches are needed to regenerate tissue and close wounds after ionizing radiation treatment. Surgical intervention is commonly performed for wound closure post-radiation, but it has a high chance of developing infection. Hyperbaric Oxygen Therapy (HBOT) is a treatment currently being used for patients with ulcers, burns, infections, crush injuries, and more, but requires further research to confirm its reliability on radiation induced wounds. HBOT, unlike surgical intervention post-radiation, mitigates infection and the disfiguring of skin. This case study was on a patient who underwent HBOT for a wound developed from radiation after a successful treatment of melanoma. The patient suffered from sequela necrosis and open wound from the radiation that measured 3cm by 2cm with 30% slough. They were presented to the Ocala Infectious Disease and Wound Center

and were prescribed 40 sessions of continuous 90-minute HBOTs at 2.0 ATA (atmospheres absolute) for a duration of 10 weeks. The size of their wound and percent slough was measured on a weekly basis to determine the effects of HBOT. A successful treatment of HBOT would be represented by a decrease in wound size and decrease in percent slough. Thus, HBOT may offer a safer and reliable alternative to radiation induced wound closure.

Everglades National Park's Historical Impact on The Seminole and Miccosukee Nations

Katherine Ryan, Florida Gulf Coast University

This research examines the consequences of Everglades National Park's establishment on the Seminole and Miccosukee Nations. The guiding questions are: How did Seminole rights change following the park's establishment? How did the park's establishment influence Florida's economy and tourism during this period? This essay argues that as a result of establishing Everglades National Park, Miccosukee and Seminole citizens experienced changes to land use rights that affected their legal sovereignty and economic opportunities in South Florida. Using Federal and State Government analyses, legal rulings, and newspaper articles, I assert that both nations' sovereignty was affected. While environmental history is well saturated with ecological histories of the Everglades and human histories of parks like Yellowstone and Yosemite, the essay argues the much-needed human emphasis of the Everglades that is often missing in the literature of the park and highlights the effects of past rulings that still deeply impact Miccosukee and Seminole economics, rights, and boundaries today.

"Just" Utility? A Bioethical Analysis of COVID-19 Resource Allocation

Isabella Jacus
St. Leo University

Introduction

The COVID-19 pandemic has strained healthcare delivery both nationally and globally by limiting the availability of healthcare resources, physical space, equipment, and medications. Such strain has brought into focus the bioethical challenge of resource allocation.[1] While the bioethical principle of autonomy has typically taken precedence for medical practice in maintaining the standard of physicians respecting their patients' choices, with the struggle of resource allocation the prime bioethical principles emerging at the forefront are conflicting ideals of utility and justice. Balancing these ideals has been challenging because, while utility has demanded that society make decisions maximizing good and minimizing harm, justice has emphasized the importance of all people getting their due (particularly with regards to distributive justice) despite what would seem most efficient.[2] Looking at how these principles could be used hand in hand without compromising each other, the question how a "just" utility, or a utility well-balanced with justice, could be attained has emerged. This is because, while the principle of utility has encouraged policies that would save the most lives when situations became dire, it has inadvertently allowed for the magnification of pre-pandemic inequities of the healthcare system disproportionately impacting the marginalized in crisis situations, marking an issue of justice.[3] The conversation has proven much more complex when considering the ventilator crisis and the importance of resource allocation for public health emergencies. To grasp fully the scope of resource allocation challenges during the time of COVID-19, the role of bioethical principles in making decisions, the concept of "just" utility, and the implications and future conversations of resource allocation post-pandemic—which includes, questions of accountability and use of innovative technologies—will be evaluated. Advocated for will be the consistent discussion of resource allocation strategies by diverse members of the community who work together to take responsibility, health officials being trustworthy and transparent during crisis situations, and the importance of planning before disasters using bioethical principles to predict and combat inequities that might be amplified during it.

Bioethics involves applied ethics centered around social, ethical, and legal considerations that arise in healthcare, research, and medical technology.[2] The four main principles that bioethics considers are autonomy (an individual's self-determination), beneficence (doing good and not doing harm), utility (producing maximal good over harm), and justice (fairness in individuals getting their due).[2] A topic of interest within bioethics is resource allocation, which considers the distribution of limited resources, especially those related to healthcare and biological research.[2] Resource allocation is looked at in relation to supply and demand, and choices made in how resources are distributed are guided by the bioethical principles.[2]

Examples in bioethics of where resource allocation needs to be considered include cases such as medical insurance, organ donations, vaccines, medical personnel, hospital equipment, and technology.[2] While in non-crisis settings, all the bioethical principles are considered alongside one another in managing resources, in crisis situations, the focus often shifts to what can appear as just (as in only) utility. While utility is important for using limited resources to save the most lives possible, it is important that it maintains the qualities a "just" utility (that is, incorporating the principle of justice), so that it can do the greatest good for the greatest number without being inequitable to those already marginalized in society. Throughout the world, COVID-19 proved a crisis situation that tested medical infrastructures, and resource allocation brought to light the challenge of maintaining a "just" utility. Through reflecting on resource allocation challenges, emergent questions and ideas of what to learn from what happened can be reflected on while using the bioethical principles as a groundwork off which to build.

Resource Allocation Challenges of COVID-19

On 11 March 2020, COVID-19 was classified by the World Health Organization (WHO) as a pandemic and quickly took its toll on medical infrastructures throughout the world.[4] Taking the lives of over 500,000 individuals in the United States in its first year alone, COVID-19 challenged healthcare systems by putting them in a position where they had to manage medical resources under a dire circumstance.[5,6] Historically, the United States had never needed to ration healthcare goods such as ICU beds, hand sanitizers, and N95 masks to the extent COVID-19 required, and though the nation predicted a ventilator shortage before pushing for mass-production, other countries, such as Italy, had to deal with staggering deficits as the pandemic escalated to critical levels.[7–9] Ventilator shortage is a concerning problem since people who need ventilators typically have a limited window in which they can be saved, and those dependent on them can die within minutes after being withdrawn from their support.[7] While 50 years ago withdrawing ventilator-dependent people was against the law because it was considered by physicians to be an act of killing, today such withdrawal has become common in the ICU depending on whether the situation was futile and permission was received by the patient or their surrogate.[7] With the onset of COVID-19, however, the situation has become more complicated because of conflicts in balancing the bioethical principles of utility and autonomy. In countries where life-saving health care resources could not be allocated to all people, public health and clinical ethics had to intersect and find a way to triage resources.[1]

The triage process, whether for ventilators or other hospital necessities, is an approach that health care providers use to manage limited resources strategically, and is more vital when understood that resources will come to be even more scarce as the incidence of infection increases exponentially.[10] As a last resort measure, different countries needing to practice the triage process during the pandemic had different protocols regarding its execution, including the prioritization of saving the most people, protecting the most vulnerable, making room for younger individuals, or allocating resources to those most important in society.[4,10] In France and Italy, countries which had to triage ventilators, the primary emphasis was placed on minimizing deaths and maximizing

years saved. These triage protocols were drafted by ICU physicians in a collegial manner without a formal committee.[4] Italy's debates over ethical guidelines erupted in their social media. Conflicts emerged because of increased outrage directed at doctors, who meanwhile sought ethical counsel because of the agony of their decisions, viewing them as beyond their expertise.[4] In France, public guidelines were primarily followed and medical paternalism, situations in which the physician determined that a patient's wishes or choices should not be honored, remained in place without significant backlash on social media because triage protocols were not as openly debated.[4] Yet other countries such as the US who did not have triage ventilators, had to establish resource allocation measures for other lifesaving resources such as ICU beds and hospital staff.[11] Similar to Italy and France, the US prioritized utilizing resources on those who had the greatest chance of recovering, though it did so at the expense of the elderly and people of color who had a lower chance of recovering.[11] Unlike Italy and France, committees held jurisdiction over how resources would be allocated, and though no policies were changed, the US could still say that more people recovered in total amidst the suffering of the marginalized.[11] Looking at such realities from multiple countries begs the question of what drove the decisions made from a bioethical perspective.

The Role of Bioethical Principles in Resource Allocation During the Times of COVID-19

Bioethically-speaking, the healthcare situation brought on by COVID-19 was complicated because the traditional prioritization of norms that health-care systems implicitly took for granted were shaken. In non-crisis clinical care, the principle of autonomy took precedence in the physician-patient relationship because the patients' interests and choices regarding their own healthcare were given the greatest weight.[1] In other words, a deontological relationship existed between the physician and the patient in which the physician had a duty to care for the patient.[1] On top of this, treatments from physicians were just, if not egalitarian, because physicians served all patients fairly to the greatest capacity they could.[12] Finally, though the patient-physician relationship was built on autonomy and the physician's practice was built on justice, the system both parties operated under was built on utilitarianism to allocate healthcare resources ethically, efficiently, and effectively (which physicians helped regulate by not always giving patients everything they demanded).[13] Looking at the onset of the COVID-19 pandemic from the perspective of how it disrupted these ethical norms, it is clear that the world was flustered in shifting from physician interactions being primarily founded on justice and autonomy to being almost completely founded on utilitarianism.[1] A new tension emerged as prioritization of community care was pitted against individual care, and processes of healthcare resembled a supply and demand flow favoring the saving the most people at the expense of the marginalized in society, thus sparking questions on the justice present.[1,4]

Looking further at how these tensions played into how actual decisions were made regarding resource allocation during the pandemic, it can then be realized that utility superceded priority and infiltrated all the bioethical principles to find methods to maximize distribution of resources in ways that would save the most people. Autonomy, rather than being wholly individual,

shifted to being relational: one person's needs paled in comparison to those of the community because there was a limit on the services (space, equipment, medications, etc.) that could be offered to one individual when they were scarce in quantity and needed by others who had a greater likelihood of recovery.[1] Nonmaleficence, while usually being seen as clinicians minimizing harms to their patients, morphed into a case of threats to population health outweighing harms to individuals, leading to the cancellation of non-urgent surgeries and medical procedures in the name of preventing the spread of the virus.[1] In crisis situations, the use of unproven treatments prevailed when standard treatments were not developed, and trials such as early mechanical ventilation and hydroxychloroquine harmed patients rather than helped them.[1] Finally, while beneficence would typically focus on what doing what was best for the patient as an individual, in the pandemic, it emerged as focusing on what was best for society as a whole in trying to save as many lives as possible.[1] Physicians, using triage protocols to prioritize who to save, would step up and work longer hours for the well-being of patients, in essence holding the healthcare system together.[1]

Analyzing justice in relation to utility, it is clear that the main issue was distributive justice in regard to how resources were allocated. Different kinds of justice considered during the pandemic were utilitarianism (favoring the greatest public utility), libertarianism (favoring individual rights over public utility), communitarianism (favoring traditions), and egalitarianism (favoring equality of all benefits).[6] Though utilitarianism generally took precedence over other kinds of justice to allow for the formation of triage priorities, other theories of justice would be practiced, such as in situations that required determining which of two people received medical attention.[6] However, utilitarianism as an offshoot of justice did not make for a "just" utility because minorities, underserved, and impoverished in society were hit up to six times harder by COVID-19 than those who were of higher socioeconomic status.[6] A new conflict would emerge between choosing the right principles for a triage involving resource allocations, balancing efficiency, equity, and justice, and sacrificing one principle at the expense of another, essentially calling for reflection regarding what to make of the situation.[6]

Emergent Questions

In considering the ramifications of COVID-19 from a bioethical perspective, an initial question to consider is whether the way utility overshadowed justice, especially with regards to its balance of multifaceted nuances outside utilitarianism such as libertarianism, communitarianism, and egalitarianism, reflected an inherent failure to plan. Some countries, such as the United States, had triage committees organized, while other countries, such as France and Italy, tackled the situation as it unfolded, developing and debating policies along the way.[4] While it could be acknowledged that the extent to which healthcare systems could manage the pandemic were tied to their access to life giving resources such as ventilators, it can also be reflected that in crisis situations requiring a high proportion of a particular kind of resource, problems would inevitably emerge unless a nation had a massive storage of every good at all times (which would likely prove unsustainable).[12] Though it is clear that, in the context of resources being scarce, egalitarianism would cost more lives than utilitarianism in using the scant amount of resources inefficiently, it must also be realized

that a more effective utilitarian position would bring its own losses too, specifically concerning the marginalized who had less access to quality health care and resources due to inequities in the healthcare system as a whole.[3,12,14] For countries without contingency plans, the pandemic proved devastating. For countries with regulations, it became clear that they were not adaptable enough to combat inequities exacerbated by the frailty of society, even if production of essential resources could increase in good time. Realizing nations' varied levels of preparedness, and the disconnect between plans being flexible, structured, and equipped with foresight in countries that did have them laid out, it is fair to say that utility's overemphasis at the expense of justice reflected a lack of complete preparation, or a failure to plan.

Considering further whether the extent of the pandemic's crisis was of man's making or merely incidental, it must similarly be reflected that complex environmental and societal factors intertwined. It can fairly be stated that COVID-19 threatened to overwhelm the infrastructure of healthcare systems due to the pressing urgency with which it forced nations to bridge deficits in critical treatment equipment. This swift response required the principle of utility more than autonomy, beneficence, or justice to rise to such a need.[15] However, though utility was called upon, it can be questioned whether it was too easily adapted in both the positive and negative senses. In the healthcare system, structural inequalities were present in allocating scarce resources to certain groups over others based on their chances of surviving treatment, pre-existing morbidities, age, presence or absence of disabilities, racism, etc. Socioeconomically, such biases were observed in that advantaged communities favored utilitarianism, whereas historically marginalized communities did not.[11] A trend that persisted was if any kind of justice, including utilitarianism, was applied to a systematically unequal society, the inequalities would be amplified and further marginalize groups in need.[11] Unsurprisingly, the consequences of such occurrences translated into the healthcare experience, leading patients to distrust physicians and public health officials as they questioned the fairness of implemented resource allocation guidelines in both crisis and non-crisis situations. This demonstrates that the challenge of the pandemic went beyond its biology, and evolved into a sociological consequence, as amplified by mankind's decisions.

Finally, reflecting on whether this situation can be justified and what it would mean to value utility in a way without giving up justice, a complexity emerges in that the bioethical principles can again become blurred. While it is clear that utility is justifiable in the pandemic scenario in which priority is to be given to patients more likely to survive over those less likely to survive, it does not apply along the same vein to non-pandemic scenarios in which enough resources exist to treat all incoming patients at a given time.[13] Egalitarianism is meant to be a norm in non-crisis scenarios, with utilitarianism taking precedence in public health crises to stabilize the situation before falling back to the standard of equal care.[13] Autonomy and egalitarianism do not afford patients the decision to have any treatment they want, but rather those available as specified by their physicians, connecting back to utility and efficient resource allocation at the societal level.[13] Examining this pattern, the realization can emerge that valuing utility without sacrificing justice requires nurturing both stewardship and trust.[18] All public health decisions regarding triaging and prioritizing certain groups must be transparent to facilitate understanding, dialogue,

and trust with the public; messages delivered at massive levels by public health officials must be purposeful and informed, affording credibility to the decision and the decision making process.[18] Inconsistent messages from the healthcare community to the public must be avoided at all costs, and trustworthiness of those addressing the public must be established through actions, rather than promises. During the pandemic, only twenty-six states within the United States had publicly available documents describing how ventilator allocation would occur, if necessary; healthcare workers in France dared not mention their triage policy, perhaps wanting to avoid Italy's turmoil.[4,18] Reflecting on such actions, the way they ferment distrust cannot be justified, because it builds walls between those "in" and those "outside of" the healthcare system, drawing lines where they should not exist. All people have their own health they need to take into consideration, thus being "in" the healthcare system even if they do not work in that sector. Trust and transparency, especially in crisis situations, are important in balancing utility and justice, because if people are aware of what is happening and why, there is a greater chance that they will follow established guidelines and help correct unintentional inequities that may manifest.[18] Inclusivity could restore the trust between the physician and patient, ultimately lasting through times of pandemics and prosperity.

Where Do We Go from Here?

Remembering the bioethical principles of autonomy (an individual's self-determination), beneficence (doing good and not doing harm), utility (producing maximal good over harm), and justice (fairness in individuals getting their due), from here, reflection must turn to lessons to be learned from resource allocation during the COVID-19 pandemic and speculations on conversations to consider for potential future pandemics.[2]

The first important issue that must be addressed is triaging and the benefit of separating front-line clinicians from those making the triage decisions.[9] As shown by the devastation physicians untrained in bioethics felt in making life and death decisions in Italy, the practice of triaging demonstrates the limits that a completely paternalistic healthcare model can stretch.[4] Ethics go beyond a purely medical expertise, and a multidisciplinary, diverse, and active triage committee is needed to help prepare standards, protocols, and priorities of care in advance of ethical challenges so that the burden can be spread throughout society and relieve physicians on the frontlines.[7,9] Rather than constantly being grounded in the past or left to be a problem in the future, issues regarding resource allocations should be constantly discussed and considered fully, and other members of the community, such as triage officials, need to take responsibility for losses experienced so that anger does not remain confined to physicians.[7,9] Separate teams with knowledge of palliative care must consider taking further responsibility for withdrawing individuals from ventilators to promote better management of the crisis so they can be where their skillsets can bring about the most good..[7] Such actions can mitigate physician burnout and positively affect the lives of physicians and the care their patients receive, bridging the seemingly apparent gap between the public and healthcare workers as the decision makers attempt to make sense of the situation.[19] In the future, one can expect continued reflections on effective triaging

protocols and further questions surrounding accountability of decisions made at the start of the COVID-19 pandemic.[4]

Along the lines of triage teams comprising of respected individuals from diverse fields, the importance of inclusivity in garnering public trust and cooperation is not a lesson to be disregarded. To advocate for the values of people of all races and ethnicities, a diversity of community voices is essential for making critical decisions and setting policies.[1] Suspicions that individuals harbor about the mission of the healthcare system will need to be addressed when utilitarianism and justice cross paths, enabling transparency to clear muddled misconceptions and support a united and hopeful society.[1] Practicing medicine without trust misses the hallmark of medical practice; trust will need to be reestablished and facilitated in times of healthcare crisis through public health officials being open to sharing resource allocation and triaging policies, and incorporating public opinions to rectify harbored shortcomings. Thus these health officials will ultimately become trustworthy through serving the best interests of society as a whole.[18] Where mistrust persists, risky behaviors endure, and ironically, those who want least to be entrusted to the healthcare system will be those who end up depending on it the most. If they are marginalized, they could potentially suffer from it.[18] Citizens will not be keen in accepting all imposed restrictions unless healthcare officials are honest about crisis situations, and pointing out the truth does not have to lead to panic as long as ample preparedness persists.[9]

Part of effective preparations will entail increasing the efficiency of healthcare resources, and the need for ventilators, as well as new models brought forth during COVID-19, will be a conversation continuing into the future. Though the ventilator shortage put forth a challenge to the world, unexpected groups, such as auto companies, stepped forward to help bridge the gap.[17] Significantly, promise emerged for widespread, small-scale manufacturing technologies and open source microcontrollers to serve as a means by which to create and mass distribute ventilators.[15] Though their designs will need refinement to become medical grade, and policies will need to be construed regarding how they are handled, efforts in the future will be funneled into establishing and considering their use in low resource settings, including future public health emergencies.[15] With newer, widespread medical equipment easier to produce in the short term, it will ultimately become possible to plan efficient resource allocation, and manage it in times of crises.

Perhaps the most significant lesson learned from the COVID-19 pandemic to consider for future pandemics will be the importance of planning to the greatest possible extent before dire situations unfold. Healthcare systems that are able to plan functionally and proactively have the best chance of appropriately facing public health crises and empowering public health leaders to organize policies in a way that can guarantee fair and consistent access to care for all.[20] With proper planning, a level of "just" utility could be reached through ethically arranging resource allocation and triage committees in ways that would serve the needs of everyone in society, and decisions about policies could be made with a balance of structure and flexibility, so that they could be adjusted as variables surrounding the given situation changed.[18,20] Importantly, at-risk populations could be preemptively identified so that resources could be especially directed towards them, and determinants in society negatively impacting health could be mitigated to the greatest extent

possible.[1] Using past data from the COVID-19 pandemic, regional models projecting the need of a given resource could be used to determine where resources could best be shared to save the most lives possible. Trends before and after flattened pandemic curves could be considered to assess how the effectiveness of resource distribution would vary based on the dependence of infections impacting a community.[12] Finally, the vicious cycle of distrust in the healthcare system could be dissipated. Rather than falling into the pattern of public health officials withholding information, the public feeling distrust, distrusting people engaging in damaging behaviors, landing in hospitals, not getting the care they need in a crisis situation, feeling newfound distrust, and continuing the cycle, proper planning could allow for complete honesty and transparency in addressing existing circumstances. Medicine and healthcare could be guided by justice and beneficence, even in times of crises. Such awareness could be supported by training physicians in bioethics and providing them the necessary skillsets for both championing the physical health of their patients and finding ways to combat inequities. This would ultimately promote a point at which people of all backgrounds could look to healthcare officials with full trust and understanding.

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An Analysis of Inoculation Rates Utilizing Statistical Learning to Validate the Significance of Predictors

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Introduction

Social distancing measures have played a role in slowing down the spread of the SARS-CoV-2 (COVID-19) virus by reducing the close-contact rate of a population. The Smith, Bouquet, and Chin (2020) study, "A Statistical Learning Regression Model utilized to determine predictive factors of social distancing during COVID-19 pandemic," determined what factors influenced social distancing rates in the counties of the State of Florida. The objective of Smith, Boquet, and Chin's research was to define the set of optimal predictor variables for a linear regression model. This was achieved through a statistical learning model method. The first set of models was constructed with just one predictor. The second set of models was created by adding another variable, a third set by adding a third variable, and so on. This process was repeated until the nth level model was achieved. The R^2 and the p-value were recorded from each model and then an optimization process was conducted to produce the most desirable model. The final model

$$y = -5.699 + 0.00061x_1 + (1.10 \times 10^{-5})x_2$$

showed that both county median income, x_1, and county population, x_2, were the most deterministic factors, and had an R^2 of 0.637 and a p-value of 7.383×10^{-14}. In addition, analysis of the coefficient's test statistic indicated that county median income was the most deterministic predictor within the optimal model.

In another study, "Neighbourhood Income and Physical Distancing During the COVID-19 Pandemic in the United States," the authors noted that income had a significant impact on social distancing and gave potential reasons as to why. For example, "Residents of low-income neighbourhoods were more likely to work outside the home, compared to residents in higher-income neighbourhoods" (Jay et al. 2020, 1294). Moreover, at the time of our original research, not much literature was available as the pandemic was in its early stages. However, there is confidence in our conclusions based off of the information obtained from the data and literature available at that time.

The results from Smith, Boquet, and Chin (2020) inspired this research. County population and county median income in the State of Florida were sorted into ranked order and then subdivided into higher and lower levels (COVID-19 Data Tracker n.d.; County Health Rankings & Roadmaps [hereafter CHR&R] n.d.). The Jay et al. (2020) results further justified the economic split of data. The purpose of this research was to investigate if there was a significant difference between the inoculation rates of the counties in the State of Florida when sorted by levels of the two most deterministic predictor variables (county population and county median income of the State of Florida) (COVID-19 Data Tracker n.d.; CHR&R n.d.). Inoculation rates were chosen over the other alternatives related to COVID-19, such as hospitalizations or deaths, because, like Smith,

Boquet, and Chin (2020), the study presented in this article focuses on the preventative methods rather than the virus itself.

For this study, inoculation rates are defined as individuals being fully inoculated either by receiving the two doses from Moderna or Pfizer-BioNTech, or the single dose from Johnson & Johnson/Janssen. The assumptions were as follows:

Income:

Alternative Hypothesis (H_a): $\mu_1 \neq \mu_2$

Null Hypothesis (H_0): $\mu_1 = \mu_2$

where μ_1 is the inoculation rate of counties subdivided with high income and μ_2 is the inoculation rate of counties subdivided with low income

Population:

Alternative Hypothesis (H_a): $\mu_1 \neq \mu_2$

Null Hypothesis (H_0): $\mu_1 = \mu_2$

where μ_1 is the inoculation rate of counties subdivided with high population and μ_2 is the inoculation rate of counties subdivided with low population

The statistical method applied to the data was a two-sample hypothesis t-test for the mean differences on the inoculation rates against the county median income, and then separately on the county population. The results presented are using the most current data at the time this study was conducted (July 2021).

Two-Sample T-Test Analysis

The hypothesis tests were conducted using the routine two-sample t-test. This test compares two samples' means to see if there is a significant difference between them. Most data sets will have some observed difference between their individual means, but the t-test uses a formal statistical analysis to determine if the observed difference is truly significant. Hence, the null hypothesis of a two-sample t-test is that there is a specified difference between the samples' means (typically zero), and the alternative hypothesis states that the difference between the two samples' means is not that specified difference. In this study, the specified difference was zero and the alpha-level, also known as the significance level, was 5%. This means that the null hypothesis was rejected if and only if the test statistic was greater than the t-critical value obtained from the distribution with 95% area within, often referred to as 95% confidence.

The common test statistic (Freund & Wilson, 2003) under the assumption of equal variances was calculated as

$$t = \frac{(\bar{y}_1 - \bar{y}_2)}{s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

where $\bar{y}_1 - \bar{y}_2$ is the difference between the two sample means. The variable n_1 stands for the sample size of the first sample, and n_2 stands for the sample size of the second sample. Also, the

pooled variance, s_p, is "the weighted mean of the two individual variance estimates with the weights being the degrees of freedom for each variance" (Freund & Wilson, 2003).

Once the test statistic was calculated, its absolute value was compared to the t-critical value. The null hypothesis was rejected if it was greater than the t-critical value. The p-value could also be used to determine if the null hypothesis could be rejected. If the p-value was less than the pre-determined alpha level, then the null hypothesis could be rejected (Freund & Wilson, 2003).

Initially, all data was collected from their respective sources. However, the inoculation variable was calculated by dividing the county's fully inoculated rate by the county's population to account for the potential population bias (COVID-19 Integrated County View n.d.). The other two variables (county population and median county income) did not require any manipulation for the scope of this study. The data was sorted by the county population from highest to lowest (COVID-19 Integrated County View n.d.). To create the two samples for the first hypothesis test, the top half was separated from the bottom half. According to Jay et al. (2020), income was discovered to be a significant factor in social distancing in response to COVID-19. Since income was a significant factor in both Smith, Boquet, and Chin (2020) and Jay et. al (2020), the county inoculation rates were sorted accordingly based on county median income to perform a binary split, creating the samples for the second hypothesis test (CHR&R n.d.). Once these samples were created, the hypothesis tests were conducted using the inoculation rates from the samples.

For the population data sets, the test statistic, t-critical value, and p-value were calculated using Microsoft Excel's t-test: Two-Sample Assuming Equal Variances function. The resulting t-critical value was found to be 1.998, and test statistic was 6.92 along with its p-value being 0.0000000027 as shown in Table 1. Since the test statistic's absolute value was larger than the t-critical value, and the p-value was smaller than 5%, the null hypothesis was rejected.

Table 1: The two-sample t-test results for the inoculation rates sorted by county population

Test Statistic	Two-Tail p-value	Two-Tail t-critical
6.924956038	2.70E-09	1.998340543

For the median income data sets, the t-critical value, test statistic, and p-value were calculated using the same Microsoft Excel function. The resulting t-critical value was found to be 1.998, and the test statistic was 6.13 along with its p-value of 0.000000064 (shown in Table 2). Again, since the p-value was less than the alpha-level, and the absolute value of the test statistic was greater than the t-critical value, the null hypothesis was rejected.

Table 2: The two-sample t-test results for the inoculation rates sorted by median county income

Test Statistic	Two-Tail p-value	Two-Tail t-critical
6.131065478	6.35E-08	1.998340543

Interpretation of Results

As the county median income and county population of the State of Florida were the driving factors of social distancing shown in Smith et al. (2020), and income was a significant factor in the study by Jay et al. (2020), the t-tests that were performed on the inoculation rate against county median income, and then separately on the inoculation rate against county population, yielded an alpha-level of 5%. Based on the t-test for the county population, the calculated test statistic (6.92) was found to be greater than the t-critical value (1.998). In addition, the p-value was established to be less than the alpha-level. Therefore, the null hypothesis was rejected. The alternative hypothesis stated that there was a significant difference between the inoculation rates of counties with a high population versus the inoculation rates of counties with a low population. Since the two-sample t-test conducted was a two-tailed test, the test was not biased towards one sample being larger than the other. By looking at the means of the two samples, it was determined that population was positively correlated with inoculation rates due to sample 1 (higher population) having a larger mean at .45 than sample 2 (lower population) at .30 as shown in Table 3. In other words, the counties with a higher population tended to have a greater inoculation rate when compared to the counties with a lower population. This means county population could potentially be used to predict the county inoculation rate (COVID-19 Integrated County View n.d.).

Table 3: The sample means for the inoculation rates sorted by county population

	Sample 1: High Population	Sample 2: Low Population
Mean (μ)	0.453524027	0.298400159

Similarly, the two-sample t-test performed on the inoculation rates of counties with a high median income and the inoculation rates of those with a low median income yielded the same 5% alpha-level (COVID-19 Integrated County View n.d.; CHR&R n.d.). This test resulted in a test statistic of 6.13, which was larger than the t-critical value (1.998). Additionally, the resulting p-value was less than the alpha-level. Therefore, the null hypothesis was rejected, meaning there was a significant difference between the inoculation rates of those Florida counties with a high median income and the inoculation rates of those counties with a low median income. Additionally, the county median income was positively correlated with the inoculation rates, as the high median income sample had a larger mean (.46) than the low median income sample (.30) as shown in Table 4. The counties with a higher median income tended to have higher inoculation rates. Therefore, the county median income could potentially be used to predict the inoculation rates (COVID-19 Integrated County View n.d.; CHR&R n.d.).

Table 4: The sample means for the inoculation rates sorted by median county income

	Sample 1: High Income	Sample 2: Low Income
Mean (μ)	0.455400182	0.303056938

As previously mentioned, county population and county median income were the two most deterministic predictors for social distancing in the study by Smith, Boquet, and Chin, and income was a significant factor for social distancing in the Jay et al. (2020) study. The current study further established that these same two variables made a significant difference in county inoculation rates (COVID-19 Integrated County View n.d.; CHR&R n.d.).

Conclusion

The two-sample t-test was conducted following the steps from Smith (2019). First, the null and alternative hypotheses were defined as $\mu_1 = \mu_2$ and as $\mu_1 \neq \mu_2$, respectively. As customary, the alpha-level was set at 5%. The t-critical value, test statistic, and p-value were then calculated for each t-test. Since the test statistic from both two-sample t-tests were larger than the t-critical value, the null hypotheses were rejected. Therefore, it was found that there was a statistically significant difference between the sample's inoculation rates of the counties with high population and those with low population. In addition, a statistically significant difference was determined between the sample's inoculation rates of the counties with high income and those with low income.

This study could be further developed by studying the observable effects of the virus. Potential variables that could be used to represent COVID-19 include deaths, hospitalizations, and confirmed cases (National Center for Immunization and Respiratory Diseases 2021). Further analysis would need to be done on each factor mentioned to determine which would be the most accurate.

This study could be advanced with a multivariable regression model. The current study demonstrated that county median income and county population could be used as predictors. Social distancing from the year 2020 could also be used as a predictor. Others have created prediction models on inoculation rates as well. For example, a logistics regression analysis was performed in the article, "Individual and Social Determinants of COVID-19 Vaccine Uptake", where it was discovered that "… race/ethnicity, risk perceptions, exposure to different media for COVID-19 news, party identification and confidence in scientists [were] factors that would be affecting COVID-19 vaccine uptake" (Viswanath et al., 2021). Another study, "Unique Predictors of Intended Uptake of a COVID-19 Vaccine in Adults Living in a Rural College Town in the United States," by Lennon et al. (2021) also predicted inoculation rates. However, their study was condensed to a more homogenous data set. They concluded that "the strongest predictors of negative vaccine intentions were worries about unknown side-effects and positive attitudes toward natural infections" (Lennon et al., 2021). Each study was slightly different in its approach and question. However, the studies by Viswanath et al. (2021) and by Lennon et al. (2021) were similar in trying to predict inoculation rates with their own ideas of predictors and models.

The authors of this article would like to see in a future study if a multivariable regression analysis could be used to predict inoculation rates in counties in the State of Florida with county median income, county population, and social distancing as predictive factors. In addition, they would also like to determine, in general, which predictive factor would be the most deterministic using a statistical learning method; however, at current time there are limitations on available data for various reasons, including that the pandemic is ongoing.

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Effect of Isolation on the Recognition of Context-Specific Alarm Calls in a Captive Vervet Monkey (*Chlorocebus pygerythrus*)

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Introduction

Animals use a variety of signals, including physical gestures, chemical signals, and vocalizations to communicate with other individuals. Most of these signals are intended for conspecifics, which can provide a variety of information such as the presence of a predator or the desire to mate (Zuberbühler et al., 1999; Vilet, 1989). Signals can have both simple and complex meanings. Simple signals are used more consistently and serve a simple function, such as a contact call that announces the location of an individual (Greene, 2003). These signals lack specific information, like an intention, situational, and/or referential context. For example, tigers (*Panthera tigris*) chuff as a greeting noise (Mills, 2004). While chuffs serve a purpose in social relationships, they do not communicate specific information about the individual or other aspects of the environment (Walsh et al., 2003). Signals can be more complicated, such as most forms of human language. Most forms of human communication contain detailed and contextual information that a receiver can use to interpret the meaning, which is known as semantic communication. Semantic, or context-specific communication, is a form of complex signals. It refers to the exchange of expressions that carry information and is interpreted consistently within a community (Bowerman & Choi, 2001). A simple vocalization could be a cry, which would communicate distress of the caller. A context-specific signal would occur when someone says "Ouch, my leg!" This expression alerts listeners about pain in the caller's leg. The receiver can then respond with appropriate medical assistance.

While animals are uncritically thought to communicate through simple vocalizations and signals, many species employ context-specific communication (Zuberbühler, 2000). Context-specific, i.e., semantic communication can provide valuable information about the environment and is crucial for many social species' survival and reproduction (Seyfarth et al., 1980a; Marler et al., 1992). Context-specific communication consists of different signal types, and each signal is selectively produced by the sender. Produced signals change depending on the situation or stimuli presented (Crockford & Boesh, 2003). Context-specific signals are given by wild Toque Macaques (*Macaca sinica*) when they adjust their vocalization depending on the quantity of food found in their environment. This signal alerts group members to move to the signal source, which communicates both the location and the quantity of food (Dittus, 1984). Environmental situations that provoke context-specific signals include the presence of resources, group leadership, and potential predators (Dittus, 1984; Seyfarth & Cheney, 2003). These signals can be triggered by auditory, olfactory, or visual information in the environment (Seyfarth & Cheney, 2003).

Alarm calls are a widely used antipredator strategy, recorded in a diversity of taxon including fish, birds, and non-human primates (Templeton et al., 2005; Smith, 1992). These calls are emitted by an animal upon the detection of a predator and can serve to warn conspecifics of

danger and/or ward off a discovered predator (Caro, 2005). The usage of alarm calls is a notable advantage for social animals, as the increase in predator detection greatly decreases predation risk (Hamilton, 1971; Schmitt et al., 2014). While the benefit of alarm calls appears to be consistent across taxa, the information conveyed in alarm calls varies among species. Spotted deer (*Axis axis)* use a simple alarm call that only communicates the presence of some type of predator that is somewhere in the environment. The appropriate response to the situation for spotted deer, to flee or stand still, is not transmitted in the alarm call (Baral, 2015). Rather than containing simple information like a predator's presence, context-specific alarm calls can identify the specific type of predator and, therefore, give receivers the opportunity to respond with the most appropriate antipredator behavior. Black-capped Chickadees (*Poecile atricapilla*) produce context-specific alarm calls to signify the type of potential threats and specify the level of threat through the type of vocalization (Templeton et al. 2005). The alarm calls that Chickadees produce can communicate multiple types of information, such as the nature of a predator and the size of the predator, by adjusting their call type and duration (Templeton et al., 2005). Upon hearing differently structured signals, Chickadees that receive the call can then respond with different intensity levels of mobbing behavior, depending on the predator (Templeton et al., 2005). Non-human primates also utilize context-specific calls as an antipredator strategy. Wild Diana monkeys (*Cercopithecus diana*) produce alarm calls to signal a threat, such as a leopard, and the members of the troop respond differently according to the presence of the specific predator (Zuberbühler et al., 1999).

Vervet monkeys (*Chlorocebus pygerythrus*) display context-specific alarm calls in the wild as an antipredator strategy. These old-world monkeys are found throughout sub-Saharan Africa in woodland areas, dry forests, and savannahs (Stone & Guy, 2017). Vervets maintain stable home ranges in areas that support their semi-arboreal/semi-terrestrial lifestyle (Willems & Hill, 2009). Vervets live in mixed sex and multigenerational groups ranging from five to seventy-six individuals (Cheney & Seyfarth, 1990). These monkeys are also adaptable; they thrive in natural environments as well as urban areas that border forests. In addition, they have been introduced successfully to different areas across the planet, where they maintain stable populations in Florida, Cape Verde, and a few islands in the Caribbean (Hyler, 1995; Dore, 2017).

When a predator is spotted, a Vervet monkey will vocalize an alarm call that corresponds to the predator type that is approaching. The troop then echoes the call and responds in a predator-specific way (Cheney & Seyfarth, 1990). Predators of the Vervet monkey include the leopard (*Panthera pardus*), Martial Eagle (*Polemaetus bellicosus*), and snakes. Each predator elicits a unique context specific alarm call from the monkeys (Seyfarth et al., 1980a). Although slight differences in call structure are seen between age and sex of Vervet monkeys, alarms calls are produced similarly for each type of predator and interpreted consistently (Seyfarth et al., 1980a). An eagle sighting will signal a monkey to produce a bark-like "eagle alarm call," which tells troop members to hide in a bush and scan the sky for an eagle. A snake sighting will elicit a "snake alarm call," and listeners will stand bipedally and scan the ground for the snake (Seyfarth et al., 1980b). When a leopard is spotted, a "leopard alarm call" is produced, where Vervets climb to a weak branch and scan the area for a leopard.

Alarm calls of wild Vervet monkeys can be malleable and change meaning when used in a new environment (Brown et al., 1992). For example, in urban areas, feral dogs can predate Vervet monkeys. Vervets that live in these areas will vocalize a leopard alarm call and climb trees to escape predation from dogs (Seyfarth et al., 1980a). Captive Vervet monkeys will apply context-specific alarm calls to novel situations when living in a predator-free environment (Brown et al., 1992). A captive population of Vervets modified their alarm calls to fit occurrences in their environments, such as giving off an eagle alarm call to airplanes (Brown et al., 1992).

Unlike adults, juveniles produce alarm calls when presented with a greater variety of species, including non-predator stimuli (Seyfarth & Cheney, 1986). Juvenile alarm calls resemble the nature of the context-specific calls. For example, immature animals signal an eagle alarm call for objects located in the air, signal a leopard alarm call for terrestrial four-legged animals, and produce a snake alarm call for snake-like objects (Seyfarth & Cheney, 2003). This behavior is similar to that of human infants, where toddlers may refer to all quadruped mammals as "dog" upon first learning the word (Mandler & McDonough, 1996). Juvenile Vervet monkeys learn to signal the correct calls through reinforcement by members of the troop (Seyfarth & Cheney, 1986). Correctly produced alarm calls are responded to more strongly and yield subsequent alarm-calling by other members along with the physical predation avoidance reaction, while improper or inaccurate signals are ignored (Seyfarth & Cheney, 2003).

Animals in complete social isolation display different physiological and behavioral traits than those reared in groups (Hall, 1998; Palanza, 2001). Dr. Hiroyuki Arakawa found that rats isolated in the juvenile stage displayed much less exploratory behavior than rats isolated in later stages (2003). Additionally, social isolation provokes neural degeneration and increases the risk of Alzheimer's disease in rats (Ali et al., 2017). Even short periods of isolation in Rhesus monkeys decreased their performance on cognitive speed and ability tests (Washburn & Rumbaugh, 1991). At this point, it is clear that captive Vervet monkeys can use context-specific alarm calls (Brown et al., 1992). In addition, naïve captive animals will produce calls, though the calls may not be semantic (Brown, et al., 1992). However, it is unclear how important social interactions and learning may be in recognizing and responding to the context-specific nature of Vervet monkey alarm calls.

This study examines the response of a socially isolated captive male Vervet monkey ("Ross") to context-specific antipredator alarm calls. If there is a strong genetic component, then this subject should recognize each alarm call type and respond in a predator-specific way (table 1). If this is the case, then the subject is expected to scan the sky and take cover when the eagle alarm call is played. The snake alarm call would cause the subject to stand bipedally and scan the ground. The leopard alarm call would make the subject scan the area and climb to a weak point. If there is a strong environmental and/or learning component, then an isolated monkey will not be expected to respond to calls as observed in social, wild, and captive populations. While this study is limited to a single subject and the results may reflect the particular experiences of this case study, the existence of Ross who had been isolated from other Vervet monkeys since birth provided an extremely rare opportunity to study the recognition of semantic signals.

Methods

Subject – The subject of this case study, "Ross," is an isolated captive Vervet monkey at the Octagon Wildlife Sanctuary in Punta Gorda, Florida. Octagon Wildlife Sanctuary is a 501(c)(3) exotic animal sanctuary that houses more than 100 animals on a 4-hectare reserve. Animals at the sanctuary arrive because of illegal ownership or abusive situations and are held in individual or group cages, depending on the species and situation. Species at the sanctuary range from non-native Bengal tigers and peafowl to native panthers and native-exotic coyotes. At the time of the study, Ross was an adult male (30 years old) and was previously kept in a facility in Sanibel, Florida, where he was socially isolated from a young age until confiscated by the United States Department of Agriculture and brought to Octagon Wildlife Sanctuary in the early 2000s. Once at the sanctuary, Ross was kept in an isolated cage as he was the only Vervet monkey at the facility.

Ross was fed a diet of fruits, vegetables, and chicken and was given a meal once a day. He occasionally got treats (nuts, raisins, etc.) in easy-to-open packaging as a form of enrichment. Additionally, there was a television playing children's shows during the day that Ross was able to watch. He was provided toys to play with, such as stuffed animals, balls, or baby toys. His enclosure was composed of a framed, chain-ink fence that was exposed visually on top with direct view to the sky above. Three of four sides were also exposed. The fourth side was covered with a mesh material that obstructed Ross' vision in that direction. The dimensions of his enclosure were 9.7 x 4.8 x 3.6 meters with two sections connected with a small door. This could be opened and closed by volunteers as needed to keep Ross on one side to clean his enclosure, which was cleaned three times a week. He had numerous shelves to climb on, a slide, a swing, and different hides to sleep in or escape from the sun (Fig. 1).

Prior to this study, there was no evidence that Ross had ever heard or seen another Vervet monkey since being weaned from his mother. His enclosure was next to an adult male Hamadryas baboon (*Papio hamadryas*). There were other animals living at the sanctuary or that lived in the area that could engage Ross, including the exposure to interspecific alarm calls. Among the animals at the facility that were similar to natural predators, there was an adult female Melanistic leopard (*Panthera pardus*), which Ross never saw but could hear. There were also a variety of Florida native and non-native snakes that frequented the sanctuary, such as Eastern Rat snakes (*Pantherophis alleghaniensis*) and Black Racers (*Coluber constrictor*), which Ross had likely seen and heard. Similarly, Ross could have seen and heard European Starlings (*Sturnus vulgaris*), Bald Eagles (*Haliaeetus leucocephalus*), and other birds that flew overhead.

Procedure – Data was collected in a playback experiment from March through June 2021. The subject was exposed to a set of five prerecorded signals to observe his behavioral response to different calls. Three signals consisted of alarm calls that Vervet monkeys made in response to different predators: an adult male monkey that called in response to a leopard; an adult female monkey that called for an eagle; and an adult female monkey that called for a snake, henceforth referred to as "leopard," "eagle," and "snake" alarm calls, respectively. Audio calls of wild Vervet monkeys were obtained with permission from Dr. Cheney and Dr. Seyfarth's website (https://web.sas.upenn.edu/seyfarth/vocalizations/vervet-monkey-vocalizations/). Ross was also

exposed to two control signals. The first was a social vocalization from an adult female Vervet monkey, which served as a non-alarm Vervet monkey call and could be used to determine whether Ross could distinguish between alarm and social calls. The other control signal was an aggressive alarm call of a European Starling, which Ross had likely heard before and served as an interspecific alarm call. The sex of these pre-recorded calls were not standardized. Vervet monkeys are known to respond equally to both male and female calls; sex of the alarm caller has no effect on the listener's response (Seyfarth et at., 1980b).

To minimize the influence of the researcher, Ross was allowed to habituate to the researcher's presence each day before a trial was run. Habituation was determined when Ross stopped directing his attention to the researcher. Habituation took anywhere from two to ten minutes. Once accustomed, each trial lasted ten minutes. The first five minutes of each trial was spent recording Ross' behavior before a signal was played. One of five signals was then played. Each signal was repeated seven times for a duration of ten seconds. This approach kept the repetition and signal length consistent and mimicked the multiple iterations of alarm calls seen in wild Vervet monkeys (Owren & Bernacki, 1998). Calls were played at an average of 82 db at the source of the speaker. The moment the signal started was considered "after" and Ross's behavior was then recorded for an additional five minutes, which concluded a trial. The behavior patterns of the captive Vervet monkey were recorded via Nodlus's Pocket Observer (2018) app on an Android tablet. An ethogram (table 2) was created by modifying previously published ethograms (Petrů et al., 2009) and was used to classify Ross's behaviors and locations around his enclosure (fig. 1).

Because of the extraordinary ethical and logistic considerations that were required to conduct this study, the experiment was limited to a single animal. At the time of the study, Ross was the only known Vervet monkey to have been raised in isolation from other Vervets since birth, resulting in a single-animal case study. Ross was exposed to each of the five signals once before being re-exposed to a signal. In this study, replicate describes the number of times that Ross was heard each of these five signal types and not the number of sampled animals. Within each replicate, the order of signals that were presented to Ross was randomized. Signals were broadcast from a movable speaker outside of his enclosure. The speaker was placed in inconspicuous "left", "right", or "center" location, which was selected at random for each trial. The speaker was roughly two meters from the front of the enclosure at any given time. A total of nine replicates were conducted in this study in which Ross was exposed to the five call types. To reduce the possibility that Ross habituated to the signals, replicates were repeated only after ten to fourteen days elapsed between observations. The study concluded when Ross started to show health problems, presumably associated with age.

Data analyses – The behavioral data was processed with the computer software Observer XT 14.4 (Noldus Information Technology). Statistical tests were run on R (R Core Team, n.d.). The lmPerm package was used to run permutated ANOVAs, with a maximum of 5000 iterations or until the p-value was resolved (Wheeler & Torchiano, 2016). A permutated test compares measured values to randomized resampled iterations of the same data, where the p-value describes

the proportion of times where randomized mean sum of squares exceeded the measured mean sum of square value. As a result, F-values and degrees of freedom are not used to calculate the p-value and are therefore not reported. Statistical patterns were described for $a \leq 0.05$. Medians and inter-quartile ranges (IQRs) were reported for the central tendencies and variations because the data was not normally distributed. The median describes the center value of the distribution and IQR describes the range between the first and third quartile. Figures were created with the ggplot2 package (Whickham, 2016).

Results

Evaluation of Methodology – To determine whether the research design affected Ross's behavior, hiding behavior was evaluated in response to external factors, as hiding suggested a fear response (Blackwell et al., 2013). Ross may have been expected to sensitize to the playback experiment if the alarm calls produced a fear response. If sensitization occurred, then Ross would show more hiding with each replicate. This was not the case; Ross did not show progressively more hiding over time. However, replicate seven showed more hiding both before and after the signal was played, suggesting that Ross may not have responded to the experiment in this replicate (Iterations = 5000, $p < 0.001$). Data analyses were conducted both with and without the seventh replicate to address any issues that may have emerged with this part of the study.

The order that each signal was played in a replicate did not appear to affect Ross. Signal order did not have a significant interaction with the percentage of time Ross spent hiding (Iterations = 162, $p = 0.994$). For example, the first signal played within a replicate (*a*) produced a similar hiding response as the fourth signal (*d*) played in the replicate. Ross spent 2.25% (0% - 38.8% IQR) of time hiding after signals in position *a* were played and 0% (0% - 17.2% IQR) of time spent hiding after signals in position *d* were played.

Ross's behavior was not affected by other aspects of the methodological design. The percentage of time that Ross spent oriented towards the researcher was not affected by the procedure. Ross spent a similar amount of time oriented towards the researcher independent of the signal played (Iterations = 1635, $p = 0.401$). In addition, there was no interaction between the timing of the playback experiment (i.e., before versus after the signal) and the type of signal that was played (Iterations = 236, $p = 0.309$). For example, Ross's focus on the researcher was 0% before the leopard call was played (0% - 0% IQR) and was 0.89% (0% - 4.98% IQR) after the call. Similar results were found for the other signals; Ross showed similar amounts of time oriented towards the researcher before and after the signal was played. This indifference to the researcher was maintained after the seventh replicate was removed from the analysis (Iterations = 758, $p = 0.5343$).

Vervet Recognition – The percentage of time that Ross spent oriented toward the speaker showed a significant interaction between when the signal was played and the type of signal that was played (fig 2a: Iterations = 5000, $p < 0.001$). Ross spent more time oriented towards the speaker after the Vervet social vocalization was played. He spent 0% (0% - 0% IQR) of time directed towards the speaker before the Vervet social signal and 3.26% (1.31% - 4.77% IQR) after

the signal. Ross did not orient towards the speaker more after the other signals were played. For example, Ross spent 0% (0% - 0% IQR) before the snake alarm call was played and 0% (0% - 0% IQR) after the snake alarm call was played. Like the snake alarm call, the remaining signals did not show a significant increase in orientation toward the speaker after they were played. The removal of the seventh replicate produced a similar significant interaction between the signal was played and the signal type (Iterations = 5000, $p < 0.001$).

Ross spent more time scanning after the Vervet monkey alarm calls were played than either the Vervet monkey social call or the European Starling alarm call. The percentage of time that Ross spent scanning showed a significant interaction between when the signal was played and the type of signal that was played (fig 2b: Iterations = 5000, $p < 0.001$). For example, Ross spent 0% (0% - 0.53% IQR) of his time scanning before the eagle alarm call was played. After the eagle alarm call was played, he increased his scanning to 13.5% of the time (6.25% - 16.6% IQR). Ross showed similar increases in scanning after the other two Vervet alarm calls were played (i.e., snake and leopard). The control signals, however, did not produce a similar response; Ross showed similar levels of scanning before and after the European Starling and Vervet social calls. Increased scanning in response to the three alarm calls was still observed after removing the seventh replicate (Iterations = 5000, $p < 0.001$).

Context-Specific Alarm Calls – While Ross appeared to recognize Vervet calls and responded differently to social and alarm calls, Ross did not appear to understand the context-specific nature of the alarm calls. For example, Ross did not show the predicted response to the snake call. Ross never stood bipedally even after hearing the snake call. While Ross stood quadrupedally during the study, there was no interaction between the time Ross spent standing quadrupedally and the type of signal (fig. 2c: Iterations = 119, $p = 0.950$). All call types produced a similar percentage of quadrupedal standing behavior both before and after signals were played. For example, Ross' median quadrupedal standing was 4.57% (0.77% - 32.6% IQR) of the time before the snake alarm call. After the signal was played, Ross stood quadrupedally for 1.73% (0% - 31.0% IQR) of the time. A similar response was observed after the removal of the seventh replicate (Iterations = 106, $p = 0.906$).

In addition, Ross did not show the expected response after the eagle alarm call. The amount of time that Ross spent hidden in his house did not show a significant interaction with when the signal was played and the type of signal (fig. 2d: Iterations = 175, $p = 0.943$). Ross spent similar amounts of time in his house before and after all signal types. For example, both the snake alarm call and the eagle alarm call had a median of 0% (snake: 0% - 1.54% IQR; eagle: 0% - 0% IQR) of time spent in the house before the signals were played. After the signals were played, both had a median percentage of time spent in the house of 0% (snake: 0% - 4.27% IQR; eagle: 0% - 0% IQR). The same pattern was observed after the seventh replicated was removed from the analysis (Iterations = 953, $p = 0.668$).

Finally, Ross did not respond as predicted to the leopard call. The percentage of time that Ross spent elevated did not show a significant interaction between when the signal was played and the type of signal that was played (fig 2e: Iterations = 60, $p = 0.883$). Ross spent similar amounts

of time elevated before and after signals were played and similar amount of time elevated in all signals, even though Ross was expected to be in an elevated position more after the leopard call. For example, Ross spent 69.6% (60.5% - 99.7% IQR) of time elevated before the leopard alarm call was played and 98.7% (50.2% - 99.0% IQR) of time elevated before the European Starling signal was played. After the signals were played, Ross spent 66.9% (11.4% - 100% IQR) of time elevated for the leopard and 100% (4.39% - 100% IQR) of time elevated after the Starling. A similar pattern was observed after the seventh replicate was removed (Iterations = 51, $p = 1.000$).

Discussion

This research outlined the degree to which an isolated Vervet monkey could interpret wild Vervet alarm signals. Ross was able to recognize calls produced by Vervet monkeys while ignoring a control call, suggesting that he could distinguish Vervet produced signals from others despite his isolation. The only time that Ross oriented towards the speaker was after the social Vervet signal was played. Ross' orientation toward the source of the social signal suggests that he may have been looking for a paired facial expression from the signaler. Non-human primates rely on facial expressions and visual cues as much as vocal communication (Hauser et al., 1993). Facial expressions and vocal communication are often used simultaneously, such as an open mouth paired with a threat call in Rhesus monkeys (*Macaca mulatta*) (Houser et al., 1993).

Ross also appeared to understand alarm calls when they were produced by Vervet monkeys. Ross showed increased scanning after all three Vervet alarm calls, adopting a behavior that suggested increased vigilance. Wild Vervet monkeys will scan the area upon hearing alarm calls (Seyfarth et al., 1980a). This response is similar to other animals that will scan their environment in search of a predatory threat after hearing an alarm call. Coots (*Fulica altra*) increased their vigilance after hearing conspecific alarm calls (Randler, 2006). Though specific directions of Ross's vigilance were not recorded in this study, the increase in general scanning after the alarm calls suggests that Ross recognized the "alarm" nature of alarm calls.

There was no evidence that Ross responded to the European Starling signal, despite being exposed to this call throughout his life. Ross may have ignored the European Starlings because he may have habituated to their signal. These Starlings live in the area, and Ross had likely heard the signal previously. In addition, Ross was not threatened with predation when he heard the Starlings call. He could have learned to ignore the signal. Alternatively, European Starling signals may not contain useful information to Ross, or Vervets in general. This indifference is not the case for all interspecific signals that Vervets hear, however. In Amboseli National Park, Kenya, wild Vervet monkeys respond to the alarm calls of the Superb Starling (*Spreo superbus*), which produce two context-specific calls that Vervets recognize (Cheney & Seyfarth, 1985). One alarm call is given to raptors, which prey on Vervets. After hearing this call, Vervets will respond to this call by looking up and scanning the sky (Cheney & Seyfarth, 1985). Finally, Ross may not have recognized the information in the European Starling signal as these species never co-existed or co-evolved. Together, these findings suggest that vocal recognition in Vervet monkeys may be an innate ability that does not require a social environment. Ross was able to distinguish between

Vervet and non-Vervet calls. He also responded in an antipredator way to the Vervet alarm calls and appeared to examine the source of the social Vervet call, suggesting he could distinguish between the social and alarm call.

Ross, however, showed no evidence that he understood the context-specific nature of the alarm calls, as he did not show a predator-specific response to each alarm call. In Vervet monkeys, individual alarm calls communicate a specific meaning that is associated with a response that reduces the animal's predation risk (Seyfarth et al., 1980a). For example, Vervets produce the predator-specific alarm call when a snake is seen, which would cause other Vervets to stand up on their hind legs and scan the ground (Seyfarth et al., 1980a). Ross, however, did not display the predicted context-specific response to each type of alarm call. Instead, Ross responded to each call in the same generalized way. If Ross was able to recognize the context-specific nature of the alarm calls, then he would have shown behavioral differences that corresponded to each predator. Recognition of the snake alarm call would cause Ross to spend more time standing bipedally and quadrupedally while scanning the ground after the call (Seyfarth et al., 1980a). In contrast, Vervet monkeys that live in social groups respond to the calls appropriately by using a different set of behaviors in response to the calls. While Ross increased scanning after the snake call, he never stood in a bipedal position and showed no changes in quadrupedal standing. Spending more time hiding and scanning the sky following the eagle call would have demonstrated an appropriate response to the eagle call (Seyfarth et al., 1980a). Instead, Ross simply increased his percentage of time scanning the general area. In addition, Ross would have been expected to move to an elevated position on a weak perch if the leopard call was understood (Seyfarth et al., 1980a). When Ross heard the leopard call, however, he only showed an increase in scanning the area.

There was no evidence that this isolated captive Vervet monkey understood the context-specific nature of the alarm calls. Ross' inability to show predator-appropriate responses to each alarm call could be because Ross never learned the alarm calls. Calls most likely need to be learned from conspecifics. While learning comes in many forms, social learning, such as observation, mimicry, and reinforcement, likely plays a role in learning alarm calls. The Song Sparrow (*Melospiza melodia*) learn their songs through listening to other birds and imitating the song (Marler & Peters, 1987). In human infants, their cries are reinforced with caring behavior from caregivers, which teaches the infants the effect of their cry (Rheingold et al., 1959). In wild populations, Vervets appear to use a combination of observation, mimicry, and reinforcement to produce and respond to calls correctly (Seyfarth & Cheney, 1986; Seyfarth & Cheney, 2003). It is possible that Ross could have learned and then forgotten these calls over time. He might have heard his mother using the alarm calls and learned their meaning before being weaned but then forgot them after he was isolated. If this were the case, then he forgot the context-specific meaning of the calls. However, this is unlikely to be the case because Ross was in captivity his entire life and was never exposed to predators. As a result, there is little evidence to suggest that his mother ever made these calls. In addition, it takes years for Vervets to learn alarm calls; it is not simply done before weaning (Seyfarth & Cheney, 1986). Since Ross lived in an environment with no predators, this may have influenced his ability to recognize and respond to predator-specific calls.

Ross also could have recognized the calls but decided not to expend much energy in a response. Because Ross repeatedly heard the call and failed to see a predator, he may have responded with just the scanning behavior rather than the appropriate antipredator response. This may be due to a lack of reliability in the caller. Ross had heard the same three alarm call multiple times and failed to see a predator associated with the call. Vervet monkeys ignore unreliable signalers (Cheney & Seyfarth, 1988). This occurs when individual monkeys use alarm calls in inappropriate situations. In these cases, the other monkeys in the troop will begin responding with minimal effort to the unreliable individual (Cheney & Seyfarth, 1988). Before data was officially collected, about a month and a half of pilot trials were conducted that were used to develop appropriate methods. It is possible that Ross had deemed the signals unreliable after pilot trials, as he had heard the calls multiple times without seeing an associated predator. While no concrete data was collected at this point, Ross initially showed an increase in scanning and rapid movement around his enclosure after the leopard alarm call was played. He then began to show less movement after a few trials, but still displayed the scanning behavior. This change in response to the alarm calls, though, is likely due to habituation and not caller's unreliable use of a context-specific call. This is because Ross still failed to show predator-specific responses to the alarm calls during the pilot trials.

This study was based on the response of a single animal and may represent the individual conditions of the animal rather than a general response of context-specific communication in isolated Vervet monkeys. While Ross appeared to understand some aspects of the different signals, other isolated monkeys may have responded differently to the predator-specific calls, showing more or less understanding. For example, the immediate environment may have influenced Ross' response relative to a different isolated monkey. Ross may have been uniquely desensitized to the signals because he was housed near potential predators that he could hear and see in some cases. If the immediate surroundings were influential, then he may have ignored the context of the alarm calls because he had never experienced a direct predation risk. Alternatively, Ross' personality may have affected his response to the context-specific nature of the different alarm calls. Non-human animals show personality differences that reflect behavioral tendencies unique to individuals and remains consistent across contexts and over time (Caspi et al., 2005; Reale et al., 2007). For example, individual-specific personalities are found in fish (Overli et al., 2005), birds (Groothuis & Carere, 2005), and mammals such as mink and elephants (e.g., Malmkvist & Hansen, 2002; Grand et al., 2012). In Capuchin monkeys (*Sapajus xanthosternos*), individuals show variation in their vigilance behavior that is correlated with the personality traits of assertiveness and aggressiveness (Fernández-Bolaños et al., 2020). Personalities affect the way that individuals respond to different situations. Ross's personality could have affected the way that he responded to alarm calls with vigilance. The degree to which personality affects how Vervet monkeys respond to conspecific signals remains to be determined in both wild and captive situations.

Despite any limitation, the ability to replicate this study with different isolated Vervet monkeys is highly unlikely. Vervet monkeys are a social species that are rarely kept in complete isolation. As a result, examining how context-specific signals are perceived by isolated animals requires the case-study approach used in this study. This case-study approach can be particularly

valuable when studying rare animals and/or uncommon situations (Metcalf et al., 2021; Shrader-Frechette and McCoy, 1993). For example, the Florida panthers (*Puma concolor*) was exceptionally rare in the 1990 with as few as 19 animals remaining in southwest Florida (Frechette & McCoy, 1993). These animals were also widely distributed across the region, making the collection of a large dataset that would be typical for wildlife research impossible. To address this challenge, Shrader-Frechette and McCoy adopted a case-study approach to examine the animal and develop an efficient management strategy for the panther (1993) that led to improved conservation of the population. According to the Florida Fish and Wildlife Conservation Commission (2017), there are now approximately 120 to 230 animals roaming southern Florida, which testifies to the success of this approach. Ross was isolated socially from birth and this circumstance provided a unique opportunity to understand semantic communication that would not have been available otherwise. Ross was perfect case-study for this experiment because of the likelihood that he never heard context-specific calls and never observed appropriate responses previously.

Ross' responses also illustrate how conspecific signals could be used as a form of enrichment to the benefit captive animals, including those that are isolated from conspecifics. Enrichment seeks to enhance a captive animal's mental wellbeing by providing appropriate stimuli (Shepherdson & Mellen, 1999). Providing enrichment to animals is beneficial for numerous reasons, including increased reproductive behavior and overall physical activity (Carlstead & Shepherdson, 1994; Chamove et al., 1982). Enrichment strategies used for captive animals include rearranging enclosures, cognitive challenges, and encouraging appetitive behaviors (Carlstead & Shepherdson, 2000). In Ross' case, he was provided with toys, children's shows from a television, and different food as forms of enrichment. Environmental enrichment is a special type that attempts to manipulate an animal's captive environment to support normal/wild behavior (Carlstead & Shepherdson, 2000). For example, wild chimpanzees (*Pan troglodytes*) use sticks as tools for digging in termite mounds. Providing artificial termite mounds in an enclosure as an environmental enrichment can encourage their natural behavior (Gilloux et al., 1992). Environmental enrichment can include auditory, olfactory, and visual signals (Carlstead & Shepherdson, 2000). Playing Vervet signals appeared to provide Ross with auditory environmental enrichment, as it simulated a natural response. Playing conspecific calls may be particularly valuable to isolated animals like Ross. Vervet-produced signals elicited interest from Ross and caused him to engage with his environment, as he displayed increased orientation to the source of the signal.

Acknowledgements

Research was conducted under FGCU IACUC Protocol ID # 2021-02. I would like to thank the volunteers at Octagon Wildlife Sanctuary, including Dee Steiner for helping me with photographs, caring for Ross, and being all around supportive. I would additionally like to thank the owner of Octagon, Lauri Caron, for allowing me to conduct my research there and providing me with

information about Ross. I would like to thank my mentor, Dr. Charles Gunnels IV, for constant guidance, advice, and unwavering support throughout my study. I am thankful for assistance and feedback from the members of the Animal Behavior Research Group through the entire process, especially Madison Hoyle, Alex Marsh, Matt Metcalf and Samantha Troast. I am so grateful for support from Dr. Minh Nguyen, Dr. Clay Motley, and the entire Honors College at Florida Gulf Coast University. I would also like to thank those who provided integral insight into my research process, including Dr. Deborah Misotti, Dr. Joyce Fassbender, and Dr. Terumi Rafferty-Osaki. Thank you to the staff and mentors of the ACE program at FGCU, who continued to encourage me throughout the process of my research. I would like to thank my friends and family, especially my parents, Maura and Sami Guedouar. Lastly, a big thank you to Ross, the Vervet monkey.

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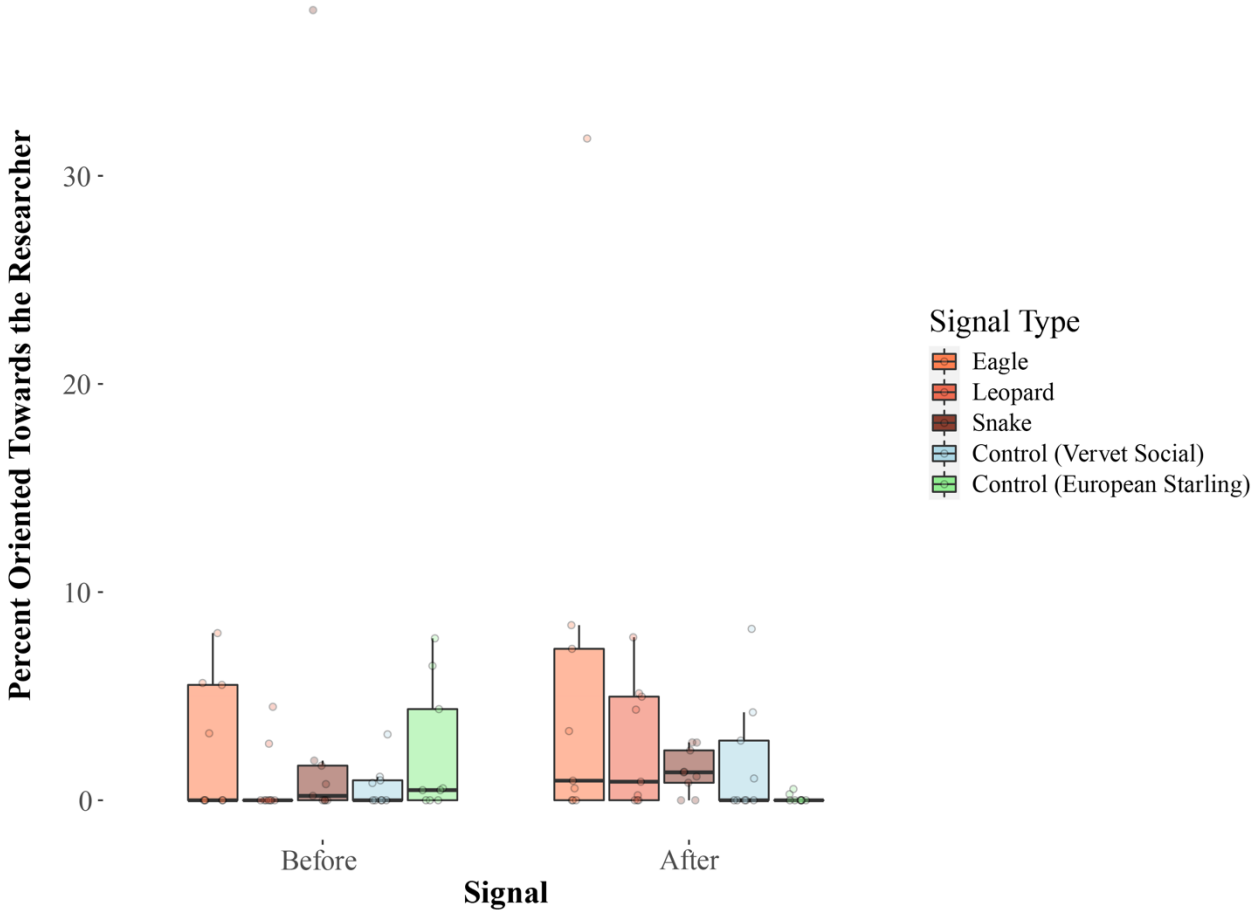
Figure 1: Ross's enclosure from the front view, the researcher's perspective.



The bold line in each box shows the median value and the upper and lower edge of the box show the 75th and 25th quantile respectively. Dots represent individual data points.

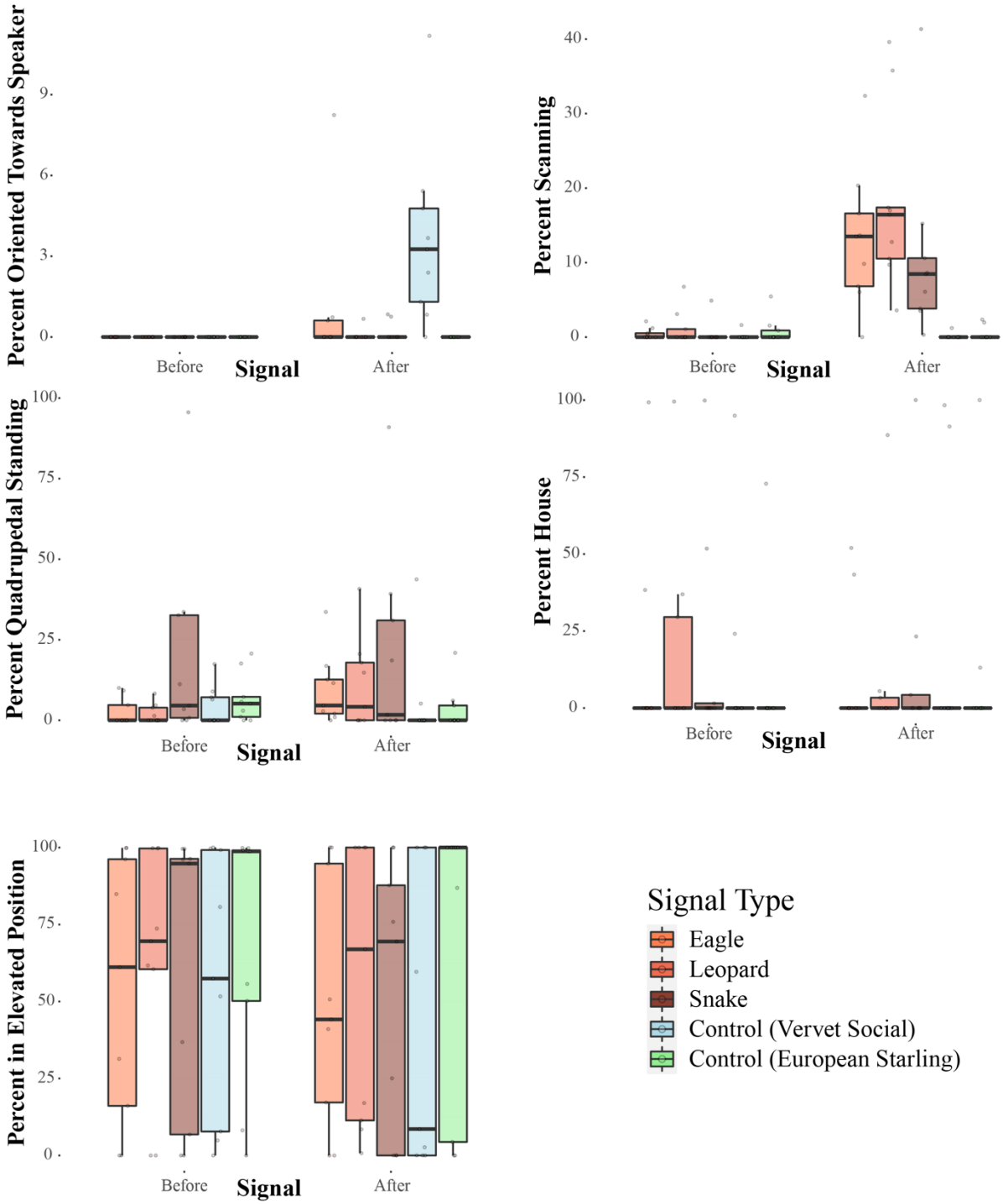


Figure 3: These figures show the percentage of time Ross spent engaging in different behaviors in response to the five signal types: a) oriented towards the speaker, b) time scanning, c) quadrupedal standing, d) positioned in the house, and e) positioned in an elevated perch.

The bold line in each box shows the median value and the upper and lower edge of the box show the 75th and 25th quantile respectively. Dots represent individual data points.

	Snake Alarm Call	**Eagle Alarm Call**	**Leopard Alarm Call**
Recognizes alarm call, not predator type	Display signs of distress, such as surveying the area, rapidly running around enclosure, or hiding	Display signs of distress, such as surveying the area, rapidly running around enclosure, or hiding	Display signs of distress, such as surveying the area, rapidly running around enclosure, or hiding
Recognizes predator call, not alarm nature	Scans the ground for a snake	Looks up at the sky for an eagle	Looks around the area for a leopard
Recognizes both	Stands up in quadrupedal or bipedal position and scans the ground in efforts to spot and avoid the snake	Scans the sky for an eagle and takes cover under a ledge or inside a hut	Scans the surrounding area, climbs to high, difficult to reach point in enclosure
Does not recognize nature of the call	Behaves as normal, no reaction	Behaves as normal, no reaction	Behaves as normal, no reaction

Table 1: Predictions of Ross's behavioral response to the alarm calls.

Behavior	**Definition**	**Prediction**
Elevated	The duration of time spent on a platform above the ground	Increase after leopard alarm call if there's an understanding
House	The duration of time spent inside the house and completely out of sight	Increase after eagle alarm call if there's an understanding
Quadrupedal Standing	The duration of time spent upright with all four limbs contacting a surface	Increase after snake alarm call if there's an understanding
Bipedal Standing	The duration of time spent upright with the hind legs contacting a surface	Increase after snake alarm call if there's an understanding
Scanning	The duration of time oriented to multiple locations in rapid succession	Increase after alarm calls if there's an understanding
Researcher	The duration of time oriented towards the researcher	Increase if Ross response to the experimental methods
Speaker	The duration of time oriented toward the speaker	Evidence of methodological issues if Ross orients to the speaker after all signals are played. Evidence of interest if Ross orients towards the speaker after some of the signals are played.

Table 2: An ethogram of vervet monkey behaviors observed used to assess Ross's behavior before and after calls were played. Adapted from Petrů et al. (2009).

The Use of Hyperbaric Oxygen Therapy to Treat Necrosis and Open Wound due to Ionizing Radiation

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University of Central Florida

Introduction

Radiation is invaluable for the treatment of tumors but causes detrimental effects on surrounding healthy tissue because ionizing radiation is nonspecific to its target.[1] Damaged tissue is slow to heal and may lead to infection, chronic ulceration, and decreased quality of life.[2] Wounds may develop from radiation therapy for cancers growing close to or on the skin, like melanoma. Clinically approved approaches are needed to regenerate tissue and close wounds after ionizing radiation treatment. Surgical intervention is commonly performed for wound closure post-radiation, but it has a high chance of developing infection.[3] Hyperbaric Oxygen Therapy (HBOT) is a treatment currently being used for patients with ulcers, burns, diabetes-related wounds, infections, crush injuries, and other wounds, but requires further research to confirm its reliability on radiation-induced wounds.[4] HBOT is a safe treatment that, unlike surgical intervention post-radiation, mitigates infection and disfiguring of the skin.[5]

Figure 1: *Hyperbaric Oxygen Chamber.*

This case study was conducted on a patient who underwent HBOT for a wound developed from radiation. This patient was diagnosed with melanoma above their left ankle and underwent radiation for treatment. After a successful cancer treatment, the patient suffered from sequela necrosis and an open wound that measured 3cm by 2cm with 30% slough. These effects were presented to the Ocala Infectious Disease and Wound Center (OIWC) and were prescribed 40 sessions of continuous 90-minute HBOTs at 2.0 ATA (atmospheres absolute) for a duration of 10 weeks. The size of the patient's wound and percent slough was measured on a weekly basis to determine the effects of HBOT. A successful treatment of HBOT would be represented by a

[1] Bernstein EF, Sullivan FJ, Mitchell JB, Salomon GD, Glatstein E. "Biology of Chronic Radiation Effect on Tissues and Wound Healing," Clinics in Plastic Surgery. 1993 July; 20(3):435–353. PMID: 8324983.
[2] Dormand EL, Banwell PE, Goodacre TE. "Radiotherapy and Wound Healing," International Wound Journal. 2005 June; 2(2):112-27. doi: 10.1111/j.1742-4801.2005.00079.x. PMID: 16722862.
[3] Webb LX. "New Techniques in Wound Management: Vacuum-Assisted Wound Closure," Journal of the American Academy of Orthopedic Surgeons. 2002 Sep–Oct;10(5):303–311. doi: 10.5435/00124635-200209000-00002. PMID: 12374481.
[4] John Hopins Medicine. "Hyperbaric Oxygen Therapy for Wound Healing," https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/hyperbaric-oxygen-therapy-for-wound-healing. Accessed November 1, 2021.
[5] Thackham JA, McElwain DL, and Long RJ. "The Use of Hyperbaric Oxygen Therapy to Treat Chronic Wounds: A Review," Wound Repair and Regeneration. 2008 May–Jun;16(3):321–330. doi: https://doi.org/10.1111/j.1524-475X.2008.00372.x

decrease in both wound size and in percent slough. Thus, HBOT may offer a safer and reliable alternative to radiation-induced wound closure.

Background

The first successful use of Hyperbaric Oxygen Therapy (HBOT) was in 1941 by the U.S. Navy Diving School. At the time, HBOT was used to treat decompression sickness suffered by deep sea underwater divers.[6] With a prescription from a healthcare provider, this therapy works by having a patient sit in the HBOT chamber and breathe in oxygen pressurized between 1 to 3 ATA (atmospheres absolute) for up to two hours. This therapy was proven to treat carbon monoxide poisoning, clostridial myonecrosis, osteoradionecrosis, and other conditions.[7]

Surgical intervention is the most common approach to close radiation-induced wounds, but results in further disfigurement of the skin and has a high chance of developing infection.[8] This case study was directed on a patient who did not undergo surgical intervention of melanoma nor any post-radiation treatment of their wound before HBOT. HBOT is a treatment currently being used for patients with ulcers, burns, diabetes-related wounds, infections, crush injuries, and other wounds.[9] These chronic wounds worsen due to poor blood supply and low oxygen delivery to the wound bed. HBOT has been used to improve oxygen supply to the wound and speed up healing.[10]

For the treatment, patients prescribed with HBOT are asked to wear a medical gown and lie in the HBOT chamber between 30 minutes to 2 hours, depending on the physician's prescription. The chamber is sealed and pressurized with oxygen higher than sea level air pressure. The patient breathes in pressurized air and the wound bed is surrounded with pressurized oxygen that is required for the wound to heal. The treatment duration and the air pressure depend on the size and severity of the wound.[11]

Although HBOT is prescribed for wound healing, further research is required to confirm HBOT success in closing wounds entirely. A study in 2015 concluded that HBOT has shown to cause reduction in ulcers within six weeks of the treatment by an average of 33%.[12] However, the authors suggested that a longer study is needed to ensure HBOT success in treating open wounds entirely. Rather than six weeks of HBOT in that study, the present case study was for a duration of ten weeks.

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[6] Davis JC, Sheffield PJ, Schuknecht L, Heimbach RD, Dunn JM, Douglas G, Anderson GK. Altitude Decompression Sickness: Hyperbaric Therapy Results in 145 Cases. Aviation, Space, and Environmental Medicine. 1977 August; 48(8):722–730. PMID: 889546.

[7] Leach RM, Rees PJ, Wilmshurst P. Hyperbaric Oxygen Therapy. British Medical Journal. 1998 Oct 24;317(7166):1140–1143. doi:10.1136/bmj.317.7166.1140.

[8] Linos E, Swetter SM,Cockburn MG, Colditz GA, Clarke CA. Increasing Burden of Melanoma in the United States. Journal of Investigative Dermatology. 2009 Jul;129(7):1666–1674. https://doi.org/10.1038/jid.2008.423.

[9] John Hopkins Medicine. Hyperbaric Oxygen Therapy for Wound Healing. https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/hyperbaric-oxygen-therapy-for-wound-healing. Accessed November 1, 2021.

[10] Thackham JA.,McElwain DL, and Long RJ. "The Use of Hyperbaric Oxygen Therapy to Treat Chronic Wounds: A Review," Wound Repair and Regeneration. 2008 May–Jun;16(3):321–330. doi: https://doi.org/10.1111/j.1524-475X.2008.00372.x

[11] Kranke P, Bennett MH, Martyn-St James M, Schnabel A, Debus SE, Weibel S. Hyperbaric Oxygen Therapy for Chronic Wounds. Cochrane Database of Systematic Reviews. 2015 Jun 24;2015(6):CD004123. doi: 10.1002/14651858.CD004123.pub4.

[12] Ibid.

Further studies are needed to verify HBOT success for post-radiation wounds. A study surveyed ten children with radiation-induced brain injuries who underwent HBOT, where five patients showed improvement in recovery. However, the authors concluded that a strong limitation of the study was that they were unable to determine if the improvement was due to HBOT or other pre-treatment factors.[13] Unlike that study, this case studies a patient who did not undergo prior treatments for the wound post-radiation. In addition, the patient in this study did not undergo treatments, like medication or surgery, to treat the necrosis directly within the span of the treatment.

Furthermore, HBOT is used to treat a wide variety of injuries. However, research is needed to understand fully the effects of this treatment. Based upon the studies mentioned before, a longer case study is needed to understand fully the wound healing effects of HBOT. In addition, a study that treats the patient who has not undergone treatments before HBOT is needed to ensure reliable results. Thus, this case study was for a duration of ten-weeks of HBOT with a patient who did not undergo prior treatments for the wound post-radiation.

Methodology

An 85-year-old female Caucasian patient was presented to the Ocala Infectious Disease and Wound Center (OIWC) with sequela necrosis and an open wound above their left ankle measuring 3cm by 2cm with 30% slough. The patient was referred to the OIWC by their oncologist after completing radiation for melanoma located above their left ankle.

Figure 2: *Necrosis and open wound measuring 3 cm by 2 cm with 30% slough located above the left ankle.*

Cell sloughing results from the arrest and death of squamous cell division. Slough comprises of white blood cells and cellular debris. It is indicative on the wound bed as a yellow substance. A high percentage of slough leads to slow wound healing and the harboring of harmful bacteria. In this study, percent slough was visually estimated by the health care provider and the wound size was measured with a ruler. The removal of slough was necessary to avoid infection and to expedite the wound healing process.[14] Since the increase of slough can also affect the health of surrounding tissue, collagenase santyl and zinc were used to prevent infection and increase in necrosis throughout the HBOT treatment. Collagenase santyl encourages the growth of new tissue via the enzyme collagenase, which removes dead skin and tissue. This

[13] Chuba PJ., Aronin P., Bhambhani K., Eichenhorn M., Zamarano L., Cianci P., Muhlbauer M., Porter AT. Fontanesi J. Hyperbaric Oxygen Therapy for Radiation-Induced Brain Injury in Children. Cancer. 1997 Dec;80:2005-2012. https://doi.org/10.1002/(SICI)1097-0142(19971115)80:10<2005::AID-CNCR19>3.0.CO;2-0

[14] Percival S.L, Suleman L. Slough and Biofilm: Removal of Barriers to Wound Healing by Desloughing. Journal of Wound Care. 2015 Nov;24(11):498–510.

ointment assists in healing a wide variety of burns and skin ulcers.[15] Zinc aids to prevent infection and the deterioration of healthy tissue.[16]

The treatment plan for this patient was 40 sessions of continuous 90-minute HBOT's at 2.0 ATA (atmospheres absolute), which is double the average sea level air pressure. This treatment plan was for a duration of ten weeks. The data was retrieved on a weekly basis, with the permission of the patient and the physician.

After each HBOT dive, the patient followed-up first with a health care provider for the measurement of the wound and the percent slough, and then by the cleaning of the wound. Wound cleaning included slough debridement, where the buildup of slough was removed with a rounded tip curette (Fig. 3). Next, collagenase santyl ointment was applied on the wound bed. A zinc paste was then applied around the parameter of the wound. Afterwards, a fabric wrap was applied around the wound.

Figure 3: *Slough removal with a rounded tip curette by a health care provider performed after each round of HBOT.*

To determine the effectiveness of HBOT, wound measurements and the percent slough was dictated throughout the ten-week treatment and compared to previous weeks. A successful treatment of HBOT would be represented by a decrease in wound size and decrease in percent slough. The data below documents the difference in wound size and percent slough from week zero to week ten.

[15] Shi L; Carson D. Collagenase Santyl Ointment: A Selective Agent for Wound Debridement. Journal of Wound, Ostomy, and Continence Nursing. 2009 Nov–Dec;36(6 Suppl):S12-6. doi: 10.1097/WON.0b013e3181bfdd1a

[16] Lansdown AB, Path FR, Mirastschijski U, Stubbs N, Scanlon E, Ågren MS. Zinc in Wound Healing: Theoretical, Experimental, and Clinical Aspects. The International Journal of Tissue Repair and Regeneration.2007 Jan–Feb;15(1):2–16.. doi: https://doi.org/10.1111/j.1524-475X.2006.00179.x

Data

Week	Wound Size (cm x cm)	Wound Size Difference (increase = +) (decrease = -)	Slough	Slough Difference
0	3 x 2		30%	
1	3 x 2	0 x 0	30%	0 %
2	3 x 2	0 x 0	30%	0 %
3	3 x 2	0 x 0	30%	0 %
4	4 x 3	+1 x 0	100%	+70%
5	4 x 3	0 x 0	95%	-5%
6	5.4 x 4	+1.4 x 1	95%	0 %
7	5.4 x 4	0 x 0	95%	0 %
8	5.7 x 3.7	+.3 x -.3	70%	-25%
9	5.7 x 3.7	0 x 0	70%	0 %
10	5.4 x 3.4	-.3 x - .4	80%	+10%
	Total Difference	**+2.4 x +1.4**		**+50 %**

Table 1: *Weekly wound size and percent slough measurement.*

Discussion

The size of the wound and the percent slough were analyzed to determine the effectiveness of HBOT on a post-radiation necrosis and an open wound. A successful treatment of HBOT would be represented in a decrease in the wound size and decrease in percent slough. However, at the end of the ten-week course of HBOT, the patient's wound increased in size by 2.4cm by 1.4cm with 50% greater slough than week one. Thus, this study of HBOT was proven ineffective for this patient. The health care provider proposed increasing the length of the treatment but because the patient complained of severe pain of the wound, an alternative treatment was considered. The health care provider will continue to see this patient on a weekly basis to treat the wound for possible infection and growth through slough debridement and the application of collagenase santyl.

Based on the data and observations of HBOT, there is room for improvement in additional studies. Firstly, an inaccurate reading of percent slough may have been evident in this study since slough percentage was determined visually. A precise method is needed to more accurately determine the percentage of wound slough. Secondly, there is a possibility that the measurements of the wound size were imprecise since measurements were taken with a ruler from different points of the wound circumference. However, one cannot conclude that the dictated increase in wound size was due to imprecise measurements because of the drastic increase in wound size by the end of the treatment. If this treatment is replicated, then measurements should be taken from the same point of the wound. Thirdly, collagenase santyl ointment and zinc were applied to the wound alongside HBOT. A stronger conclusion about the effects of HBOT could be made if a comparison

study was done between solely HBOT and the ointment application. Fourthly, confounding factors need to be considered to evaluate the results of this study. These factors include the advanced age of the patient, and whether the initial size of the wound was too large. A study utilizing a larger pool of patients with diverse ages and wound sizes would be beneficial to strengthen a conclusion.

Conclusion

Radiation of cancers growing close to or on the skin, like melanoma, commonly develop open wounds. Post-treatments, like surgical wound closure, results in further disfiguring of the skin and possible infection.[17] Thus, clinically approved approaches and treatments that mitigate further disfiguring of the skin and infection are needed for wound treatment. The patient in this study suffered from an open wound due to ionizing radiation of melanoma. The patient was prescribed 40 rounds of HBOT for 90 minutes each at 2.0 ATA for a duration of 10 weeks with no adjunctive treatment. By the end of the ten-week treatment, the wound increased in both size and percent slough. The patient's wound increased in size by 2.4cm by 1.4cm which indicated that the HBOT treatment plan did not sufficiently regenerate tissue to close the wound. Along with an increase in size, there was 50% greater slough at week ten compared to week zero. Thus, the ten-week course of HBOT on the open wound was not a successful treatment for the patient.

Although this study was unsuccessful in treating the wound, HBOT is currently being used for patients with open wounds.[18] Further research is needed to determine the reliable effects of HBOT on wounds caused by radiation, preferably where the wound size and percent slough is measured precisely. Additional studies should consider a larger pool of patients with diverse ages and wound sizes. A comparison study between HBOT and the ointments applied during this treatment plan is also suggested. HBOT may have a possible future in radiation-inflicted wound healing because, unlike surgical wound closure post-radiation, it mitigates infection and further disfigurement of the skin.[19]

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Signed Consent Form

[redacted]

OCALA INFECTIOUS DISEASE AND WOUND CENTER

Request to Use Health Information for a Case Study

[redacted]

Dear Sir or Madam,

I would like to ask your permission to use your medical chart information for a case study. Due to your treatment of infection with both traditional antibiotic treatment and Hyperbaric Oxygen Therapy, the information about your case would be educational for medical treatments. If you agree to allow us to me your medical record for this study, we would need to access the following types of information: age, medical conditions, case history, physical examination results, progress pictures of wound, treatment plan, outcome of treatment plan. This information will be provided to me from staff at the Ocala Infectious Disease and Wound Center facility.

Your decision to allow your health information to be used for a case study is entirely voluntary. You are free to say no without any impact on your current or future treatment. Although you will not benefit directly from allowing your case to be presented, this information will help to advance our understanding of Hyperbaric Oxygen Therapy. This case study will be submitted for possible publication on accredited research journals.

All of the data used for this study will be de-identified, which means that information such as your name, medical record number, and patient number will not be included in the case study.

If you give permission to use your personal health information for this case study, I kindly ask that you sign the next page and return to staff at the Ocala Infectious Disease and Wound Center.

If you do not give permission, no action is required on your part.

You may see a copy of the final case study if you wish. If you have any questions, you may contact me via the email listed above.

Sincerely,

[redacted]

[redacted]

OCALA INFECTIOUS DISEASE AND WOUND CENTER

Consent Statement

[redacted]

- I have read (or someone has read to me) the information in this consent form.
- I was given sufficient time to think about it.
- I had the opportunity to ask questions and have received satisfactory answers.
- I give permission to the use and disclosure of my de-identified information collected for use in this case study, as described in this form.
- I understand that by signing this document I do not waive any of my legal rights.
- I will be given a signed copy of this consent form.

[redacted]

Name of participant (please print)

[redacted]

Participant signature

12-10-2020

Date

[redacted]

Name of investigator (please print)

[redacted]

Investigator signature

October 16, 2020

Date

Everglades National Park's Historical Impact on the Seminole and Miccosukee Nations

Katherine Ryan
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Introduction

In 1938, J. J. Cameron, a National Park Service employee, circulated an internal memo titled, "The Seminole Problem," to the Everglades National Park (EVER) staff. In this memo, he collected various letters debating Seminole removal from the swampland south of US Highway 41 that had been set aside for the park by an act of Congress in 1934. In this memo, J.E. Scott, the superintendent of the Seminole Agency, wrote,

> "The Seminole of Florida has been pushed about from place to place for the past century and if he is to be pushed again into this forbidding wilderness with his hunting grounds greatly reduced, I only have to say that their predicament is going to be most serious."[1]

Scott's statement indicates clear doubts and warnings regarding federal policies affecting Native Americans in Florida during the twentieth century. Despite these warnings, EVER continued to develop. As a result, its establishment in 1934 and opening in 1947 challenged Seminole and Miccosukee land rights, thus complicating their sovereignty and economics, and tourism in South Florida.

Rarely discussed is the human history intertwined with EVER, among many other National Park Service (NPS) units.[2] Today EVER is most well-known for its diverse species and subtropical climate. In 1915, the construction of US 1, the first interstate highway in the United States and commonly referred to as the Dixie Highway, was completed connecting East Florida to the Northern United States. Simultaneously, construction began on US 41, commonly known as the Tamiami Trail, connecting Florida's west coast to Miami and attracting many tourists and newcomers to the south.[3] As a result of the construction and widespread publicity campaigns, Florida real estate experienced its first land boom. Speculation of the wetlands was prolific, as marketing teams promoted the Florida subtropical environment as an oasis to northerners searching to escape brutal winters.[4] Upon arrival, newcomers found the wetlands uninhabitable and unsuitable for farming. These homesteaders were not the only residents experiencing

[1] J.E. Scott, "The Seminole Problem," *Everglades National Park Archives* (Homestead, Florida: 1938), 11.
[2] NPS is a federal agency under the Department of the Interior. As of January 2022, NPS manages more than 400 units across the country and U.S. territories that include national parks, national monuments, and other recreational spaces with varying titles.
[3] Allen H. Andrews, "Blazing the Tamiami Trail across Florida through the Heart of the Everglades," *The Dearborn Independent*, February 2, 1924.
[4] Christopher F. Meindl, "Past Perceptions of the Great American Wetland: Florida's Everglades during the Early Twentieth Century," *Environmental History* 5, no.3 (Jul, 2000): 380.

hardship. In the land boom, speculators fraudulently sold tracts of the Everglades in which Seminole people had resided since the Second Seminole War.[5]

Responding to environmental activists and promises of tourism revenue as a result of Florida's development, Congress established EVER in 1934 and it subsequently opened to the public in 1947. This paper highlights the effects of early twentieth-century federal and state rulings that still impact Miccosukee and Seminole legal sovereignty, land use rights, and economics today.[6] Moreover, it examines the human history of EVER, asserting that the Park's establishment profoundly shaped the Seminole and Miccosukee Nations' sovereignty, land use rights, and economies. The following narrative provides a background of relevant literature regarding the National Park Service, the intertwined efforts of white environmental advocates, Seminole War history, as well as federal and state legislation, all of which led to EVER's creation. These complicated relationships are then applied to the concrete experiences of Native Americans in South Florida, including land use rights, economy, and tourism.

Historiography

In reviewing the literature on national parks, including Everglades, historians typically take one of three historiographical perspectives: the benefits, the negative aspects, and the economics of national parks. Historian Alfred Runte wrote extensively on how the parks helped elevate the United States to near equals with European nations and their cultural monuments. As the first cultural history on the parks, Runte's work is essential to national park historiography. In his book *National Parks: the American Experience*, Runte argued that the National Park Service's establishment responded to the United States' cultural insecurity or lack of culture. He stated that America's last hope to fill the cultural void was westward expansion and leverage of natural landscapes.[7] Similarly, Richard Grusin, in his book entitled *Culture, Technology, and the Creation of America's National Parks,* argued that within the United States, nature is viewed as art and utilized for recreation. Simultaneous to the establishment of the parks taking place, Grusin emphasized that the resulting rise in photography faced its own scrutiny as an art form.[8] Also, in agreement, historian Richard Sellars wrote, "the Park Service truly can claim leadership in the field of recreational tourism—the development and management of parks for public use,

[5] For clarification purposes, until 1962, the Seminole and Miccosukee tribes were recognized as one tribe under the name "Seminole" by the United States Federal Government. However, they are distinct nations, as the Miccosukee descended linguistically from the Lower Creek and Seminole from the Upper Creek language. Often in primary and secondary sources from the early to mid-20th century, Miccosukee is spelled "Mikasuki," referring to the language group rather than the cultural group and sovereign nation. In this paper, Miccosukee will be used from here forward as it is the current spelling for the Federally Recognized Tribe. See "History," Miccosukee Tribe, (September 11, 2020): https://tribe.miccosukee.com/.

[6] It is important to note that Native American sovereignty as used in this paper addresses the ability and authority of a nation, in this case the Seminole Nation of Florida and Miccosukee Tribe of Indians, to govern itself. There is an extensive history of the United States Federal government infringing on Native American sovereignty.

[7] Alfred Runte, *National Parks: the American Experience* (Lincoln: University of Nebraska Press, 1979), 43.

[8] Richard Grusin, *Culture, Technology, and America's National Parks* (Cambridge: Cambridge University Press, 2004), 30.

enjoyment, and education."[9] A clear consensus among these historians is that national parks provide a benefit to American culture and society.[10]

While Alfred Runte spoke directly about NPS, Marjory Stoneman Douglas's work, *The Everglades: River of Grass,* highlighted the unique environmental attributes of the specific region. Douglas's work is one of the first works to discuss the South Florida environment, history, and wildlife. Douglas' monograph can be read from two perspectives. The first, as a chronology detailing the environment and environmental history of South Florida, and the second as a political writing emphasizing the value of the Everglades. However, it is problematic for several reasons. Reading her text with a modern eye, it conveys the ethnocentric beliefs of the mid-twentieth century. In her second chapter, *The People of the Glades,* she employed pseudo-science when writing about evolution and migration in South Florida.[11] Moreover, the text, as opposed to Runte's work, utilized few, if any citations, instead merely listing a series of bibliographical entries at the end of the publication. Despite shedding light on the rich biodiversity found in the Everglades, Stoneman Douglas' writing is used sparingly in this article because of its historical limitations.

In comparison to Runte and Stoneman Douglas, those writing about the National Park Service's negative aspects find fault with the historical narrative portrayed by park creators who argue that the parks exist within an undisturbed wilderness. Mark David Spence's *Dispossessing the Wilderness: Indian Removal, National Parks and the Preservationist Ideal* argued that uninhabited wilderness had to be created before it could be preserved. In other words, the uninhabited wilderness did not exist, contrary to what park literature leads patrons to believe.[12] A significant point of contention is the extent to which the parks' creators knew their effect on Native American populations. Historians Robert H. Keller and Michael F. Turek refuted the prominent administrative belief that Native Americans were not affected and did not use the Yellowstone region, a view which Spence accepted. Keller and Turek wrote, "prior human occupation left evidence of ancient campsites…and a trail system (which modern park highways follow) that dated back at least seventy-five hundred years."[13] Since a modern highway follows these trails, illustrating human inhabitance, administrators clearly knew much more about the park's prior use than they admit. The conflict amongst this school of thought is that Native American groups experienced further disenfranchisement due to national park establishments. The coordinating literature does not recognize this history. Although William Cronon's *Changes in the Land: Indians, Colonists, and the Ecology of New England* spoke explicitly about colonial England, long predating the National Park Service, his arguments were soundly reflected in their

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[9] Richard West Sellars, *Preserving Nature in the National Parks: A History* (New Haven: Yale University Press, 1997), 280.
[10] Sellars, *Preserving Nature*, 280.
[11] Marjory Stoneman Douglas, *The Everglades: River of Grass* (New York: Rinehart, 1947), 58–59.
[12] Mark David Spence, *Dispossessing the Wilderness: Indian Removal, National Parks and the Preservationist Ideal* (New York: Oxford University Press, 1999), 5–6.
[13] Robert H. Keller and Michael F. Turek, *American Indians and National Parks* (Tucson: University of Arizona Press, 1998), 22.

historiography. Cronon also argued that a pristine or golden age of nature never existed.[14] Instead, he stated that Native Americans and colonists both imposed changes to the land to benefit their lives, although each group utilized distinct methods. Cronon concluded that the most significant shift in land use was the European shift to a globalized capitalistic society compared to Native American consumption of resources, which focused on subsistence or regional trade.

Aside from addressing the National Park Service's consequences, many authors have also written about the park's economic impact. To most who research the National Park Service, the program itself appears to be a long string of poor economic decisions. In his article, "Market Failures and the Rationale for National Parks," economist Robert Turner wrote that the economics behind public parks do not support their existence.[15] Turner stated that the National Park Service provides a public good that private companies could provide more efficiently. However, several economists recognize that value is not purely quantitative. The economic values of family time, culture, and identity are inherent within the parks. Unlike Turner, authors David Harmon and Allen Putney named the intangible values found within a public park, such as spiritual and educational values.[16]

Notably missing from the narrative are the experiences of contemporary Seminole and Miccosukee stakeholders due to limited documentation and considerable oversight. Through analysis of federal and state legislation, this paper asserts the much-needed study of human history in the Everglades that is often missing in scholarship on NPS. More work must be conducted by analyzing the effects of past rulings and decisions that significantly impacted Miccosukee and Seminole Nations and continue to impact? today. With the majority of histories about EVER focusing on the efforts of environmentalists and subsequent conservation practices, this article builds on the work conducted by Robert H. Keller and Michael F. Turek, who highlighted this gap of written human history in South Florida. Moreover, this article fits at the intersection of federal, state, and Native American history in Florida, and underlines a frequently forgotten story by elucidating the significant impacts of EVER's establishment on the Seminole and Miccosukee Nations. Finally, this article is only the beginning of the research process on Everglades history. Moving forward, more primary work utilizing Native American sources must be conducted to gain a comprehensive understanding from each stakeholder group's perspective.

Displacement and Making the Everglades Home

In order to understand the intertwined relationship between Native American, state, and federal sovereignty, along with land use rights and economies in South Florida, it is important to know why the Seminole and Miccosukee Nations began living in the Everglades region. The Seminole

[14] William Cronon, *Changes in the Land: Indians, Colonists and the Ecology of New England* (New York: Hill and Wang, 2003), 12.
[15] Robert W. Turner, "Market Failures and the Rationale for National Parks," *The Journal of Economic Education* (Milton: Taylor and Francis, 2002), 347.
[16] David Harmon and Allen D. Putney, *The Full Value of Parks from Economics to the Intangible* (Lanham: Rowman and Littlefield, 2003), 7–8.

Nation was at war in some form with the United States from 1812 to 1858.[17] The distinct boundary between the United States and Spanish Florida following the American Revolution provided a safe haven for escaped enslaved people and more land for opportunistic white Americans. In 1818, the First Seminole War was a series of skirmishes between Americans and Seminoles led by Andrew Jackson to recapture runaway enslaved people.[18]

The Second Seminole War resulted from the United States' attempt to remove Seminoles west to Indian Territory, in contemporary Oklahoma, following the passage of the 1830 Indian Removal Act. In 1832, fifteen Seminole Leaders signed a contract with the Federal Government regarding potential land in Indian Territory, believing the contract to be binding only if the Nation in its entirety agreed to removal.[19] American negotiators, however, deemed the contract final upon signing. A significant number of Seminole citizens disagreed with the terms of the negotiation and ultimately refused to be removed. In response, the United States Army was sent to Florida to enforce the contract, leading to a brutal seven-year war. Outnumbered and with several significant leaders captured, the United States forcefully removed an estimated 3,000 Seminoles to Oklahoma Territory.[20] A minority of about 500, however, fled to the Everglades in South Florida.

With increasing numbers of white Americans moving to South Florida and encroaching on Seminole Land, skirmishes continued between the United States and the remaining Seminoles beginning in 1855. These skirmishes, now known as the Third Seminole War, ended in 1858 when another Seminole group of around 200 was forcefully removed west.[21] After this final group was removed, the remaining citizens escaped to the Everglades' relative safety where they separated by linguistic group, with Muscogee speakers moving North of Lake Okeechobee and Mikasuki speakers to the Everglades.[22] Although the Seminole Wars predated EVER by nearly a century, the sources utilized elucidate Seminole and Miccosukee perspectives regarding their nations' relationships with the Federal Government and the long history of conflict over sovereignty, land use rights, and economics.

Early Environmental Activism

As one of the earliest advocates for Everglades preservation, Minnie Moore-Wilson wrote extensively on the environment's protection, the Seminole of Florida, and their use of the Everglades. Moore-Wilson fought an ongoing battle against land speculation in the Florida swamps. In a letter to the Florida Legislature in 1863, she wrote, "One hundred-thousand acres may seem at first glance, like a large tract for 600 Indians, but when it is considered that at least four-fifths of that land would be most of the time underwater, very little is left for

[17] "Seminole History," Seminole Tribe of Florida Tribal Historic Preservation Office.
[18] Mikaëla M. Adams, *Who Belongs?: Race, Resources, and Tribal Citizenship in the Native South* (Oxford University Press, 2016), 172.
[19] Ibid., 173.
[20] "The Seminole Wars," Seminole Nation Museum.
[21] Adams, *Who Belongs?,* 174.
[22] Ibid.

homemaking."[23] Her insights, although driven by an environmentalist perspective, cemented that while Seminoles did have land rights in the late nineteenth century in South Florida, it certainly was not desirable land, further establishing these land issues as innately Floridian. At the same time, northern speculators purchased farmland after hearing promises to drain the swampy environment by redirecting Lake Okeechobee overflow using human-made canals, overshadowing many of Moore-Wilson's efforts.

By the twentieth century, rates of tourism, emigration, and destruction of Florida wetlands resulting from the economic boom grew rapidly. Consequently, Marjory Stoneman Douglas became a well-known advocate of protecting the Everglades ecosystem. A historian cannot write about the Everglades without discussing Stoneman Douglas or her book, *The Everglades: River of Grass,* which was published in the same year as the park's opening in 1947. In her closing chapter, Stoneman Douglas opens with the memorable statement, "the Everglades were dying," in her assessment at the hands of Floridian tourism and settlement.[24] In the final chapter, she blamed the quick development of the City of Miami and the land boom for the devastating consequences she saw in the Everglades landscape.

Twentieth-Century Legislation and Advocacy

In 1934, when the Everglades National Park Act was passed by Congress, the Bureau of Indian Affairs Commissioner John Collier seemingly advocated for the Seminoles of South Florida. Collier saw himself as a champion of Native American rights and culture, despite in many instances lackluster results. His efforts effectively pushed United States policy regarding Native Americans from assimilationist to preservationist.[25] As part of those efforts, Collier wrote into section three of the act, "Provided further that nothing in this act shall be construed to lessen any existing rights of the Seminole Indians."[26] While this language may initially seem like a genuine effort to protect Seminole sovereignty, it is insufficient and far too vague to be of use.[27] Such ambiguous language was often used in treaties purposefully to provide loopholes for future manipulation of rights, territories, and sovereignty. Collier does not enumerate existing Seminole rights or indicate what would qualify as an infringement or effort to lessen such rights, making the statement ineffectual and susceptible to manipulation.

Despite the Everglades National Park Act's protective statement, the language was not substantive enough to protect Native American interests and merely placated the general public. This is demonstrated in a letter from John Collier to Ernest F. Coe, an outspoken supporter of EVER and prominent advocate for its establishment. Collier states, "[the Seminoles] have no special rights or privileges in the National Parks. Of course, they may be employed…but this is

[23] Moore-Wilson, "The Florida Legislature," (1863), 4.
[24] Stoneman Douglas, *The Everglades*, 349.
[25] "Indian New Deal" National Archives and Records Administration, accessed April 13, 2021, https://prologue.blogs.archives.gov/2015/11/30/indian-new-deal/).
[26] Everglades National Park Act, H. Res. 2837, 73rd Cong., 2nd sess., *Congressional Record,* vol. 45, ed. (May 30, 1934).
[27] Keller and Turek, *American Indians and National Parks*, 226.

an individual matter."[28] Ultimately, Collier's letter cements that the objective was not to protect Seminole rights but rather to assuage Seminoles into compliance while drafting and passing the Everglades National Park Act.

Ernest F. Coe used the vague language in the act to his advantage.[29] Initially, Coe supported Collier and the Seminoles in understanding their needs, arguing in the Everglades National Park Congressional Hearings that if "given the chance," the Seminoles would keep to the Everglades and out of Miami; thus, the national park would act as a haven and provide continuity for the Seminoles.[30] Coe even said the Seminoles were an integral part of the Everglades' experience and could perhaps act as guides in the park. The language in the Everglades National Park Act sounded agreeable. However, as with the establishment of other parks like the Grand Canyon and Yellowstone, Native American rights would be unquestionably challenged.

Importantly, historian Alfred Runte argues that the Florida Everglades' adoption as an NPS unit marked a unique turning point, indicating a shift from history building to intentional environmental protection.[31] From the outset, it was evident that EVER was established for preservation purposes. Supporting Runte's argument, Marjory Stoneman Douglas wrote in her book that the Federal Government procured worthless acres and turned them into the national park, thus fulfilling her goal of protecting the unique environment.[32] The social consequences of this early expansive environmental protection effort, however, fell on the Seminole and Miccosukee Nations.

Land Use Rights

Seminole Land rights were in constant fluctuation. In the *Survey of the Seminole Indians,* the Bureau of Indian Affairs provides specific geographic boundaries and notes that camps were far removed from any roads or shops.[33] The *Survey of the Seminole Indians* continues, stating that since 1880, white settlers went to Labelle for hunting and Fort Myers for cattle ranching, crowding out the Seminoles.[34] In addition to geographic holds, the document states that Seminole populations had grown between 250% and 270% since the 1880 census, indicating good quality living conditions and few health complications.[35] While these statistics are encouraging, one must note that they are considered inaccurate because of inconsistent transportation, housing, and location on the Bureau of Indian Affairs agent's part of Seminole

[28] John Collier to Ernest F. Coe, "The Seminole Problem," *Everglades National Park Archives* (Homestead, Florida: 1938), 12.
[29] "Ernest F. Coe: Father of the Everglades," National Parks Service, April 14, 2015, accessed October 31, 2020, https://www.nps.gov/ever/learn/historyculture/ernestcoe.htm
[30] *Hearing Before the Committee on The Public Lands*, HR 12381, to Provide for the Establishment of the Everglades National Park in the State of Florida, and for Other Purposes 1931, 71st Cong., 3rd sess., December 15, 1930, 75.
[31] Runte, *National Parks*, 108.
[32] Stoneman Douglass, *The Everglades*, 380.
[33] Roy Nash, *Survey of the Seminole Indians*, S. Doc. No. 314, 71st Cong., 3rd Sess., (1931), 3.
[34] Ibid., 20–21.
[35] Ibid., 22.

camps. Figure 1, *Approximate Locations of Permanent Seminole Camps,* created by Roy Nash indicates the locations and geographic size of Seminole camps in 1930 and shows how widely dispersed the encampments in South Florida were.[36] This general growth and prosperity, however, would not last.

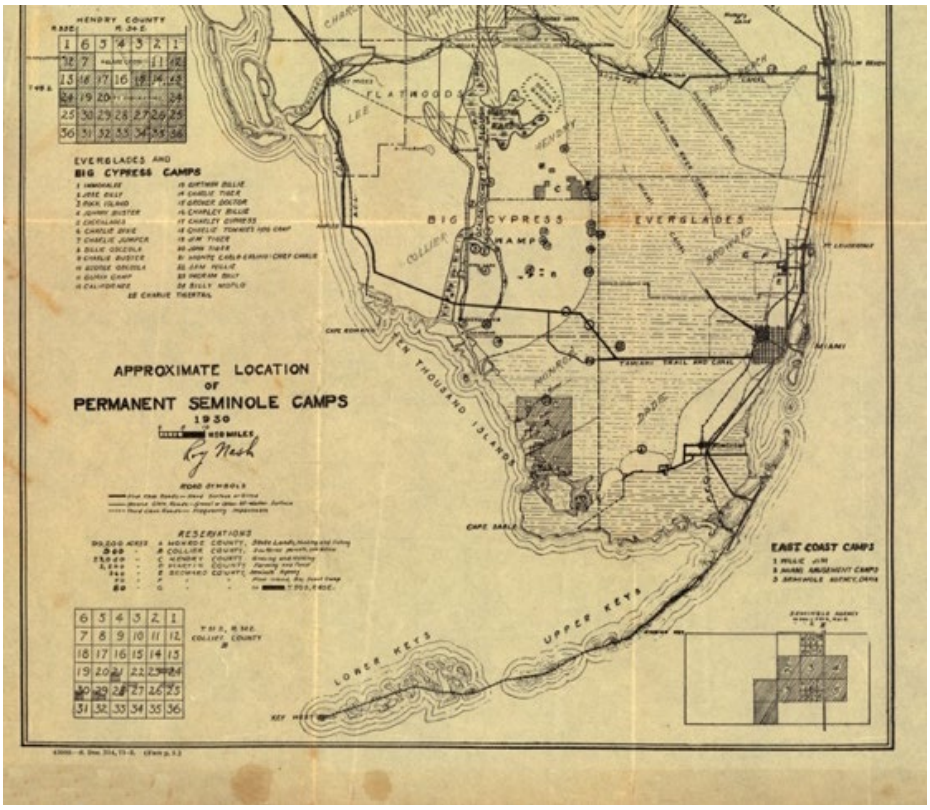

Figure 1: Map of South Florida indicating the approximate locations of permanent Seminole Camps, 1930. State Library of Florida, Florida Map Collection. © Florida Memory State Library and Archives of Florida.

EVER's development challenged the land use rights of the Seminole and Miccosukee Nations. In the thirteen years between the Everglades National Park Act and EVER's opening, Coe began disagreeing with Collier and Nash on what to do about the Seminole and Miccosukee people living on the proposed park land. In a variety of letters, Coe made every effort to convince the Bureau of Indian Affairs and Department of the Interior to eliminate Seminole and Miccosukee hunting rights from EVER boundaries and remove the people from the proposed park lands. Following establishment, J.J. Cameron circulated *The Seminole Problem* memo to park management in which he made several broad conclusions. First, he wrote that Seminoles primarily hunted and used natural resources north of The Tamiami Trail, while the boundaries for EVER were for the most part south of The Trail.[37] Based on the 1930 map, *Approximate*

[36] Roy Nash, *Approximate Locations of Permanent Seminole Camps*, Scale ca. 1:1,013,760, Florida, 1930, State Library of Florida, Florida Memory State Library and Archives of Florida.
[37] J. J. Cameron to Mr. Diedrich, "The Seminole Problem," *Everglades National Park Archives* (Homestead, Florida: 1938), 11.

Locations of Permanent Seminole Camps, Cameron's claim is unfounded as a significant portion of land south of The Tamiami Trail is highlighted as Seminole camps.[38]

J.J. Cameron continued his assessment in the 1938 "Seminole Problem" memo recommending removal and acknowledging that if EVER was established, then the Bureau of Indian Affairs and the State of Florida should make preparations to remove Native Americans to reservations created within the state.[39] It is essential to acknowledge that these decisions were made within various bureaus of the federal government in conjunction with the State of Florida, thus leaving Seminole people out of the discussion and decision-making process, further challenging their national sovereignty and self-determination. Cameron recognized that not only have Seminoles strongly opposed removal in the past, referring to the Seminole Wars in the nineteenth century, but in 1938 they were also citizens of the United States, per the Indian Citizenship Act of 1924.[40] Cameron's memo further proves that despite historical context, legal knowledge, ethical concerns, and certain opposition from the Seminole Nation of Florida, the Seminole Agency, Department of the Interior, and the State of Florida still advocated for removing Seminoles to reservations in Collier County and Northeast Florida.

In 1935, a small delegation from the Seminole Nation of Florida appealed to the Secretary of the Interior, Harold L. Ickes, to request reservation lands. The request was arguably a result of the impending establishment of EVER, pressure from environmentalist groups, and the influence of white Floridians like Minnie Moore-Wilson.[41] However, the request and consent to remove were not supported by the rest of the Seminole Nation. This division, as a result of external manipulation, is reminiscent of the disagreement that led to the Second Seminole War, which occurred nearly a century earlier. Ultimately this final and most recent fracture in the nation led to the distinct recognition of the Miccosukee and Seminole tribes today. Those agreeing with the delegation moved to reservations, like the Big Cypress Reservation, as the Seminole Tribe of Florida. As explained by the Seminole Nation of Florida and the Miccosukee Tribe of Indians of Florida, those in disagreement with the delegation remained in the Everglades as the Miccosukee Tribe of Florida.[42]

Economic Implications

Another consequence of the establishment of EVER was its effect on the local South Florida economy. According to *The Survey of Seminole Indians,* in 1931, the primary income source was hunting and trapping, specifically the fur and skins trade.[43] However, economic trade was not equitably accessible in that white fur traders could receive "better prices than do the Indians by

[38] Roy Nash, *Approximate Locations of Permanent Seminole Camps*.
[39] J. J. Cameron to Mr. Diedrich, "The Seminole Problem," 1938, 12–13.
[40] Ibid., 7.
[41] "Seminole History," Seminole Tribe of Florida Tribal Historic Preservation Office.
[42] "History," Miccosukee Tribe, Accessed October 27, 2020, https://www.miccosukee.com/history.
[43] Nash, *Survey of the Seminole Indians*, 35.

mailing [their] fur direct to Sears, Roebuck, and Co., in Philadelphia," in comparison to Seminoles, who only started mailing furs in 1930.[44]

Before EVER's establishment, hunting areas became increasingly limited for the Seminoles. The concept surrounding these limitations is that skillful conservation would preserve a sportsman's paradise for years to come. Although scientifically correct, this thinking did little to limit new hunting methods being used by whites in Florida, and primarily focused on Native American limitation. The biggest issue regarding hunting to C. C. Woodward, the state game commissioner, was that Native Americans were not obligated to hunt according to the season as white hunters were. While Native Americans typically hunted with rifles or traditional weapons, limitations and restrictions were implemented quickly after *The Survey of Seminole Indians* was released. On top of these restrictions, Native American hunters were frequently undermined by white hunters in the same areas. Stories from central Florida written in the survey described white men decimating populations, killing eleven alligators in a single night with the use of torches, and killing 103 alligators in two nights using powerful reflectors.[45] Coe's focus on the effect of Seminole and Miccosukee hunting on Everglades species was far off base considering their relatively small impact compared to that of white Floridians. As Ernest F. Coe wanted, hunting rights were restricted within EVER, in which the Seminole and Miccosukee were not permitted to live or hunt.[46] Thus, once EVER was established, Seminole and Miccosukee land rights and sovereignty were affected.

The great egret and snowy egret were additional valuable game sought out by hunters in Florida for the plume and feather trade. The plume trade was so popular that the sale price for widely desired snowy egret plumes could bring in up to $50 in Fort Myers, while a 6-to-8-foot alligator skin could be sold for around $2.[47] However, this profitable trade did not last long either because of diminishing population sizes and environmental protection policies. The Audubon Society, in particular, advocated for environmental policies to protect plume birds like the egret. Arguably, the conservation of such species was not purely for biologic conservation, but also preserved an important aspect of Florida tourism: birding. Despite these efforts to protect waterbird species, Florida lawmakers chose to drain Lake Okeechobee and divert water to the west and east coasts through canals to allow for increased speculation and farming.

The Seminole and Miccosukee Nations significantly felt the consequences of rerouting the runoff because their primary means of navigation were by canoe on the Everglades waterways.[48] Additionally, the lack of water running through the Everglades forced species to migrate toward the remaining swampy locations, severely limiting available game in the region.

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[44] Nash, *Survey of the Seminole Indians,* 36.
[45] Ibid., 37–38.
[46] Keller and Turek, *American Indians and National Parks*, 222–223.
[47] Harry A. Kersey Jr., "Pelts, Plumes, and Hides: White Traders Among the Seminole Indians," *The Florida Historical Quarterly* 51, no. 3 (January 1973): 254, 259, accessed February 3, 2022, https://doi.org/10.1093/ohr/6.1.81.
[48] Patsy West, "The Miami Indian Tourist Attractions: A History and Analysis of a Transnational Mikasuki Seminole Environment," *The Florida Anthropologist* 34, no. 4 (Coral Gables: The Florida Anthropological Society, 1961), 206.

In 1931, *The Survey of the Seminole Indians* acknowledged that the lack of game made the Seminole's economic position even more precarious.[49] The creation of EVER and environmental protection advocates resolved many of these issues in population decline and water management, but at the expense of Seminole and Miccosukee economic stability.

Effects of Tourism

The national park's establishment also served as a catalyst for significant change in the tourism industry. Seminole and Miccosukee citizens were already involved in tourist attractions leading up to the park's establishment. Two of the first tourist attractions were Coppinger's Tropical Gardens and Musa Isle, both of which were popular in the "curiosity trade" attraction where Seminole villages were set up and open for public entertainment. These villages blurred the lines between reality and performance, often commodifying the Seminole and Miccosukee cultures.[50] Commonplace attractions in these villages were alligator wrestling, hand-crafted goods, and even staged weddings. The craft trade was especially profitable across genders and produced supplemental income opportunities.[51] Furthermore, it provided an outlet for employment aside from difficult labor, carried on traditions, and educated the public on their economic endeavors.[52] While tourist attractions like Coppinger's provided much-needed economic opportunities for Seminole and Miccosukee people, there was a significant element of cultural exploitation and commodification that left many Native Americans and their advocates uncomfortable. Ultimately, these villages provided much-needed economic stability for the physical survival of individuals and long-term survival of the Seminole and Miccosukee Nations because they leveraged the tourist trade to their economic benefit.

The widespread publicity of the newly established tropical national park added to the tourist boom. In establishing the national park, the only official roadway entrances were in Everglades City on the Gulf Coast, along the Tamiami Trail, and in Homestead on the east coast. Organizing the park with multiple entrances, NPS aided overall tourism revenues, which ultimately overflowed into the curiosity trade and Native American tourist attractions throughout South Florida. Although there are not quantified records comparing tourist revenue to park attendance, it is clear based on EVER data, that tourism increased after the park's opening in 1947. [53] From 1947 onward, visitation rates steadily increased in the years that followed. Therefore, it can be concluded that the increased tourism and establishment of EVER did positively affect revenue for Seminole and Miccosukee people in the Miami and US 41 areas.

[49] Nash, *Survey of the Seminole Indians,* 41.
[50] Keller and Turek, *American Indians and National Parks,* 223.
[51] Jessica Cattelino, *High Stakes: Florida Seminole Gaming and Sovereignty* (Durham, Duke University Press Books, 2008), 41.
[52] Cattelino, *High Stakes*, 41.
[53] "Everglades National Park Total Recreation Visitors." National Parks Service. October 4, 2020.

Conclusion

As a result of EVER's establishment, Seminole and Miccosukee people's land rights were challenged, affecting their respective nations' sovereignty, economic opportunities, and tourism. Leading up to the proposed park's formation, conservationists advocated for limited hunting and use of the wetlands; a significant reason for the relocation of Seminoles to reservations was the newly established national park. The issue of removal and hunting rights greatly affected sovereignty. The economic story is just as complicated as the analysis of the effects on sovereignty because some changes ultimately limited the economic independence of the Seminole and Miccosukee people, changes such as hunting limitations and draining the Everglades. At the same time, other efforts, such as increasing tourism, likely benefitted Seminole and Miccosukee people. This analysis is only the beginning of understanding the interconnectedness between EVER and South Florida Native American Nations.

Additional work must be conducted to include Native American perspectives of the park's establishment and to insert their voices into the narrative taking shape. The key takeaway from this research is that the issues of sovereignty, economic dependence, and land use are historically Floridian issues, many of which are still relevant today. The most recent legislation regarding Miccosukee land rights was renewed in 2014, and the final phase of the Everglades water restoration project began in September 2020.[54] Moreover, debates over water quality and ongoing oil drilling have sparked public demonstrations by the Miccosukee Tribe of Florida whose citizens are impacted by these actions. These topics of sovereignty, economic opportunity, and land use rights are issues that all Americans should reflect on for many years to come to provide equitable access to inclusive historical narratives, natural resources, and economic opportunities.

Furthermore, in the broader literature of National Park history, EVER is only one example in a 423-unit system that consistently ignores modern Native American history and its own part within that checkered past. Many of these units certainly impacted Native American communities, and their stories are not told within academic or public history. In leaving these narratives out of public history, Americans are kept unaware of how their outdoor recreation spaces came to be, and at what cost to Native communities. Yet, it seems that NPS is in the midst of a cultural shift that presents a moment of opportunity for historians and government officials to center Native histories within the larger narrative. For the first time in American history, Native individuals hold leadership positions in the Department of the Interior with direct oversight over the national parks system. In 2021, the Biden administration appointed Deb Haaland as Secretary of the Interior. Haaland, a citizen of the Pueblo of Laguna tribe, became the first Native American to hold a cabinet seat. In November 2021, the Senate also confirmed the appointment of Charles "Chuck" Sams III as the Director of the National Parks Service. Sams is an enrolled member of the Cayuse and Walla Walla tribes which are part of the Confederated

[54] "Contract Awarded for Completion of Tamiami Trail Next Steps Project," National Parks Service, September 2, 2020, accessed January 29, 2021, https://www.nps.gov/orgs/1207/contract-awarded-for-completion-of-tamiami-trail-next-steps-project.htm

Tribes of the Umatilla Indian Reservation. Haaland's and Sams' appointments signal a potential opportunity to place a greater emphasis on these stories and their inclusion in public history, as significant numbers of tourists benefit from the historical displacement and removal of Native Americans.

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