

3-1-2021

SOLUTIONS Human Centered Approach to Conservation

Illustration Department
Rhode Island School of Design, illustration@isd.edu

History, Philosophy, and the Social Sciences Department
Rhode Island School of Design, liberalarts@risd.edu

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Recommended Citation

Department, Illustration and Department, History, Philosophy, and the Social Sciences, "SOLUTIONS Human Centered Approach to Conservation" (2021). *Illustration Course Work & Materials*. 1. https://digitalcommons.risd.edu/illustration_courseworkandmaterials/1

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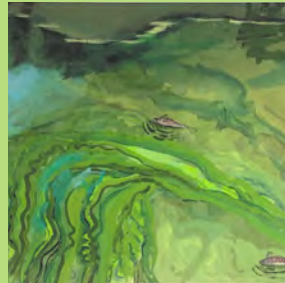
Santiago Alvarado

Alisa Boardman

Margaret Broughton

Ashley Chang

Eunhyung Chung



Talia Garrido

Louis Hand

Kaitlyn Hui

SOLUTIONS

Human Centered Approaches to Conservation

Moritz Lonyay

Marcella Sanchez

Mary Seol

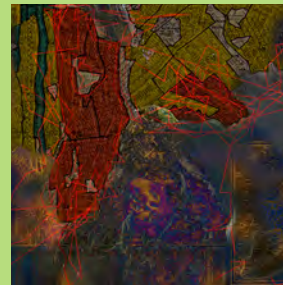
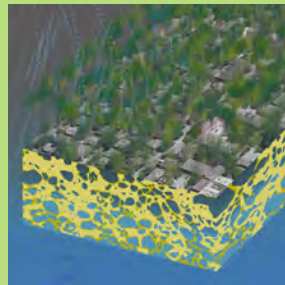
Manmeet Sodhi

Elisabeth Tai

Avantika Velho

Xinran Wang

Alexandra Watson

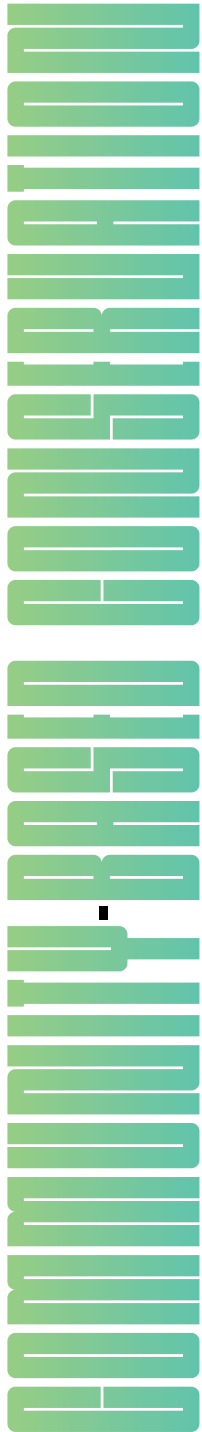


Introduction

These essays were written and illustrated by students at the Rhode Island school of Design in February, 2021. Their perspectives are entirely personal and reflect their efforts within a 5.5-week fused studio/seminar course that was centered on the Sixth Mass Extinction and how biodiversity is changing because of humans.

Discovering that science communication is more than delivering just the facts, students were invited to research a topic of personal interest that is relevant to human impacts on biodiversity. Through analysis of data and other scientific information, each sought to synthesize their research and opinions on the topic through a combination of text and illustration.

Susan Doyle
Dr. Lucy Spelman
Faculty



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Avantika Velho

Expanding Biodiversity-focused Citizen Science on a Global Scale

Biodiversity-focused citizen science can be scaled to become a legitimate system for global conservation research and education by analyzing prevalent approaches, outcomes and obstacles faced.

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Louis Hand

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Mary Seol

Green Infrastructure: A Porous City

Green infrastructure provides a potential solution to counter the effects of human pollution while fostering resilience; however, green infrastructure should be equally accessible to all communities in order to combat inequity and environmental racism.

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Climate Conscious Cities

To actively anticipate and combat the negative effects of urbanization, urban planners will have to think outside what is standard, and consider many micro-solutions that value the participation and education of the community they serve.

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What Goes Around, Comes Around - Consequences of Society's Plastic Dependency

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Muck in the Suburbs: Educating Kids About Harmful Algal Blooms

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The Future of Agriculture Lies Under the Sea

To solve food insecurity and combat climate change, the future of agriculture depends on the expansion of aquaculture, or underwater farming, focused on newer crops like seaweed as well as traditionally wild-caught crops like mussels and bivalves.

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Manmeet Sodhi

Consuming Beyond Repair

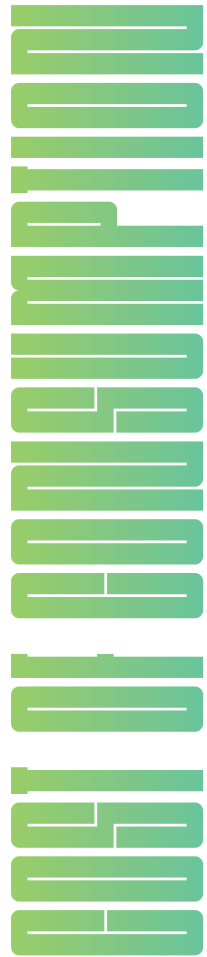
Overconsumption is a problem that is at the core of many issues faced today and the change required to fight it should stem from the thought process of the general population, not compensation through innovation of technology.

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AVANTIKA VELHO

EXPANDING BIODIVERSITY-FOCUSED CITIZEN SCIENCE ON A GLOBAL SCALE



Introduction

The massive scale and complexity of current environmental issues pose serious challenges for the fields of conservation biology, natural resource management, and environmental protection. Citizen science - public participation in scientific research- offers a powerful tool for tackling these challenges. Before science was practiced as a profession, keen amateurs and volunteers conducted scientific research and made key contributions to the understanding of climate, geology, electricity, evolution, electricity, astronomy, and other phenomena through their observation. Today, citizen science not only allows researchers to gather large amounts of biodiversity-related data, but it also has the potential to actively

engage the public in research. Biodiversity focused citizen science, therefore, has the potential to create a more conservation-literate society. This article attempts to understand how biodiversity focused citizen science can be scaled to become a legitimate system for global conservation research and education by analyzing prevalent approaches, outcomes and obstacles faced.

Approaches

Citizen science projects are often collaborations between scientists who want to capture more data without spending additional funding and community groups that are already collecting such

information, such as birders or weatherbugs (Ullrich, National Geographic, nd). Biodiversity focused citizen science also plays a huge role in surveying and cataloging species. An event called a *bio-blitz*, also known as a biological inventory focuses on finding and identifying as many species as possible in a specific area over a short period of time (Ullrich, National Geographic, nd). Participation in citizen science initiatives are by no means exclusive, everyone from children on school trips to adult naturalists participates in these events. Contrastingly, there are annual species counts like the Big Butterfly Count that take place over a time

frame of a few months. They encourage registered participants to document the species on their own time (Big Butterfly Count. 2020).

Recent technological advances have streamlined traditionally time-consuming tasks of data entry and volunteer coordination. Digital citizen science platforms such as eBird (largest bird population directory), iNaturalist, and Safecast are engaging millions of people in observing environmental phenomena (Palacin et al., 2020). Public participation in policy and decision-making through citizen science is starting to gain traction and is an irreplaceable part of the United Nation's sustainable development agenda as it improves the quality, acceptance, and durability of environmental policy decisions (2020).

To summarize, some citizen science projects focus explicitly on decision making, some focus on engagement and environmental education, some are accelerated species inventories, some are long-term monitoring programs aiming to provide data for eventual use in science, however, all of them cannot exist without their participants.

Participation Drivers and Outcomes

It is clear that participation is the glue that holds all citizen science projects

together. Therefore, it is necessary to understand the drivers and outcomes of participation to find the key to the global success of biodiversity-focused citizen science.

Palacin et al (2020) attempted to highlight the psychological drivers that drive citizen scientist participation. They point out that initial participation is usually self-directed and a result of the participant's curiosity and pursuit of stimulation/excitement. On the other hand, sustained participation is attributed to the universal tendency to pursue action and understanding for the well being of everyone and nature (2020). Incentives are also an essential component to nurture sustained participation behaviors (2020). This is usually done through remuneration via micropayments, gamification, and reputation mechanisms or through social rewards (2020).

To understand the role that the location of a project might play in participation, Newman et al. (2017) outline the " power of place" concept which embodies actions motivated by the cultural, emotional, and material connection people have for the place they live in, sometimes expressed as 'love' or 'attachment to place and argues that citizen science projects that leverage this attachment are successful at transforming the relationship between people and their environment, have a greater engage-

ment and retain a high amount of participants (2017).

Peter et al. (2019) investigated the outcomes of biodiversity citizen science projects on the side of the individual participants found that the most common outcome was gain in knowledge about biodiversity, ecology, and species conservation. Participants also began to change their attitude regarding biodiversity, by developing an appreciation and concern for the environment (2019). Behavior changes were also seen in the form of adapted everyday practices, getting involved in conservation action, and recruiting others to participate (2019). They also reported gaining skills in species identification and data collection (2019).

All in all, it seems like establishing some personal connection to the project, either by place or values drives people to start participating. Trusting that their work is helping to make a positive difference and other incentives and rewards systems are key to keeping people engaged. Lastly, participation in biodiversity-focused citizen science leads to ecologically positive changes in people's mindsets and behaviors and furthers their science literacy.

Challenges

Citizen science provides research

institutions and governmental bodies with opportunities to rethink the ways they do science and connect with society to improve their positive social and ecological impact and increase trust in science. However, as a democratizing approach in research, citizen science is bound to encounter some resistance for recognition by the status quo of science governance (Eleta, et al. 2019). The dominant bottom-up approach of citizen science initiatives while extremely locally engaging faces concerns of reliability and usefulness that gets in the way of legitimizing citizen science as an official stream of scientific research. As a result, some proponents of the field are pushing for the institutionalization of citizen science by attempting to systematize the available research and agree on common methodologies. (Irwin, 2018). On the other hand digital citizen science platforms, which can be viewed as centralized hubs of information, face privacy and security concerns (Palacin et al., 2020). Lack of transparency in this case leads to distrust in the system and deters participation (2020). To combat this, scholars are proposing are pushing for further democratization by designing mechanisms that enhance transparency, accountability, openness, and shared ownership of the data and technology (2020).

Discussion

The scientific community is often viewed as exclusive and inaccessible and consequently have been othered by the public. People are waiting around for change to happen as they have grown to believe they don't have the knowledge or skill to be the change-makers in science-driven areas. Therefore, the democratization of science through citizen science is an exciting idea that can help bridge this disconnect and one that makes complete sense when dealing with wicked problems like climate change and biodiversity loss that require everyone's consideration. When it comes to biodiversity conservation we have seen the potential of biodiversity citizen science to positively impact participants' knowledge, attitudes, and behavior regarding biodiversity. These results suggest that biodiversity citizen science is a promising format in environmental and sustainability education.

Modern technology has made citizen science more accessible today than ever before. I think that the strength of the citizen science model lies in its ability to connect people to their surroundings and by doing so takes a step towards undoing centuries of cultural separation from nature that have undoubtedly led to us disregarding the living systems around us

to push unsustainable economic growth. The increased resolution gained through the localization of biodiversity focused citizen science can significantly enrich the global picture while informing effective and nuanced environmental policymaking and conservation approaches. Leveraging people's connection and concern for their homes is known to be an effective way to encourage participation and sustained involvement in projects.

Citizen science works on mutual trust. Citizen scientists are trusted to do their due diligence and, in return, they trust that their contributions will serve a greater purpose and not be trivialized. In my opinion, the centralization of citizen science will create a power dynamic that will eat away at this mutual trust and might discourage participants. To make biodiversity citizen science successful on a global stage we must design systems that make room for self-organization and the creation of new ways of setting up projects that are perfectly suited to thrive in their respective niche. Finding a technologically mediated way to connect these niches to each other and larger systems of information exchange is a design problem that must be iterated on when thinking about expanding citizen science on a global scale.

Conclusion

Biodiversity focused citizen science shows tremendous potential towards creating a more conservation-literate society by taking complex environmental issues out of the scientific realm and inserting them into people's daily lives. Connecting abstract concepts like climate change and mass extinction to tangible exploratory experiences have the power to make ecologically positive changes in people's mindsets, attitudes, and behaviors. The success of biodiversity focused citizen science on a global scale can be achieved only by legitimizing citizen science, without losing its democracy and location specificity. Further research must be done to understand how we might integrate the seemingly opposing trajectories (institutionalization vs democratization) of citizen science. Resolving this dichotomy in a flexible, inclusive, and engaging citizen science platform is a design problem that is worth investigating as we work towards a collaborative future.





Rethinking Zoos

Transforming zoos to be leaders of conservation

Elisabeth Tai

Introduction

Introduction

The reason that I chose this topic is because of the debate on zoos. Are they good or bad? Many people have decided they are bad despite some positives they might have, for example, being able to

house wild extinct species and having an ability to reach a large audience. However, I see zoos as potential to become leaders in conservation, if strict regulations are implemented and zoos move away from being a source of entertainment while also

cracking down on zoos that are unqualified to care for their animals. Currently, captive animals are kept in unsuitable environments and that is detrimental to their mental health. Zoo visitors end only seeing a ghost of what the animal was in the wild.

Some animals are forced to perform unnatural tricks to entertain us and forced to exist in uncomfortable situations that they would not be in if they were in the wild. There is so much potential for zoos to reverse their harmful activities and to be educational. Instead of representing a collection of animals, the zoos of the world could become local sanctuary release centers that are geared towards conservation, education, and ethical treatment of animals.

Literature Review

I wanted to investigate Zoos that may have less funding and to see how they can manage the animals. An experiment was set up by the Wild Welfare audit, they sent two trained staff to 11 zoos in seven developing countries (Ward). Each zoo answered 110 questions and were marked on nutrition, environment, health, behavior, mental state, records, health and safety, other, and personnel (Ward). They were either marked a 3(acceptable), 2(questionable), 1(unacceptable), or N/A (Ward). The results in the categories related to the health and safety of the animals were shocking. On average, only 2 of 11 zoos scored an acceptable. The research could have picked better questions. Some questions, in the category environment, had low standards. A zoo can receive a 3 (acceptable) as long as the enclosure can lock in the animal and if the animal is not tethered, which is a low

standard. There were no questions on the size and comfortableness of the enclosure to the animals. That made me think that the tested zoos may be worse off than the data displays. The main reason zoos in developing countries lack animal welfare is because they lack the knowledge for proper care and opportunities to learn (Ward). These are serious concerns, if staff are unable to have the needed knowledge to care for these animals should these zoos exist if the animals will only suffer? This idea does not only pertain to developing countries but all places with zoos.

Next, I wanted to look at enrichment, one of the main selling points of zoos to ensure the public that they are engaging and treating their animals well. The science article that I looked at examines if and how enrichment is enriching for dolphins and how it may also cause harm (Lyn). One statement that stood out to me was how enrichment is rarely formally assessed, therefore it is hard to say if it works or not (Lyn). Furthermore, sometimes enrichment can be harmful, for example when an animal alters the enrichment object/toy is a way that could harm the animal. Another dangerous situation is when they start to exhibit dangerous or normal wild behaviors that might be difficult to manage in captivity. The last example of a dangerous activity is if animals in groups become aggressive towards one another when an enrichment toy is in use

(Lyn). I found how enrichment activities are not formally assessed to be misleading because of how enrichment is pushed to be beneficial to the animals. Logically it makes sense that a simple toy with food inside cannot appease an animal that would be a hunter in the wild.

Space is an issue for zoos. Is it fair for animals that were free roaming to be captive in small enclosures? Tigers held in small enclosures are affected mentally but also physically. Confined space has even caused an increase in infant mortality (Veasey). I found this information to be very interesting as it is not released to the public. When we hear of confined spaces in zoos we often think of pacing animals. Perhaps those who researched more might know about animals whom self mutilate. However, infant mortality due to small enclosures is not common knowledge, when it should be. Furthermore, small enclosures are unable to allow for natural behaviors such as hunting, which frustrates the animal (Veasey). I think people might start to relate during COVID. We are in quarantine for a short amount of time, but these animals are quarantined for their entire lives.

I wanted to learn about both sides of the argument, so next, I looked at an article that says zoos are positive. This specific article highlights the fact that zoos have had successful breeding programs, where originally endangered species are now no longer

endangered (Ganzert). However, I like how this article is not sickly positive. The article highlights how some zoos do not have the recourses and are more harmful than helpful (Ganzert). The article also sees the potential of zoos in combating the threats of the sixth extinction (Ganzert). I find that it is easier for reputable zoos to help ease the impacts of the sixth extinction. They have more resources like research centers, knowledgeable staff, and the money to run programming.

An argument for zoos is that they are an educational experience. In this article, two studies were discussed. One shows that 62% of children did not show a change in knowledge relating to animals or conservation. Another shows that 72% of the visitors had learned something new. However, the main issue with the second study is that the survey was taken immediately after the visit, therefore the knowledge is easily recalled (Kristen). I agree that zoos may be an educational experience, however many zoos have not taken this opportunity to build a truly educational experience. I only learned from zoos because my family would read every sign, which I enjoyed. But a typical person would be more interested in looking at the animal and glance over the visuals of the tiny placard for a second. The topic of education is where I see the most potential. There are many ways to redesign signs and to incor-

porate interaction alongside knowledge to make zoo visitors learn without them even knowing.

Finally, I wanted to look into where zoos source animals, specifically zoos rich in resources. Despite being a short article, I think this article says a lot about the transparency of zoos on the topic of where their animals are from. At the ZSL London zoo, they say that they bring in new animals mostly for breeding (Zoological Society of London), however, the entire article is very vague. They say animals are brought in when it “justifies their presence” (Zoological Society of London). What does justify mean, does needing an exotic animal on display a reason that justifies bringing in an animal? The zoo also says they send some animals birthed from breeding programs to collections to breed with other individuals. What I question is who are managing these collections and what do they count as a collection. The zoo also says they send some animals birthed from breeding programs to collections to breed with other individuals. The zoo also states in one sentence “In some very special circumstances we do get animals from the wild.” (Zoological Society of London). What are the special circumstances? There needs to be elaboration. Are wild animals only taken in when they are in critical need or are they taken in for other reasons unbeneficial to the animal? The article is very vague and

transparency and clarity are needed.

Discussion

It is vital to rethink zoos to become local sanctuary release centers that are geared towards conservation, education, and ethical treatment of animals. The new model is based on 5 main requirements. One, they should be local and well-funded, which means they should only have local species and that they can support. Two, they should only have release programs where animals that are brought in or bred will eventually be released into their natural habitats, unless special circumstances. Three, they should not be for entertainment. Human contact should be at a minimum. Four, they should be built for the animal, which means all enclosures and activities should be good for the animal’s body and mind. Five, there needs to a strong focus on educating the public so that visitors are motivated to continue helping in their daily lives. These are very drastic changes and I think it would take years for zoos to change their models. I also think that change will only happen if the government sets strict laws.

Zoos should only contain local species. This allows for zoos to effectively focus on preserving the immediate habitat around them. By taking in injured local animals (that will be healed then released) there could be a cycle of different animals that could educate visitors. This cycle could increase profit as there will be new animals every so often,

therefore bringing back customers. Furthermore, this could a chance for zoos to increase in-depth education programs for each temporary animal. Zoos can also start local breeding programs for endangered species in the area. Those animals from the breeding program will then be released until they are no longer endangered. Being local is beneficial for the animals because “exotic” animals are brought in for entertainment and to be looked at, which is not positive for the animal. This also helps zoos make money as they will have a higher return rate if there are new animals. On rare occasions, when an animal cannot be released because of extreme injury, it could stay as a special educator to the visitors. However, corruption may occur without strict regulations, for example, zoos bringing in local animals that are not hurt or endangered. That brings me to my next point.

Zoos need to be regulated, a good zoo should have an educated team of professionals, the ability to properly house animals, and not be driven by profit. If large zoos have trouble giving space to their megafauna then roadside zoos cannot be ethical in any way. Strict requirements need to be placed so that new smaller zoos lacking the resources and knowledge are unable to open. The best way to stop bad zoos that are already open is for the government to put in regulations where they

cannot breed or bring in new animals. The zoo can stay open (if these places are shut down displacement would be a huge issue) till the animals can be properly relocated. This gives these unethical small zoos some time to prepare as they could still be earning money. This, however, is a complicated issue and would need extensive planning to be successful. Zoos that focus on animals as entertainment, profit, and objects do not treat animals ethically. They are a bad example to visitors who will only learn that animals are toys.

Finally, human contact needs to be at a minimum. That means farther distances from enclosures and no close encounters, especially if they allow touching. Touching an animal can be stressful to them but more importantly, it teaches the visitors that these animals are meant to be touched and can be captive like pets. This can be a problem with people purchasing illegal pets. Close human contact may also decrease the chances of a successful release especially if they become reliant on humans in any way.

Conclusion

In conclusion, I think that there is a lot of potential for zoos. With hard work and more regulations, they could be leaders in saving endangered species. For the future new models that are for nature need to be tested and implemented, even if on a small scale. How can we allow the beau-

tiful animals to become educators and not entertainers? Most importantly we need transparency and strict rules within these organizations. That could be another question for future investigation. How can we demand transparency and high standards among zoos? How can we stop zoos that are taking animals from the wild, keeping them in horrible environments, and forcing them to do tricks? I urge large influential zoos to start making changes and rethink what a zoo is.

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Margaret Broughton

Ecological Thread Between Knowledge and Nature

Introduction

To many, the island of Madagascar is revered as one of the most unique biological hot spots in the world, but for me it is a part of my heart, mind, and home.

For four years, I lived on the great red island and I experienced the multiple complexities of trying to help both the people and its endemic biodiversity against larger global forces of corruption, climate change, globalization, and exploitation. Through informal interviews and preliminary data collection, I realized the capital held a starkly different perspective than that of locals living in the countryside of how they viewed themselves in relation to nature. In certain regions, farmers use a biocultural

approach to protect both endangered species and traditional knowledge systems, but such practices have been belittled as “uneducated”, or peasant farmer beliefs, by those in the city. When teaching in the capital, I noticed another pattern between both students and teachers knowing largely of the iconic ring-tailed lemurs (maki or “King Julian” in part to the popularized Madagascar animation film series) but could not easily identify other lemur species especially from the north or south. It is situations such as

Protecting **indigenous**
knowledge...

protects **biodiversity**



these I kept wondering why such knowledge production systems are becoming lost.

To help combat the 6th mass extinction, society must incorporate the needs, knowledge, and values of indigenous communities to find nature-based solutions. By incorporating these traditional values at global and institutional levels can help safeguard behaviors that are beneficial to both the future of community

engagement and biodiversity, especially to avoid reverting to previous destructive activities. This essay will highlight through articles and specific case studies: 1.) the symbiotic human and forest relationship 2.) the effectiveness and success of integrating traditional ecological knowledge (TEK) into conservation and government, and 3.) global awareness of how indigenous lands and beliefs overlap with biodiversity enriched areas.

Literature Review

The Symbiotic Relationship of Human and Forests

After reading “Indigenous knowledge networks in the face of global change” by Cámara-Leret et al. (2019) it was interesting to look across 57 neotropical communities where plants are held with the same high regard as cultural heritage, both symbolizing the act of regeneration of preserving indigenous knowledge both locally and regionally. The authors demonstrate that when plant species go extinct, the knowledge networks collapse, especially when cultural diffusion cannot occur through horizontal (neighbors) and/or vertical (nuclear) relationships. Significant correlation between distance and knowledge exchange that “differences in knowledge increase as communities are farther apart...simulated loss of species (plant nodes) or knowledge (links)

across communities affects the robustness of the metaweb.” (Cámara-Leret et al 2019, 3). When plant species are driven to extinction, the large metawebs decrease, indicating when plants are gone it threatens human well-being due to the loss of cultural heritage; that the “simultaneous loss of both biological and cultural heritage leads to much faster erosion of indigenous knowledge metawebs” (Cámara-Leret et al 2019, 4).

This links to the article by Styger et al. (1999) of “Indigenous fruit trees of Madagascar: potential components of agroforestry systems to improve human nutrition and restore biological diversity” highlighting the importance of local farmers and rural communities living next to forests; that much of the information of native plant resources in primary forests largely resides with rural populations keeping a close interrelated relationship with the forest. Additionally, local frugivorous lemur species are highly dependent on these indigenous fruiting trees which are dire for successful regeneration of flora vegetation (Styger et al. 1999, 307). This loss of knowledge is occurring due to poorer sections commercializing fruits and, more largely, people migrating to urban cityscapes causing displacement as groups move further away from primary forest and a significant gap between older and younger generations to transfer knowledge. A reduction in “forest knowledge and its benefits can lead to alienation and indifferent attitudes of

how local people situate themselves to these resources, resulting in haphazard exploitation of the forest resources. The vicious circle of primary forest destruction continues while traditional consciousness and natural resource management skills are being progressively lost” (Styger et al. 1999).

Awareness and Success of Community Based Strategies

In the article “Local awareness and perceptions: Consequences for conservation of marsh habitat at Lake Alaotra for one of the world’s rarest lemurs” by Waeber et al. (2018), a similar pattern arises how community knowledge, ecological value and awareness were heightened next to the park and lake. However, the authors discussed how local knowledge, like fishing grounds and seedling nurseries, need to be identified early on during conservation planning, by emphasizing current values can help safeguard (both ecology and community values) from unexpected immigration for natural resource profit that are non-local specific values. The results also indicated majority of people were unable to estimate the size and purpose of the park, prompting an important question “without understanding the purpose and potential positive impacts of a protected area, or knowing the delimitation of a protected area’s boundaries, how can local communities be expected to support the protected area and

respect its borders?” (Waeber et al., 2018, 682)

Such traditions of the community are crucial for the success of biodiversity survival, as the results from Waeber et al. suggest improving resource use management within protected areas can occur if a balance is maintained regarding the needs of the local community: food, water, health, beliefs, and income. By attempting to support these areas, conservation can restore, rebuild, and maintain positive attitudes towards protecting intact ecosystems and endangered species, without risking exploitation and commercialization. “There is hope that with improved protection and management Lake Alaotra’s marsh and unique lemur species can survive in an anthropogenically shared landscape” (684-685).

According to the IUCN, USAID, and Save Our Species (SOS), from 2019-2020 there have been new localized projects in Madagascar, successfully working with local communities to continue biodiversity efforts, by specifically focusing on integrating traditional community-based knowledge systems (IUCN & Save Our Species; USAID Hay Tao). In the article *How traditional knowledge forests helping save lemurs* on the website Save Our Species (SOS), it states “in a country where 60% of people are under 25 years of age, capturing and transferring traditional knowledge across generations that can improve [lemur] conservation actions

is a race against time”. In relation to this generational knowledge, SOS worked with 160 Bara people who consider the forests as sacred that it is the spiritual home of their ancestor(s). The Lonaky, local Bara Kings, have insisted that their descendants respect the sanctuary to ensure the future of their community.

One of the main objectives for this SOS project was to “empower indigenous peoples with skills and livelihood options to help them co-exists with lemurs, as well as support local communities”. Through such organizations and projects locals have been regarded as an instrumental process in choosing how to strengthen ecological communities, carefully choosing native species of plants that is suitable for growing as well as interpreting the needs of landscapes like traditional firebreak to prevent destruction against key forests hosting lemur species. With the right support from both regional and global forces, local communities and conservation can thrive and flourish together, as observed with the Bara, the forests to this day remain intact due to the protection by the community’s behavior and values, which is now supported by SOS and local governments.

Global Awareness of Displaced Indigenous Groups

In an article “Biocultural approaches to well-being and sustainability indicators across scales” by Sterling et al. (2017), the

authors highlight how in situ-based models and culturally grounded perspectives are greatly lacking from medium and large-scale organizations created by government and national institutions that are attempting to achieve successful and sustainable resource guidance and management (2017, 2). The article introduces a model that can be used by scientists and political organizations to recognize indigenous groups, using the term biocultural approaches –building upon the foundations of local cultural perspectives, to encapsulate their wellbeing: values, knowledge, and needs in relation to the ecosystem.

If resource managers, scientists, and policy makers adopt this approach, it would stimulate and facilitate a linkage and communication between local and global systems, especially to evaluate what in situ indicators are missing from many regional and international frameworks of sustainability. If global and regional institutions do not integrate community needs and values, it can result in “large miscommunication, misdirected resources, and policies that fail to inspire appropriate action [or behavior]” (Sterling et al. 2017, 3). It is the local and traditional ecological knowledge (TEK) that allows a “creative resilience response” to environmental stressors, however, both researchers and stories have recently indicated a low capacity of such resilience by both humans and ecosystems to frequent outsized impacts and global pressures

(Sterling et al., 2017, 4).

The author Julia Watson, in her book *Lo-Tek: Design by Radical Indigenism* (2020) similar to the biocultural model proposed by Sterling et al., highlights four interrelated levels of ecosystem management known as the Knowledge-Practice-Belief Complex, that can be utilized by governmental and scientific disciplines. Watson also expands on nature-based solutions and technology across cultures through indigenous or LoTEK designs (local traditional ecological knowledge systems). “It is these complex systems that helps humans and nature live in symbiotic status with one another” (Watson 2020, 20). The Shadow Conservation Network is also briefly discussed, stressing the importance of how protected sacred lands encompass much of the world's cultural and biological diversity. It is not surprising the correlation between the mass extinction of earth's species is closely related to the displacement of millions of indigenous people (Watson 2020, 21-22).

Discussion

Based on the literary sources and conservation projects, there has recently been great strides and success in research and sustainability projects integrating local values, helping to illustrate that nature-based solutions are not only protecting cultural heritage and knowledge but keeping alive

biodiversity through knowledge transmission. The authors Watson, Waeber et al., and Sterling et al., all demonstrate the collective society must apply new methodologies of how to understand, design, and communicate traditional knowledge systems, as well as how to better recognize and develop indicators of success for communities at the scientific, global, and international level. By using the biocultural model, we can help promote local values that help safeguard biodiversity and community engagement, like that with sacred forests where spiritual beliefs and practices are often overlooked, when they symbolize other forms of appreciation, respect, generational knowledge, and science.

Including and supporting local traditional knowledge through government and policy planning will less likely cause individuals to relocate for personal gain (economic or wellbeing), which brings in another important topic to be explored – the causes of relocation and displacement of indigenous communities. Cities, like the capital of Madagascar, need to reconnect with nature to relearn traditional knowledge systems of the past to value what is left of the country's ecological system, especially younger generations who are essential in continuing the transmission of this knowledge. This can then better integrate and reshape the negative stigma of how groups in the capital identify rural communities and their own agency. That “indigenous communities are

care takers of lands and seas that encompass a significant portion of the planet's biodiversity and carbon stocks” (Sterling et al., 2017, 4). Although indigenous communities have survived climate change before, through traditional technologies and practices, “they cannot survive this global displacement. Their knowledge is dependent upon multi-generational interactions within ecosystems” (Watson 2020, 10).

Conclusion

When first given this assignment, I was excited at the opportunity to do an art piece for this class in relation to the 6th mass extinction, to illustrate the importance of integrating cultural values by protecting indigenous communities at local, governmental, and national institutions. However, creating an art piece in relation to the literature became a complex task especially how to influence and reshape the current values and behaviors of those in the city and government, to promote protection and implementation of a biocultural approach.

Much of the literary resources pertinent to this essay were before 2016 but illustrates an observation from the articles that more work is needed to be done to fully understand local beliefs and how to integrate community-based values. The research process was also gratifying as more scholarly articles and projects have

surfaced across cultures, not just Madagascar, in relation to sacred ecology and indigenous knowledge systems, which helps empower and validate the farming communities I was working with in Madagascar. It would also be interesting to create a project in the capital to have artists, schools, and government officials come together to exchange ideas and art on how to work together to inspire and promote understanding and support of ecological communities and the people living next to them.

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REWILDING HOKKAIDO

A Future for Red-Crowned Cranes in Japan



Introduction

This paper will investigate to what extent strategies of rewilding can be employed to protect and rehabilitate populations of the red-crowned crane (*Grus japonensis*) in Hokkaido to further population stability and avoid species extinction. According to

Jepson, rewilding can be defined from a policy-perspective as “a multifaceted concept with three broad dimensions that interact with each other: 1) restoring and giving space to natural processes, 2) re-connecting wild(er) nature with the modern economy, and 3) responding to and

shaping cosmopolitan perceptions of nature conservation among society.” (Jepson, 2016) The first point in this triad refers to restoring a functioning and healthy ecosystem by re-establishing a balanced food-chain flow through the reintroduction of species. Secondly, the re-establishment of wilderness must have a sustainable future

in relation to its co-existence with post-industrial human systems. Thirdly, rewilding includes the shaping of human perception of nature and its value to us. This paper will investigate rewilding and its implications as a general concept as well as its applicability to the case study of red-crowned cranes in Japan. Due to the destruction of more than half of Japan’s wetlands since the 18th century, red-crowned crane populations have dwindled and were pushed to the brink of extinction. The applicability of strategies of rewilding in the context of an increase in the abandonment of farmlands in Hokkaido will be investigated to find out the most suitable strategy to safeguard crane populations. Finally, this paper will discuss a case comparison between the government’s rewilding attempts of forests to help recov-

er populations of the golden eagle (*Aquila chrysaetos*) to show the potential of restoring abandoned, post-industrial landscapes.

Discussion

The majority of ecosystems have been detrimentally impacted by human existence. We are currently experiencing the sixth mass extinction in the age of the Anthropocene. Rewilding seeks to reverse biodiversity loss by giving back landscapes that we have altered to wilderness. (Perino et al., 2019) While rewilding has become a very fashionable term in recent years, this paper will also look into its possible downsides. Finally, various strategies of rewilding, ranging from passive to trophic, will be compared and contrasted to better understand their degree of applicability to the case of the red-crowned crane.

Due to the expansion of agriculture, wetlands have become one of the most critically endangered ecosystems in the world. Farming, resource exploration (oil), aquaculture and most recently lack of water due to decreased rainfall and/or irrigation represent the main causes for shrinking wetlands in Japan. Due to habitat loss and deterioration, the red-crowned crane (*Grus japon-*

ensis) continues to face problems relating to population instability. (Su, Zou, 2012) In contrast to migratory red-crowned crane populations in continental China, Japan's populations are non-migratory. The main problems encountered in the context of Hokkaido's crane population include a lack of genetic variety, too few feeding stations, conflict with local farmers, traffic accidents because of breeding grounds' proximity to urban structures and wetland degradation. (Masatomi, Masatomi, 2018)

The red-crowned crane's name is derived from a bare red part of skin on the top of its head. Its feathers are often white, grey and brown with a considerable part of its wings and throat charcoal or black. Red-crowned cranes are one of the tallest crane species in the world, with adults reaching a height of up to five feet and a wingspan of around eight feet. These cranes have sharp, dark green beaks and feed on small amphibians and rodents as well as reeds and other aquatic plants found in wetlands.

They also bear cultural significance in countries across East Asia, including Japan, China, Korea and Mongolia. Red-crowned cranes are famous for being monogamous and their impressive courtship behaviour. The cranes' courting dance has inspired arts

and literature for centuries across East Asia because of its perceived beauty. Currently, *Grus japonensis* is the second most endangered crane species in the world, as there are around 1,800 cranes living in the wild, but numbers are dropping. This observation has to be understood in the context that a much larger decline in numbers can be attributed to habitat loss for continental populations in China rather than the Japanese populations that are concerned in this case study.

The focus of this paper lies on the intersection of human population decline because of ageing in Japan and what opportunities this opens up for rewilding projects for wetland ecosystems inhabited by red-crowned cranes. The thesis of this investigation is to show that multifaceted rewilding strategies in combination with respect and inclusion of local communities could play a significant role in increasing crane population size and therefore preventing species extinction.

Japan's Ageing Population and Farmland Abandonment

As mentioned above, the main driver endangering red-crowned crane populations in Japan is farming and its correlated degradation of wetlands. Due to Japan being the

“oldest” country in the world, with 32% of its population over 60, and an increasing trend of urbanization, rural landscapes that were formerly used for farming are now increasingly being abandoned. It is important to note that researchers view “farmland abandonment as an opportunity for habitat regeneration, with an added nature value from forests or grasslands restoration(...)” (Su, Okahashi, Chen, L., 2018). Hence, the current situation in Japan represents an ideal opportunity for the implementation of rewilding strategies that target abandoned farmlands and the protection of red-crowned cranes.

In its early stages, rewilding as a concept focused on the rehabilitation of large swathes of land for the purpose of re-introducing large carnivores, but it has since progressed to embracing a more case-specific, dynamic character. According to Perino et al., the two major areas of focus for rewilding should be the “trophic complexities” or variance and diversity of food sources available as well as species dispersal, which refers to the availability of sufficient space to allow for population increase. (Perino et al., 2019)

As part of understanding the concept of rewilding, one has to acknowledge the variety of ecosystems and their inherently different characteristics. A one-fits-all

model is therefore not only unrealistic but could cause damage and destruction if implemented in the wrong ecosystem. Furthermore, it should be noted that rewilding projects should never disregard variables in direct proximity, such as local communities and their interactions with the ecosystems. Rewilding has to take researchers, managers and local stakeholders into consideration when planning a project. While often perceived as restoring wilderness, many scientists agree that depending on the case, a certain degree of management or human interference might be impossible to avoid. The more precisely formulated the end goal of a rewilding project is, the more human interference is required to decrease uncertainty and increase predictability. In the past, rewilding projects have faced criticism when disregarding local communities by trying to implement a universalist approach. Therefore, it is crucial to understand the importance of “home-grown” solutions that facilitate local knowledge for problem-solving. The significance of local involvement is also highlighted by Perino et al. in underlining that rewilding needs to “account for social-ecological dynamics, from the point of view of both addressing people’s preferences and the effects that humans have on ecosystems.” (Perino et al., 2019)

In the case discussed in this paper, strategies of rewinding will be applied specifically to the increasingly abandoned farmlands in Japan. As seen in cases such as the “accidental bird paradise” in the demilitarised zone between North and South Korea, allowing formerly populated landscapes to rewild can result in an increased population size of cranes. (Seely, R., 2019). Here it should be noted that while rewilding with a focus on a specific species might be the starting point, it usually allows for a net positive impact on population increase of other species inhabiting the same ecosystem. In the Korean case mentioned above, the demilitarised zone not only allows for red-crowned crane populations to grow but also those of other critically endangered species such as the Asiatic black bear, leopards and Korean tigers. (Seely, 2019) It is critical to understand this since the rewilding of ecosystems might sometimes need an “ambassador” species that enjoys popularity in order to start the process, which has the potential to result in an overall benefit for a whole list of other endangered species that could go unnoticed.

In the context of abandoned farmlands, it is important to understand that farming in close proximity to red-crowned crane breeding grounds is not necessarily negative. In the Korean Anbyon planes, popu-

lations of red-crowned cranes benefitted from surplus harvests during the fall and winter months until farms increasingly became abandoned and no food was available anymore. (Seely, 2019) What seems to be central to population stabilisation of red-crowned cranes is organic growth and the availability of food resources and space. Connecting this to the case study of Japanese crane populations, their more recent increase in numbers has created a social dilemma. While population size has increased over the last decade, this had a considerable impact on the way humans interact with cranes. In Hokkaido, where most of the cranes are located, farmers increasingly complain about destroyed crops. On one hand, the wetlands representing the cranes' original habitat continue to shrink, while on the other hand rewilding efforts are not supported sufficiently to allow for the recent increase of population size to spread, therefore resulting in cranes ending up in human territories. (Hiroyuki, I., 2017)

This development implies a myriad of risks for cranes. Many cranes have gotten used to being fed by humans and therefore have lost the fear of being in close proximity to settlements. This has caused an increase in traffic accidents, with crashes amounting to up to 10% of overall crane deaths. More-

over, an increasing number of cranes have started to steal food from farms in order to survive. This has consequently frustrated farmers who have sometimes stopped feeding cranes altogether. Hence, the issue in the Japanese case is clear: since the 1800's, almost 50% of marshlands in Japan have disappeared, turning red-crowned cranes into a critically endangered species with no real home, which is then left to wander and becomes dependent on being fed by humans in order to survive. While recent efforts to increase crane population size have succeeded, it was a single-layered approach that disregarded the long-term consequences of larger crane populations and their impact on human settlements. Momose Kunikazu, the chairman of the Red-Crowned Crane Conservancy (CRR) emphasises that "We can reduce their feed to encourage the cranes to disperse, but the marshlands that provide them with a safe habitat are not available throughout Japan. There are actually very few areas where they can subsist on their own. In fact, they may become even greater threats to local crops, inflicting even more damage. The question is how the cranes and humans can coexist. We need to explore methods of conservation based on scientific data that will continue to be effective thirty to fifty years from now." (Hiroyuki, I., 2017)

What has become apparent is that sustainable, long-term conservation efforts are required to not only safeguard the stability of red-crowned crane populations in Japan but also their existence in harmony with humans. Nakamura's argument for a rewilding of abandoned farmland in Hokkaido represents a strategy that focuses on the red-crowned crane employing the status of an umbrella species "requiring large areas completing their life cycle" therefore also "offering protection of other species that share the same environment." (Nakamura, 2018) Research by Japan's National Institute of Population and Social Security Research has predicted that populations in East and North Hokkaido will decrease by around 40% over the next 30 years. (Nakamura, 2018) Therefore, the restoration of abandoned farmland into forests and wetlands represent a key strategy that allows for the further population expansion of red-crowned cranes as well as a decrease in negative crane-human interactions. Successful case studies of rewilding and stabilising endangered avian species in Japan already exist. Over the last 75 years, Japan's disastrous forestry policies resulted in the majority of forests turning into timber monocultures, pushing the golden eagle (*Aquila chrysaetos*) to the brink of extinction. Just like the red-crowned crane,



the golden eagle is an umbrella species. Therefore, the restoration of timber monocultures into natural meadows and diverse forests benefits not only the eagles but also encourages the population growth of bears, rabbits and endangered deer inhabiting the same ecosystem. (Bird, 2017) Just as in the case of the abandoned farmland in Hokkaido, the timber business in Japan has seen a decline in profits resulting in its gradual abandonment. Hence, over the last two decades, the Japanese Forestry Agency has slowly embraced the reconversion of monocultures into diverse, ecologically rich forests. It is predicted that within the next century Japanese forests could be restored to diverse landscapes with gaps due to fallen trees essential to hunting golden eagles. The main conclusion from the golden eagle case study is that rewilding is a slow process and government support remains insufficient to achieve large-scale change. One of the suggestions of the Nature Conservation of Japan is to generate income by creating a brand around “eagle-friendly” products whose profits feed the effort of rewilding. Applying this notion to red-crowned crane populations in Hokkaido, the branding of rewilding projects appears to be a key resource to generate necessary funds as an incentive. Whether or not abandoned farmland is available or public support is

present, restoration projects are always dependent on available funding. Should the Japanese government not fully embrace the suggested rewilding efforts in Hokkaido, alternative monetary sources could function as a crucial factor determining success.

Conclusion

The discussion of this case study has shown that due to an ageing population in Hokkaido and a trend of urbanisation, there is a significant potential to restore abandoned farmland into wetlands. Moreover, a recent increase in red-crowned crane numbers and a concurrent lack of available space for this umbrella species has resulted in clashes with human settlements, potentially posing a threat to the long-term stability of crane populations. This paper has shown that earlier conservation efforts focused too much on short-term gains rather than envisioning the long-term health of the cranes. Dependency on human-managed feeding stations or farms represent problematic factors in efforts to protect the species. Hence, it was proposed that rewilding poses a viable strategy that allows red-crowned crane populations to fully recover. As evidenced by cases such as the demilitarised zone in Korea or the very recent efforts of the Japanese gov-

ernment to restore diverse forests to protect the golden eagle, rewilding represents a successful tool for biodiversity protection. Nevertheless, it should also be noted that rewilding as a universalist approach is potentially problematic as it must take into account nuances and local variables unique to each case. Finally, the success of ecosystem restoration depends not only on the visibility of an endangered species but also significantly on the willingness of local populations to cooperate and the funds made available by the government to allowing for full implementation.

Abstract:

Serving the Chinese citizens for thousands of years, the Yangtze River is currently in a bad shape. People need to reflect on the impact of human activities and change their values and behaviors. People should pay more attention to the ecological system and biodiversity of the Yangtze River and its vicinity regions.

Introduction:

The Yangtze River, which has bred the Chinese nation for thousands of years, is in danger. It is time for humans to take the responsibilities. Ancient Chinese citizens have established village tribes along with the Yangtze River since Neolithic Period. Originated from Tanggula Mountains, the Yangtze River flowing through the Qinghai-Tibet Plateau, the Sichuan Basin, The Yangtze Delta, and finally reached the sea. As the largest river in East Asia and 3rd longest river globally, the



- Chinese paddle fish extincted in 2019.
- Hilsa Herrings and Chinese River Dolphin have respectively functionally extincted in 1990s and 2002.

Take Action Now: Save China's Mother River in Time

Yangtze River is considered the Chinese nation's mother river. It supports the lives of more than 400 million people. However, the Yangtze River's situation is predominantly challenged by the growing need of the population, over-exploiting natural resources, global climate issues, and reducing biodiversity. Therefore, it is urgent and necessary to consider and implement the Yangtze River's conservation from ecological and sustainable perspectives and reevaluate human position in the environmental system. (Lander, Brian 2014.)



A sociologist would say that society and environments often influence individuals' perspectives. The formation of value is a long term process. It is crucial to understand the history of the target

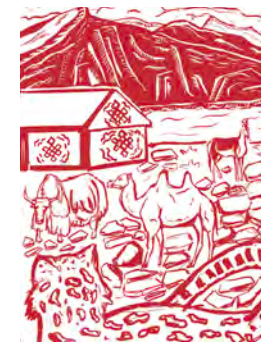
region to advocate actions and instructed changes. Furthermore, a region's values are also heavily defined by civilization's level and technological advancement. Chinese people's recognition of their relationship with natural resources and wildlife have been continuously changing throughout history. Archeological discoveries have discovered sapiens settlements and hunting and living tools from the Neolithic period in regions along the Yangtze River and Yellow River, another primary water resource of ancient China. Throughout the history of over 4000 years, Chinese people have established over eight centralized feudal regimes. There have been splendid and ambitious projects of people who tried to challenge nature. Chinese citizens have proved their intelligence and dedication by accomplishing project such as the Beijing-Hangzhou Canal. The project was initiated in 486 B.C.E. and completed in the 6th century. The canal has been continu-

ously adapted through history and has been functioning till today. Since then, Chinese emperors have considered water-controlling and management as a showcase of their abilities and authorities. Chinese tradition maintain the control and utilization of natural and water resources in recent decades. Throughout history, Chinese people took a human dominance perspective and rarely considered from an ecological perspective. However, technological and scientific advancement and the human population's ever-growing need have already caused tremendous destruction and effects on the Yangtze River region. Hence, the primitive focus should no longer be either citizens' life quality or the energy generated from the power station, but the long-term benefits of taking an ecological equilibrium perspective and proceeding conservation of biodiversity.

Literature review:

After establishing the Republic of China in 1912, the contemporary president Sun Yat-sen proposed an ambitious project that could be considered an initial version of the Three Gorges Dam project. When the project is revisited after the formation of the People's Republic of China, it had been long experiencing debates between its potential of bringing tremendous energetic produc-

tion and reinforcing flooding control and the possible destruction it might cause on the environment. Historically, the Three Gorges Dam has reduced the country's reliance on Coal and dramatically reduces the pollution caused by coal-burning while producing a sufficient powering system that dramatically changes people's lives. New cities, such as Chongqing province, were established. One of the significant economic regions, the Yangtze delta, was formed because the Three Gorges Dam also caused long-term effects on people's lives next along the river. Native people experienced mass immigration, and the ecotourism of the dam was introduced. The flooding control also changed the farming method and increased the number of crops by reducing its effects. The Three Gorges Dam has indeed caused a significant impact on increasing the countries' energy output and economic income in the past decades.



However, it also caused a sequential effect on the environment and wildlife species that initially lived in the region. Thus, it is essential to be aware of the current issues brought up by the construction

of the Three Gorges Dam. Contemporary scientists have proposed that it is superficial to merely focus on visible economic benefits and be aware of ecological conservation's permanent benefits. It is time to revisit the constructions along the Yangtze River and their impact on the ecology and natural environments. People need to be aware that this is not only for other species but for humans themselves. (Ke, Zhang, 2018)



According to Kaifeng et al., “Dam is an example of human’s attempt to control nature.” The Three Gorges Dam’s original aim was to reduce the gap between supply and need while minimizing the flooding impact in developing China in the last century. This trend is continuously extending currently. For example, the Shennongjia Nature Reserve, located in Hubei Province with 3253 km², is rich in animal resources while encompassing three vertical vegetation zones. For its ecological value, it is known as the heart of the Yangtze River’s middle reaches. However, it is estimated that 90 dams have been established in the surrounding area, and one of

them reaches the height of 96m.

Moreover, another ten dams are under construction while four new dams have been planned. These could cause massive danger to the environment and biodiversity of the Shennongjia Nature Reserve. (Kaifeng, Li, 2013)

By the end of the 20th century, there have already been more than 22000 large dams established in China, which are almost half of the world’s total. Compared to the fact that there were only 22 large dams before 1949, this tendency reflects China’s tremendous energy demands caused by its rapid progress. Dam construction in the Yangtze River basin is growing at an alarming rate, and if this tendency continues, the speed of dam construction in China is expected to be higher. The large quantities of dams and changes in water flows could cause tremendous pressure on the surrounding environment. Since Carder first pointed out the earthquakes could be triggered by water reservoirs, more quakes were recorded. The impoundment of a reservoir can reduce rocks’ strength by reducing friction or reducing rocks’ cohesive power. Seismic events in the dam region have indeed been increasing in recent years. Even though the massive earthquake

events such as the Wenchuan earthquake in 2008 are majorly agreed by Chinese scholars not caused by the Dam projects, people should still need to be aware of the dams’ potential effects.

Furthermore, there have also been frequent landslides in the Three Gorges area. Slope instability links to geological and socioeconomic environments. After reservoir impoundment and the associated resettlement to higher ground, the frequency and magnitude of landslides are expected to increase through the reactivation of old landslides and the triggering of new ones. Studies showed that there had been an evident slow increase of landslide occurrence on valley slopes of the Yangtze River is found, with an increase in the casualties and holes families from individuals. Studies also revealed a connection between the amount of impoundment and the frequency of mountain slides. (Kaifeng, Li, 2013)



Moreover, the Three Gorges dam also raises challenges in the aspects of water quality control. The Yangtze River’s primary pollutants are natural runoff from the upper streams,

industrial and domestic wastewater and agricultural runoffs, waste materials from shipping, and internal sources of the contaminant from toxic industrial sediments left behind. Hence it is clear that human activities have significantly affected the natural environment and habitats for wildlife species. Therefore the impacts of the dam.



Human activities also have sequential effects on the ecological system and result in a wide range of regional changes in terrestrial and aquatic biodiversity and ecosystem

structure and functioning. China's flora center and habitat for over 1777 kinds of fishes have become more and more fragmental. The change of flooding period and flooding intensity also changes the fishes' prodding period, which has pushed the Chinese sturgeon into a dangerous situation. Chinese paddlefish, river dolphins have become extinct because of the destruction of habitat. The Three Gorges dam's impact is terrestrial and impacts the down streams, Yangtze River mouth, and adjacent shelf region. The modified river flows also change the amount and compo-

sition of sediment and nutrients and affect the vegetation of wetlands and cause soil salinization. The dam's construction could even be harmful to citizens because it is highly used for farming and living. There are also indicates of Three Gorges Dam being effective for precipitation and temperature in vicinity areas. (Kaifeng, Li, 2013)



Last but not least, the project has also been caused by the sediment discharge decline. Yangtze River traditionally carried a vast load of sediment from the upper reaches of its watershed to the East

China Sea, hence flourishing the river delta's fisheries and ecological process. The reduction of sediment and downstream channel erosion occurred because large quantities of deposits were trapped behind the Three Gorges Dam. This process added considerable pressure on the Yangtze coast and the East China Sea.

(Chen Xiqing et al. 2005)

The Three Gorges Dam is only one product caused by human actives. Chinese governments have once increased the number of planters and protected zones around

the Three Gorges Dam region to preserve animal species around the area. However, those protected zones were lately used for ecotourism, and their value for species protection needs to be further discussed. Furthermore, farmers have been enlarging their farming spaces and invaded animal habitats. Farmers have also overkilled snakes and other animal species that they sought to be harmful to their harvests without considering the impacts on eco-balance systems. Farmers used many foreign species to increase crops, which also affects the local ecology system. Overfishing has also taken place in history. Hilsa herring had once been considered a typical delicacy from the Yangtze River and had been hunted till functional extinction. Currently, the species could only breed artificially. Chinese sturgeon is another example of sufferinf from overfishing and habitat destruction and current living on



artificial breeding. A similar pattern could also be discovered at the origin of the Yangtze River.

Indigenous farmers and nomadic assemblies did not receive enough guidance from the scholars and do not have an awareness of

protecting wildlife habitats and biodiversity. A case of over-killing of wilder wolves had once taken place and ended up with an increased amount of wild rabbits. The overwhelming amount of rabbits destroyed vegetation, farmland, and the ecological system. Animal poaching has also been another issue that destructs biodiversity in China. Species are hunted for animal trades and Chinese traditional medicine, such as antelopes, Yangtze alligator, and pangolin. The extinction of paddlefish also caused an increasing amount of carp and catfish. People need to be aware that ecological issues are sequential and could lead to significant outcome. (Bai-ping Zhang 2002)



Scholars Ke Zhang et al. have conducted a case study on the Freshwater ecosystem and transitions in the Yangtze River Basin over the past century. By focusing primarily on the Changdang Lake, which is located in Yangtze Delta, the scientists aimed to dig into the relationship between the ecological and social systems to get inspiration from lake management. The essay concluded that the environmental shift corre-

sponded to significant social and economic transitions. Chinese societies transitioned from the traditional agricultural-based culture to an industrialized and urbanized society by developing technology, market, policies, cultures, pollution, hydrological modification, and land reclamation, which are the drivers of the ecological shifts ChangDang Lake. The authors address the links between the demands of people and the dynamics of the lake ecosystem. (Ke, Zhang, 2018)

Discussion

While people try to resolve a problem, new problems would be raised, and humans are fully responsible for the newly established problems. Even though there is no such thing as “truth” during scientific and cultural development, people should be open to ideas and changes always be aware of self-reflection of their behaviors. Therefore it is significant to advocate for value shift and cultural differences. Humans need to be mindful that they are also part of the ecological circle and protect other species in nature. People need to understand the long-term benefits of protecting environmental systems and biodiversity for the animals and humans themselves. However, according to Manfredo et al., “Deliberate value shift is improbable. Being aware of the

cost of the shifting public’s value might be particularly crucial in the Chinese region, considering the large geological and cultural variations, economic status, and educational level between various locations.



Therefore, it is always vital to figure out an effective way to allow scientists to educate the indigenous people and workers. The government also needs to function as a supervisor, administrator, and supporter when the society and country pursue ecological balance and biodiversity.

Here are some possible solutions for saving biodiversity along the Yangtze River:

- 1) Increasing government funds for institutions and protection zones send more scholars and experts to help local farmers to help them learn about biodiversity and ecology.
- 2) Investigating new forms of energy to reduce the reliance on water power. Technologies like solar powering, wind powering, and hydrogen powering may be investigated.
- 3) Stop establishing more dams. Set up barriers to ensure the natural breeding of fishes. Establish more protection zones for fish.

4) Use online media to access broader audiences and educate the public more effectively.

5) Scientific organizations, governments, and animal protection organizations might establish apps or online platform for data and information sharing and multidisciplinary communication.

6) Increase fellowships and grants for scientific projects related to the field to attract more scholars.

7) Investigating apps and supervising systems against poaching and over-farming. Reinforce physical borders of protection zones and animal habitats.

8) Using cultural and historical aspects to advocate the public's love for the Yangtze River and hence cause more action.

9) Reduce dam utilization in spawning season, adjust reservoir action in the spawning season, scientific arrangement human-made flood peak. (Fan et al. 2006)



The critical issue of the conservation of biodiversity in China is that majority of the public have not recognized the severity of the problems and still believes The significant difficulties of implementing solutions

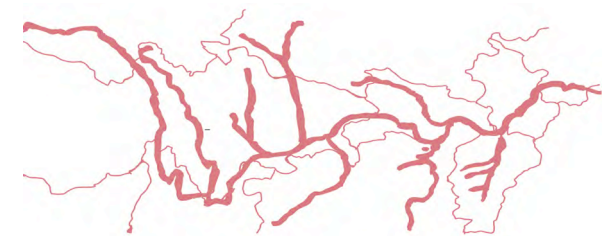
for protecting the ecological system would be communicating ecological perspectives to indigenous people. However, being aware that value shifts are a long term process, scholars and governments need to have a long term perspective rather than focus on economic aspects. Only if the society changed as a whole, the individuals could be better evaluate their behaviors.

Conclusion



The Yangtze River is in a dangerous situation because of human activities. Chinese citizens who have utilized the natural resources of Yangtze River for thousands of year-end are responsible for protecting the region's ecology and biodiversity. However, biological diversity is still a relatively novel concept for Chinese society. Many people have not fully understood the consequence of ecological issues and hence scarcely put them into action. Furthermore, society has just experienced urbanization and industrialization. Therefore shifting the value of the society might need extra effort and particular methodologies. However, three species in the Yangtze River have already extinct, and the negative

impact of the destruction of the ecological circle is hurting humans themselves. The most effective method might be constructive a more effective educational system through the internet will put into actual efforts such as establishing protection zones. All in all, it is time to change.



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LOUIS HAND

RHODE ISLAND FISHING AT A CROSSROADS

Climate futures in aquaculture and revitalization



Rhode Island's fisheries are one of the state's most culturally significant industries, not to mention one of the critically threatened economic resources for coastal communities. The influx of urban and suburban expansion along the coast has caused many human-induced pressures on the environ-

ment. Issues of climate change, hypoxia, acidification, and physical degradation are changing the water quality and causing loss of habitat. Rhode Island native fish populations are moving to colder, deeper waters and are in decline due to disruptive practices. The long-term future of Rhode

Island's unique coastal ecosystem depends on proper management of its fisheries, including developing shellfish habitat around (new) wind turbines and revitalizing eelgrass populations along the coast.

The shorelines of Rhode Island collect toxins, debris, and particulates concentrating

from runoff across the state. These account for some of the most volatile changes in ecological well-being and can directly impact consumer health, as wildlife ingests pollutants. High levels of mercury and PCBs contaminate mussels and fish near these developments. (State of Rhode Island, 1). Shellfish are not safe to eat in large quantities due to these metals and chemicals, even though the mussels naturally provide omega-3 fatty acids beneficial to brain development. As urbanization continues, mussel farms and fisheries will be compromised more distinctly. For instance, the acidification of the water caused by carbon emissions will inhibit the formation of mussels shells. They will henceforth spend more energy to build their shells than reproduce and grow. (Ekstrom, 1). Regulations

have impacted clam and oyster fishermen's livelihood, as these species become more dangerous to consume and more regulated to sell. If the hard infrastructure (roads, roofs, parking lots) affecting the runoff are not upgraded to semi-permeable surfaces, then the fish habitation will be increasingly at risk. Water quality degrades when there is more than 10% of the watershed covered in hard-surfaced roads. Since 14% of Narragansett Bay and more forested land along the Taunton River and Pawtuxet River will be urbanized, there will be more compromised habitat (Ferguson, 1). The effects of the hard-surfaced cities and roadways have negatively impacted our watershed, inhibiting groundwater replenishment. Due to climate change, precipitation events are becoming heavier but less frequent, causing drought in between the rainfall. These storm patterns and infrastructural faults contribute to polluted runoff and low water quality.

Current initiatives like "Save the Bay" and "Eating with the Ecosystem" work towards helping the public understand the multilayered needs of Rhode Island's environment through community engagement. Eelgrass and SAV (submerged aquatic vegetation) have been replanted to sequester carbon. Eelgrass has a monetary value twice that

of coral reefs, mangroves, and salt marshes in the ecosystem services they provide. ("Eelgrass and Other SAV," 3). Currently, Narragansett Bay's 96,000 acres are only covered with approximately 1300 acres of SAV ("Eelgrass and Other SAV," 1). Eelgrass provides a habitat for juvenile fish as a shelter from predators and as a mechanism for filtration. Additionally, their roots help prevent shoreline erosion caused by storms and wave energy. Unfortunately, shoots do not live for more than two years, growth is slowed in the winter, and they naturally take a long time to develop. Mapping projects have determined eelgrass makes up (91%) of SAV in Rhode Island and has been in a decline of 18% between a four-year study between 2012 to 2016 in RI. Natural eelgrass grows back slowly, and recovery of healthy meadows from one square foot to an acre through rhizome expansion can take up to 100 years (Cornell, 1). Human intervention and community engagement can speed this process. Some positive increase of the eelgrass in the Narrow River area of 47% is believed to result from restoring tidal hydrology, the estuary, and salt marsh habitats that feed into the ocean (Bradley, 7). There is not enough data to map our precise impact on eelgrass populations in RI. However, declines in mussels and fish have been linked with these trends.

Revitalizing eelgrass habitat will feed into the health and supply of aquatic life.

The act of dredging (removal of sediment and debris from the ground) can be helpful when removing the overflow of harmful contaminants from a body of water. However, in the practice of catching mussels from the ocean floor, the physical disturbance of SAV can destroy years of growth. Shellfish that grow and feed on dead eelgrass help reduce nitrogen levels that have caused algae blooms and hypoxia. Hypoxic events like the "brown tide" and "wasting disease" of the 1930s have resulted in significant die-offs along the coast, and algae blooms have been regularly occurring into the twentieth century. ("Eelgrass and Other SAV," 3) Refocusing our shellfishing industry to artificial reefs will take some of the weight off natural oyster and mussel populations, allowing nitrogen levels to be filtered and preventing further die-off events. Tongs, boat propellers, and dredging have physically disturbed the natural habitat. Some studies have found a decline in eelgrass due to oyster density within aquaculture areas, whereas eelgrass rehabilitation did not affect oyster density. (Tallis, 1). Shellfish are not naturally taxing to their surroundings, but the intensified methods and aquaculture farming can negatively impact the sur-

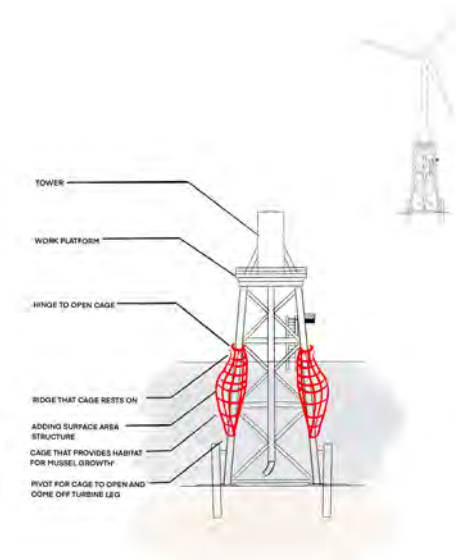
rounding species.

Current RI fishing regulations do not allow specific permits to overlap with other species, so fishers have the option to fish harder from limited sources, follow the movement of the species away from RI, or move on from the profession all together. The fishing industry is at a steady decline with an aging workforce. Climate change trends have repositioned species these fishermen are used to catching like cod, lobster, and winter flounder while quantities of scup, black sea bass, fluke, butterfish, and squid increase (“The Resilient Fisheries RI Project,” 12). These fish are migrating to colder deeper waters to avoid high pH levels. Utilizing Rhode Island’s BIS (Island Sound) as an estuarine habitat with some of the lowest salinities and seasonal mean currents, will imitate Rhode Island’s coastal conditions and act as insurance for the warming temperatures.

Currently, National Grid wind turbines remove mussels as a form of maintenance. What if instead of paying divers to dispose of them, they could be harvested efficiently as a means of revenue for shellfishers. Growing shellfish habitat on the legs and struts of deepwater wind farms would benefit the fishing industry because these mus-

sels would grow more separated from concentrated pollutants and runoff. Deepwater aquaculture farms and artificial substrates would provide an alternative to damaging fishing techniques that destroy eelgrass. The bases of offshore wind turbines have become natural habitats for complex ecosystems. The typical turbine can account for up to four metric tons of shellfish. In Germany, these wind farms have calculated mussels stocks equal to 20% of the natural stock along the coast based on their energy plans. (Alvarez, 1). This food attracts other species of fish and crustaceans like crabs. In Denmark, seals have migrated to these artificial reefs. Offshore wind farms of Block Island already view this naturally occurring, and divers have found populations “loaded” with striped bass, mahi-mahi, and scup, describing the wind farms in visits as a “magnet” (Prevost, 1). There is enormous potential in linking deliberately designed fish habitats to these bases, giving more surface area to produce more quantities of shellfish and providing the opportunity for harvestable ecosystems that replenish over time. The growing seaweed market as a biofuel and livestock feed could be another opportunity off these farms. With the ability to absorb CO₂, nitrogen and phosphorus, seaweed could supplement wind farm technology efforts in providing green

energy. There are boundless possibilities in wind farm agriculture, and restorative habitats.



The fishing industry has been in steady decline despite the vast market opportunities for shellfish. In the past forty years, fisherman prosperity declines have been also paired with fluctuations in large shellfish markets and profitability. The aquaculture industry has grown, landing oysters and clams at 4.2 million dollars in the last five years. However, there has been an absence of youth joining the ranks, and declines in independent practice (“The Resilient Fish-

eries Project,” 12). Changes to the Rhode Island fishing practice are needed and wind farms can be a part of the solution. However, many anglers are cautioned by wind turbines. Construction, metal materials, and noise upset the traditional nature of fishing. Many fear the underwater cables producing EMF (electrically transmitted frequencies). These produce irritable sounds to some species of fish and cause irrational behavior. This is a challenge to the trust and growth of underwater agriculture. Future generations need technological solutions to continue harvesting fish. The conveniences of shellfishing wind turbines promote critical species habitats and can help fishermen.

Rhode Island has witnessed significant fluctuations in its coastal environment's conditions, causing some species to migrate north and others to move into RI waters. Tapping bases and other man made structures is protection and insurance against climate damage, as acidification progresses, sea temperatures rise, colder deeper waters become more favorable to seafood. Eelgrass is a valuable resource to revitalize shellfish and deep-sea fish, acting as a critical habitat. Wind farms and artificial reefs can be used for productive aquaculture. New ecological developments will take advantage of seafood distribution

infrastructure that can benefit the Rhode Island economy while benefiting fish species.

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MARY SEOL

GREEN INFRASTRUCTURE: A POROUS CITY

Using green infrastructure in designing a healthy, permeable, and equitable urban fabric.

Introduction

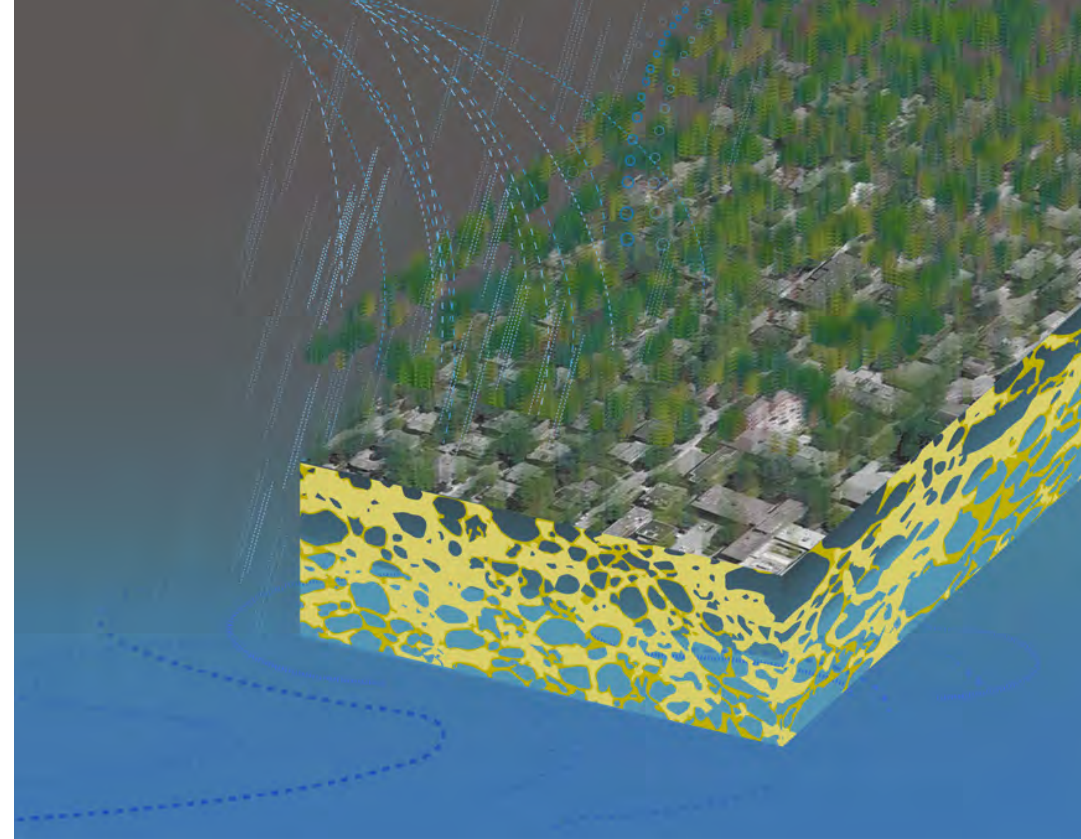
As distinctly dependent creatures, our humble human lives are intricately intertwined. Advancements in technology have emphasized more than ever how interconnected our environments are. Roads, dams, and bridges reshape our lands and allow for us to move where, when, and how we want. Contrary to the freedom and benefits infrastructure may provide, it seems contradictory that the systems intended to connect too often divide disadvantaged communities—not just humans, but also animals and their ecosystems. Infrastructure existing

today tends to cater towards select groups of people while isolating many natural habitats and inhibiting the movement of many species. As the current mass extinction continues to emphasize the inequality between classes and communities, we must be conscious of inclusion as we propose solutions. One promising potential is green infrastructure, as it would provide many benefits for both nature and humans—particularly in urban areas. Green infrastructure provides a potential solution to counter the effects of human pollution

while fostering resilience; however, green infrastructure should be equally accessible to all communities in order to combat inequity and environmental racism.

Literature Review: Defining Green Infrastructure and its Impact

Before exploring the benefits of green infrastructure, it is necessary to understand what the term entails. Green infrastructure is very broad spectrum of systems that adopt varying methods to manage precipitation; however, all forms of green infrastructure



aim to increase the permeability and porosity of surfaces, allowing for stormwater to be absorbed into the ground or other watershed systems. From the Clean Water Act, green infrastructure is defined as "... the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspire stormwater and reduce flows to sewer systems or to surface waters" (What is Green Infrastructure?). Storm water management will become increasingly important as the EPA cites runoff as one of the fastest growing causes of pollution in the United States (Denchak, 2019).

One primary example of green infrastructure is permeable pavements. By utilizing porous materials or spacing between repeating units, precipitation is able to penetrate into the ground instead of pooling aboveground and becoming runoff. Other methods used to combat runoff include water retention systems that store and collect rainwater for later use. As the climate crisis will likely lead to water scarcity, stored rainwater can be reused commercially or in households for tasks that do not require purified water: washing cars, flushing toilets, watering gardens, etc. (Denchak, 2019). Other examples include green roofs, which

serve as an absorptive surface that can reduce stormwater maintenance costs; not only do green roofs have longer longevity than normal roofs, but they also provide sound insulation that may be highly desired in dense cities. The prevention of runoff not only reduces runoff-induced pollution, but also helps reduce the risk of flooding. Increasing the absorption of water into the ground becomes increasingly important as the global temperature rises, especially in coastal or low level areas that may be prone to submerging fully underwater. Many additional forms of green infrastructure include vegetation such as bioswales, rain gardens, or green corridors/streets. Ideally, eliminating sources of airborne pollution is one of the most effective methods in cultivating healthy and sustainable habitats; however, studies have found that incorporating plants into urban infrastructure systems can help mitigate effects of urban air pollution (Hewitt, et al 2020). One such example is through utilizing green infrastructure to extend the distance between a pedestrian and the pollutant emission source. In other words, trees and shrubs serve as semi-permeable barriers that obstruct the path of pollutants and help dilute them in the air. However, it is important to note that if vegetation is not customized for the given location and appropriate filtering role, the

overall effects of urban air quality may be negative or none. Therefore, it is crucial for urban planners or landscape designers to customize each addition of infrastructure its intended location; this may include consideration for which plants are native to local lands.

In addition to improving urban air quality, adding flowering plants may provide needed food and/or habitat for pollinators. Studies have also shown that as land is repurposed for agriculture, pollinators are oftentimes dependent on green infrastructure along roadsides as refuge (Li, et al 2020). Maintaining and increasing such habitats is crucial, as agriculture heavily depends on wild and local pollinators. Cultivating such habitats would aid pollinators, local native species, strengthen resilience, and potentially increase biodiversity. Aside from aiding pollinators and cultivating biodiversity, added vegetation can also help reduce the urban heat island effect in denser cities; in other words, plants in green infrastructure can help control temperature in urban areas (Shi, 2020). Mediating urban temperatures would reduce the risk of many heat related illnesses and potentially reduce the need for air conditioning or other cooling systems. By simultaneously encouraging vegetation growth through green infrastructure, the urban environment would be able to sup-

port mentally and physically healthier communities.

Currently, most built architecture and constructed systems use grey infrastructure [solid surfaces such as concrete, metal pipes, and drainage systems] to divert storm water. Rather than solving the needs of water management, grey infrastructure tends to divert both pollution-based problems and excess stormwater elsewhere. Rather than pooling on top of hard surfaces and overwhelming waterways, green infrastructure allows for water to be absorbed where it falls—therefore reducing runoff and runoff induced pollution. Green infrastructure can help alleviate flooding stress particularly if implemented in urban areas, as cities tend to have a higher percentage of nonabsorbent materials used in construction. Additionally, cities with declining growth tend to have vacant lots that have the potential to be repurposed as spaces of green infrastructure (Zhang, et al 2019).

Despite its many benefits, green infrastructure must be implemented thoughtfully. Although there seem to be few downsides to adopting green infrastructure throughout our cities, rash applications can lead to further inequity within urban areas. Already studies have shown that historically, neighborhoods with more green spaces

tend to be associated with neighborhoods with higher property values and gentrification (Shi, 2020). If local communities are not allowed to have an input in green infrastructure, outside prescriptions of these systems may cause further gentrification and inequity.

Discussion

Since 2011, the global population passed and continues to surpass 7 billion people. Assuming the human population continues to grow at the current rate, societal and environmental issues will likely be amplified if no action is taken to solve them. Human based pollution continues to harm more than just humans. Habitats and homes are rapidly at risk of disappearing. It has been speculated that if the protection and revitalization of nature is neglected, the future may be one where only the privileged have claims to nature. However, I have found that upon observing our habits and analyzing our cities we can conclude that this is already a reality; a simple satellite image contains visual disparity of green spaces between various communities. With this in mind, I believe everyone should have equal access to green spaces; a healthy life and environment should be a right— not a privilege for a select few. As the gap between those with and without continues to grow,

we must aim to reform our infrastructure to be sustainable and equitable.

Although ‘green’ has come to symbolize prosperity in health and nature, its use as a modifier must be questioned; often ‘green’ can falsely imply a positive perception. Green infrastructure appears to be one of the more promising possibilities for mending the effects of human pollution. In addition to mitigating water contamination and managing stormwater, green infrastructure contributes to air health, increases pollinator habitats, biodiversity, and fosters resilience. However, we must confirm that the implementation of green infrastructure will not further divide ecosystems. For communities to determine if ‘green’ infrastructure is actually beneficial for them, it is crucial to raise awareness of what green infrastructure entails and the exact benefits it provides. Within the topic of combating and inequity, as I believe green infrastructure can only be a successful solution if it is designed and implemented in collaboration with local neighborhoods; moving forward, we must also prioritize full engagement with native or minority communities that have historical knowledge/practices of such systems. Too often, green infrastructure plays a role in gentrification when large-scale projects lead to the displacement of people rather than embedding itself within

a community. In order to guarantee equal opportunities to live with nature, we must start by educating general audiences about the importance of nature [particularly in cities, where there might be a lack of it], its positive implications, and the concept of one health.

Conclusion

As the planet undergoes another mass extinction, we must reflect upon our role in it. During this Anthropocene, humanity's actions impact and affect much more than just people. Unfortunately, man-made products and systems often fail to consider their influence upon communities that do not get a voice in such designs. While learning about various species and the threats they face, it is clear that many of the factors endangering life also affect humans. However daunting, we must accept the weight our role can play in damaging and saving the natural world by actively caring for the health of our environment. Continuing to research ways in which green infrastructure can be integrated into social and cultural spheres will become more crucial to understanding successful strategies for redesigning our current infrastructure systems.

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THE RIPPLE EFFECT OF REDLINING

Environmental Racism in New York

Section 1: Introduction

This topic is important to me because of the lack of learning I had surrounding this in my education in public school. The private institution that I currently attend has made me more aware of both environmental issues as well as social justice issues. I aim to address the intersectionality between the two issues and convey the importance in recognizing marginalized communities should not come as the cost of environmental justice. Environmental racism is a byproduct of institutional racism, and thus an effort must be made to combat specific policies and change regulations and laws to compensate for the disproportionate negative environmental impacts on low-income Black and Latino communities. A prime example of

environmental racism is the South Bronx, New York.

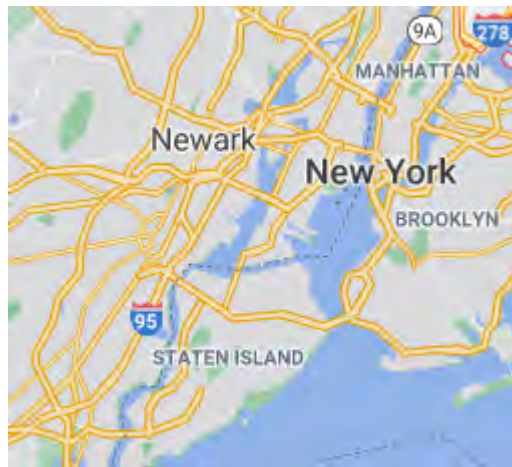
Section 2: Literature Review

“Environmental racism, a form of systemic racism whereby communities of colour are disproportionately burdened with health hazards through policies and practices that force them to live in proximity to sources of toxic waste such as sewage works, mines, landfills, power stations, major roads and emitters of airborne particulate matter. As a result, these communities suffer greater rates of health problems attendant on hazardous pollutants.” (Beech 2020)

Spatially Informed Analysis of Environmental Justice: Analyzing the Effects of Gerrymandering and the Proximity of Minority Populations to U.S. Superfund Sites (Kramar 2018), notes instances of systemic racism and quantifies how gerrymandering specifically has had a ripple effect to today's lack racial disparity in environmental, social and health issues between low income Black/Latino communities and White wealthier communities. This investigation highlights the "long histories of colonialism and white supremacy" as well as that the current status of waste sites and other negative environment/health sites resulting as a byproduct of systemic racism. It does this by highlighting white privilege and the correlation between gerrymandering, and congressional districts, and as the authors describe, "naturalized decisions of millions of whites in a racialized society." (Kramar 2018, p. 31). This study explains the long term effects of a study and an example of environmental racism, "in 1987 following a controversy over the placement of a polychlorinated biphenyl (PCB) landfill in a minority community in Warren County, North Carolina. The study showed nationally that 60% of African Americans lived near an unregulated toxic waste site... When the UCC revisited the study 20 years later, the disparities between racial groups and proximity to environmental pollution

had magnified." (Kramar 2018, p. 30). Data presented in the Kramar study explains the relationship between congressional districts, gerrymandering, and how this data explains the disparity between white and black people. and more so explains that gerrymandering is yet another form of institutional racism that must be addressed lest marginalized populations continue to be systematically exposed to environmental hazards

Gerrymandering is another example of racial discrimination that manifests in conjunction with environmental justice. Gerrymandering manipulates district boundaries and in this case deprives Black and Latino communities of political power and voice in issues such as environmental issues that directly affect us. The Voting Rights Act of 1965 was established to equalize political power by preventing large disparities in



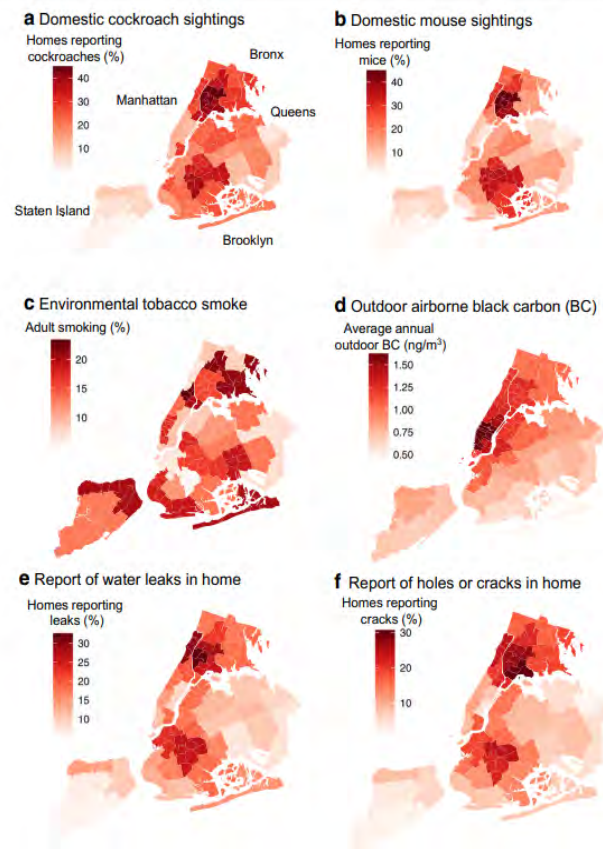
Display of current highway systems intersecting and surrounding the Bronx

populations between districts and what gerrymandering does is redistrict areas to manipulate and deprive jurisdictions of political power (Kramar 2018, p. 31). Thus, environmental hazards such as waste sites, carbon emissions from highways and other pollutants are streamlined to districts that hold less congressional power and voice. As it so happens, this commonly befalls communities that were previously redlined areas that were deemed high risk neighborhoods and security risks both in terms of danger and for payment. Redlining had segregated neighborhoods (Gross 2017), and had barred/prohibited Black families from buying homes beyond these redlined districts. As time passed and the Federal Housing Administration (FHA) changed the blatant discriminatory tactic, prices of the low risk neighborhoods that had previously deemed eligible for white communities had been raised to the point that, although Black families were permitted to be housed and allowed a mortgage loan, the disparity in wages, education, and it allowed only a small percentage of these families to enter the gatekept white elitist neighborhoods.

The South Bronx is home to several high risk environment related health conditions with the dominant issues of respiratory health and specifically Asthma. This urgent health care issue has affected the South Bronx so drastically that it's now nicknamed

Asthma Alley. The Role of Environmental Controls in Managing Asthma in Lower-Income Urban Communities (Conrad 2019) focuses on allergens in NYC specifically and the impact low income communities of color face with a higher risk of severe medical emergencies related to these allergens. Cockroaches, dust, tobacco smoke, fungi, pesticides, vehicle exhaust and other combustion byproducts have a higher intensity in urban environments, as well as are more concentrated in Black and Latino communities is of notable accord. Conrad finds that, “Children living in lower-income communities are at much greater risk of developing asthma, going to the emergency department (ED) for an asthma attack and being hospitalized for asthma than children living in upper- and middle-income communities” (Conrad 2019). This is shown in Fig. 3 A-F, where the distribution of asthma related environmental exposure in NYC. (2012–2014 reported by NYC Department of Health on their Environment and Health Data Portal) (Conrad 2019). Williams 2019, finds that in a study between University of California-Berkeley and the University of California-San Francisco, that the air in once-redlined neighborhoods have significantly higher levels of pollution from diesel engine

Fig. 3 a-f Distribution of environmental exposures related to asthma by neighborhood in NYC. Data for 2012–2014 reported by NYC Department of Health on their Environment and Health Data Portal [2]. Greater detail on survey methods available in supplementary online material.



exhaust. This point is further emphasized within the Figures A-F higher percentages of intensity of these allergens are always prevalent in the Bronx. This is most notable in Figure A, B, E and F, with the highest rates of the allergens in the overview of New York City entirely. Furthermore, “The Bronx is home to more than 1.4 million people, and one of the nation’s poorest urban counties, with over

30% of residents living below the federal poverty line. Not only is the Bronx the poorest of the five boroughs, but it is home to the highest percentage of minorities, about 89 percent minority population, but also the highest percentage of poorly educated residents, with 30 percent of adults not high school graduates” (Morrison 2019, p. 9). What is clear between these two points is that the correlation between public health and environmental factors are linked with systemic forms of racism that ripple to today.

The environmental racism is ingrained in the way that cities are planned. The data is evident with racial disparity despite having a lower percentage of carbon emission rate as follows:

“Blacks are more exposed than whites/others to pollution from every emitter group (Fig. 2). The same holds for Hispanics, with the exceptions of PM2.5 originating from agriculture, from coal electric utilities, and from residential wood combustion, for which they are exposed to 11%, 40%, and 14% less, respectively, than whites/others. Those three types of emissions are concentrated in regions

of the United States with relatively low Hispanic populations (Fig. 1). Whites/others consume more—and cause more exposure—than do blacks and Hispanics across all seven end-use categories; the end uses representing the greatest differences in consumption-caused exposure are food (for which whites/others cause 61% and 49% more exposure than blacks and Hispanics, respectively), transportation (74% and 93%), and services (118% and 114%).” (Tessum..., 2019)

Sulfur dioxide and Nitrogen dioxide have some of the highest volumes in the local area of the South Bronx, including “printing presses for the Wall Street Journal, a sewage treatment center, a parcel depot, and a warehouse for the food distributor Fresh Direct.” (McLoughney 2019, p.12). The Breath of the Bronx: Limited Greenspace and Poor Respiratory Health, explains that because of failure on an institutional level of clean air quality, the South Bronx specifically in relation to the positioning of environmental hazards, is the most affected and contributes significantly to the “poor air quality”. This then leads to one of the highest rates of asthma in the region, in fact McLoughly points out a study from 2009 where Bronx asthma rates and living conditions in relation to other areas of the U.S. where Bronx children were at a higher rate of risk to asthma than anywhere else in the country. “As a result,

children in the Bronx are also “twice as likely to die” from asthma than the average American child” (McLoughney 2019, p.15).

As noted in The Breath of the Bronx: Limited Greenspace and Poor Respiratory Health, the Bronx has several highways running through the borough. Chemical compounds such as SO₂ that are released through fossil fuels as well as NO₂, exacerbate airways and trigger asthma attacks (McLoughney 2019, p.10). Levels of these compounds spike in near cities and even more so towards non-environmentally protected and unregulated areas such as that of the South Bronx. This overlap in roadways can further contribute to the pollutants that exacerbate the asthma of residents, despite being non contributors to the emission of fossil fuels. “As they pass through the Bronx on their daily commute, they pollute a community that they are not even a part of. 184,000 cars are said to drive on the Cross Bronx Expressway every day, making it one of the busiest roadways in the United States of America” (McLoughney 2019, p.11). This is just one example of a designed detriment to the community, one that has impacted families and cost lives. It furthermore, goes to show the intentional placement of pollutants and health hazards away from upper class white communities and towards the lower previously redlined spaces. This can be supported with Dr. Robert Bullard’s

2007 study found, “race to be more important than socioeconomic status in predicting the location of the nation’s commercial hazardous waste facilities” (Beech, 2020).

Environmental racism shows from as early as the planning of the borough, with redlining deeming the area undesirable, and thus deemed the butt end of pollution traffic, waste sites and preventions to regulate air quality. It also can create a kind of feedback loop of having waste processing facilities that leads to needing more vehicles to bring waste to this plant and thus raises the carbon emissions even more. “The Bronx is home to several facilities that process sludge, sewage, water treatment, and garbage. In 2016, the New York City Council confirmed that “80 percent of the city’s waste [was] processed at stations in the South Bronx, north Brooklyn, and southeast Queens.” (McLoughney 2019, pp. 27-28). Neglect towards enforcing environmental protections stem from baseline government testing of measurements for abnormal elevated chemical levels that trigger worse asthma responses (were recorded wrong and unaddressed), “concentrations tended to be “60-90% higher than those recorded by DEC monitoring stations.” (McLoughney 2019, p.14), and as such government mandated testing has failed to protect this community.

Section 3: Discussion

What this literature contains addresses

neglect especially prominent in these previously redlined cities. For this reason, we must look forward to rehabilitating these communities with clean energy as well as free health care as a contribution to reparations deserved of these historically targeted Black and Latino communities.

Preventatives can be taken to prevent gerrymandering, for example by potentially using the spatial analysis offered in Kramar's study. This can be utilized by basing the G (gerrymandering) coefficient at a limit for government congressional districts. It can also be further helped by creating legislation that bars gerrymandering from happening in the first place.

When studies find that Black Americans are exposed to about 56% more pollution than is caused by their consumption, (and Hispanics 63% more) while, "Non-Hispanic whites breathe about 17% less air pollution than they cause (Kilani, 2019), action must be taken. There is legitimate research and evidence that shows this disparity, so there must be implementations to closing this gap. This can take the forms of taxing high income individuals who don't use clean energy (vehicles, electricity, etc), and using the funds to reparate the communities most affected by these issues. This is important because, "current legislation aimed at reducing environmental insults is on a system that

benefits all equally while failing to recognize the increased vulnerability of specific population" (Kramar 2018, p. 30). Although it is important for all communities to benefit from environmental justice, low income communities of color are much more affected generationally from these issues even today, and so the gap in health and environmental security must be met. Gerrymandering, and redlining explain how the current status of poor public health the South Bronx has resulted in. The environmental factors of emissions and other pollutants are why today the South Bronx is so heavily concentrated with cases of chronic asthma and poor public health.

What I found astounding and most concerning is the vehicle emissions rate found within New York. Vehicle emissions contribute to more than 80% of the total cancer risk from hazardous air pollutants in New York City. Additionally, "lifetime cancer risks due to diesel exhaust in both Bronx County and Queens County is over 900 times the acceptable Environment Protection Agency standard", while New York County is more than 3,000 times that limit" (Morrison 2019, p. 28). For this reason, large scale initiatives should be further pursued on a national level. Of such, may include that of mandated cleaner energy direction for vehicles and corporations in areas surrounding and passing through the South

Bronx or other centralized major polluted areas affected by redlining.

Conrad 2019 brings up another solution that could be implemented for community health care workers as well as home construction for these low income communities that are "asthma-friendly". However, it is important to be wary of low cost new construction, as to avoid gentrification and the loss of low income housing, as well as be aware of the outside effects of solely housing such as the concentrated amounts of highways that the South Bronx bears the brunt of emissions from. Environmental interventions targeted within an individual's home may be a part of the solution but not

[Note: "(Figure 2 Provided by Morrison 2019).

The South Bronx is home to thirteen waste transfer stations, while Greenpoint and Williamsburg have twenty-four. These two neighborhoods are responsible for managing about 73% of the city's total debris." (Morrison 2019, p. 31)"]

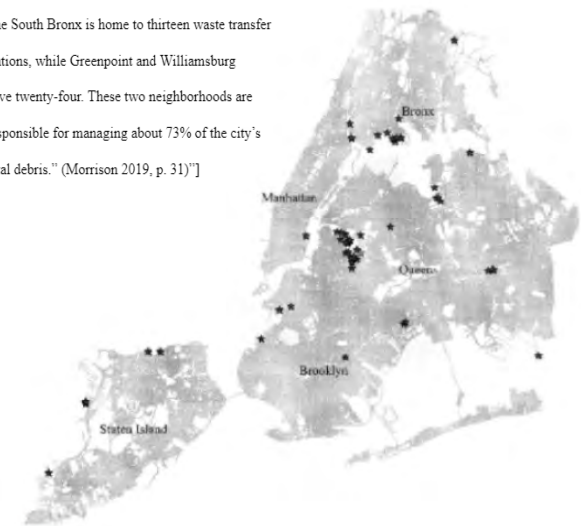


Figure 2

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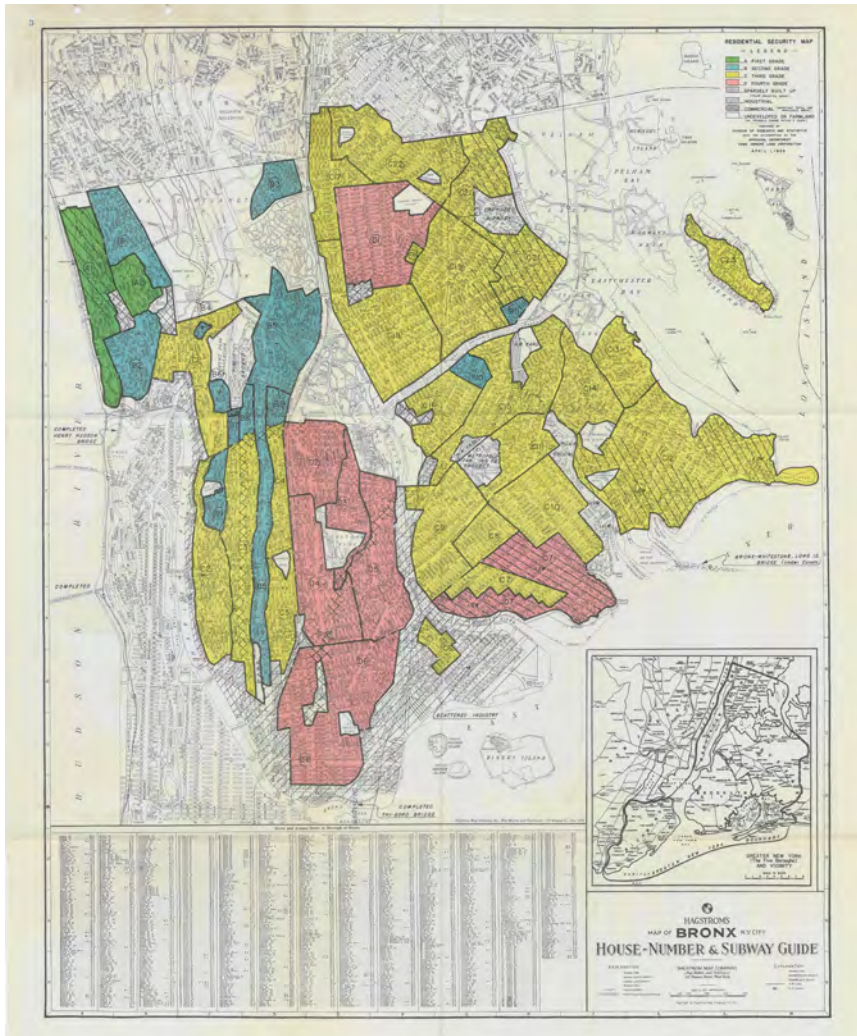
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Section 4: Conclusion

The data and resources presented show with clarity the effect of institutional racism on Black and Latino low income communities, with a focus on the South Bronx. Future research may be necessary to explore more possible long term solutions to the generational issue of environmental racism. Funding should be allocated from the police to community welfare as well as to grants for specific grassroots organizations targeting environmental issues and public health, especially in the communities where redlining



Redlining map of the Bronx (1932)

has a direct correlation to environmental racism. More initiatives in policy making must take into account the racial disparities compiled in this paper and the intersectionality between racial issues and environmental justices. These two topics cannot be considered as separate entities, but instead more work should explore potential solutions that are intertwined with each other.

The issue doesn't just stop in the Bronx or even New York. In 2014 to 2020 Flint, Michigan's case of environmental racism had exposed over 100,000 predominately Black residents, (knowingly to "save money") to contaminated untreated lead water even finding traces of E. Coli. For this reason, the issue of environmental justice is also a human rights issue that's intersectionality must be kept in mind. In the case of the work I produced for the class The Art of Communicating Science, the illustration-animation displayed in the first page is meant to exemplify where concentrated areas of carbon emissions are most high and how over time the relation to redlining has been forgotten, but is still clearly affected. I hope to revise it in the future with updated data sets of plotted points changing over time of the highest allergen / asthma morbidity is found.

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A DOOMED DELICACY

The Japanese Eel and
its Road to Extinction



Every summer I go to Japan to visit my grandparents on my mother's side. Though we are a close knit family, this brief time is the only opportunity during the year I have to see them. To celebrate this occasion, we always go out to a local Japanese restaurant to eat a traditional dish, the unagi don. The food arrives in a simple but elegant black lacquer bowl. Inside, served over steaming rice, is a slice of grilled unagi or eel, steeped in a rich bronze colored sauce made from sake, mirin, sugar and soy sauce. This savory yet sweet eel, is a favorite delicacy among Japanese people, and is often eaten on special occasions. But as my

family and I begin to eat, my grandmother makes a remark that concerns us all. She explains that the unagi prices are skyrocketing, and we may not be able to eat them anymore. Why? Because the eels are disappearing.

The Japanese Eel (*Anguilla japonica*) was officially considered endangered by the environment ministry of Japan in 2013, and was later added to the International Union for Conservation of Nature (IUCN) Red List the following year (McCurry). The endangerment of the eel can be attributed to climate change affecting oceans, habitat

loss, but most significantly, to its overfishing. While the species has been officially considered endangered, the demand for eel has not subsided, placing even more pressure on its waning populations. However, the long history and cultural significance eel holds as a delicacy forces the solution to be much more complex than simply curbing consumption. Furthermore, eel aquaculture largely relies on the fishing of wild-born eels, making eel farming difficult. While efforts to put restrictions and limitations on the fishing of eel have been implemented, there are still numerous reports of illegal fishing and trading encouraged by the

demand for eel, which in turn continues to threaten the species. Through more research and understanding of the Japanese eel culturally and as a species, the protection of eel habitat, better international legislation, and the development of more sustainable fishing and farming methods, this animal can remain part of its indigenous habitat, Japanese culture, and the wild.

The Japanese eel has a unique life cycle in which it spends its lifetime in two types of habitats, saltwater and freshwater. Beginning in the ocean, the Japanese eel hatches from its egg, and enters a larvae state called leptocephalus (Hamidoghli). They are small, and transparent, making them well adapted to the marine environment allowing them to drift with the current undetected. By late winter, or early spring, the larvae eels have developed enough to begin their migration into freshwater (Hamidoghli). When the eels enter their freshwater habitats from the ocean, they are referred to as “glass eels” because of their translucent skin. As they continue to develop, they go through pigmentation changes, becoming elvers, yellow eels, and finally silver eels, in which they stop developing and eating (Hamidoghli). At this point the eel will begin its long journey back to its spawning grounds out in the

ocean. Using geomagnetic sensing, the eels are able to reverse their original journey as larvae, returning to the Mariana Islands in the Northwestern Pacific Ocean (Hamidoghli).

While the species has been around for about 15 million years, it also has a long history in Japan. As early as 4,000 years ago eel was being consumed in Japan. But the unagi was more recently popularized by kabayaki, a specific Japanese style of grilling that was established during the Edo Period, about 200 years ago (Nihombashi). Of all of the eel that is being farmed in the world today, 70% is being consumed in Japan due to the popularity the taste the kabayaki grilling style gives the eel (Nihombashi). First, the eel has to be skillfully cut in half, which can be difficult due to its slippery mucous outer layer, and its blood that contains lethal neurotoxins (Jarnes). The sliced halves are then skewered and grilled over a charcoal fire with the special sauce that brings out its rich flavors. During the Edo Period, an eel eating holiday was also established and continues to be celebrated today. The occasion is called Doyo no Ushi no Hi and is celebrated on the hottest day of the summer, usually in July or August (Nihombashi). During this time eel consumption is at its highest in Japan.

Most of the eels being consumed are being provided through aquaculture production. Eel aquaculture relies on the harvesting of glass eels from the wild that then get raised to be consumed (Tanaka). During the night of a new moon, eel farmers shine bright lights into the rivers scooping up the glass eels into their nets. The amount of eels that are required to maintain these farms are one of the main drivers of its extinction. The domestic eel supply was at its peak around 1965, when approximately 160,000 tons of eels could be fished, but now the amount has decreased to around 40,000 tons (JWCS). The use of wild eel stock also makes the economy quite unstable and the depletion of the population causes the price of eel seeds to rise. Meanwhile, the competition between Japanese and Asian eel producers forces the price of eels to be lowered. This competition also encourages eel farmers to look elsewhere, impacting other species such as the European and American eel species, both of which are also greatly threatened (Drouineau). In this way, a closed system of eel aquaculture has become even more of a necessity and could become an economic stabilizer, but the lack of knowledge on the Japanese eel’s breeding and feeding habits make it very challenging.

The changes in the Japanese eel’s

environment also pose a significant threat to the survival of the species. Due to global warming, induced by anthropogenic causes, rises in the sea temperatures and shifts in the ocean features affect the currents that the leptocephalus larvae use to migrate and the plankton they eat to develop (Drouineau). Contamination in the waters also affects the eel greatly because of its high trophic level, and high concentration of fats in its body, that allow chemicals and other harmful substances to accumulate (Drouineau). Not only is this harmful to the eels, but it is also harmful for humans to consume. Movement also plays an incredibly important role in the lifespan of the eel, and without proper habitat, the eels cannot complete their life cycles properly. The Japanese eel has two major migration movements, from the ocean to the land and the journey back, which is being obstructed by the construction of dams which has almost depleted 40% of the eel habitats on its own (Drouineau). As the eel habitats continue to be destroyed it continues to make it more challenging for Japanese eels to survive.

Currently, scientists are working on developing a sustainable full cycle method of cultivating eels. This would mean that the eels would be hatched from eggs on a

farm, cutting out the fishing of wild eels altogether. This could potentially allow the commercial industry to continue their production without straining the wild population. Efforts to research eels began in 1955, but not until recently in 2002 was the National Research Institute of Aquaculture able to successfully raise glass eels from eggs (JWCS). The scientists had finally figured out that the eel larvae fed best on a slurry of powder shark eggs, but after a while the larvae growth would be stopped by how polluted the water became, and the scientists had to change the type of food to continue eel development (Drouineau). In this way, scientists have had to spend a lot of time figuring out the delicate balance of food and habitat that the eels need to survive. However, if successful, full cycle eel cultivation shows great promise for sustainable commercial eel production in the future.

There have also been international efforts, especially amongst the Asian countries that are most prominently involved in the eel trade to create conservation legislation. In 2012, Japan, China, South Korea, and Taiwan engaged in talks surrounding eel production and agreed on three joint statements that they would carry out later in the year (JWCS). Firstly, they would

reduce the number of Japanese eels placed in aquacultures down to 20% of the previous year's amount (JWCS). Secondly, all of the countries need to establish eel farming management organizations that can help administer and oversee eel production, and lastly, the countries were to consider a legally binding agreement (JWCS). Later in 2014, Japan established the Alliance for Sustainable Eel Aquaculture (ASEA) in which an upper limit was established as to how many glass eels and eel fries could be fished. In 2015, the Act to Promote Fishing in Inland Waters required eel farmers to obtain special permits, which further limited the amount of eels that could be farmed. According to the Chairman of All Japan Association for Sustainable Eel Aquaculture, Torami Murakami, he feels that Japan's role as one of the largest consumers of eel, they as a country need to take leadership in protecting the species, but to not forget the importance of collaboration among all countries as well as the individual stakeholders within the eel trade. In these ways, countries are starting to take initiative through legislation to promote more sustainable fishing practices.

Habitat restoration has also been started by local communities to preserve the Japanese eel species. In order to counter

the dams that have blocked eel migration, fishways that provide the eels an alternative route to move over dams have been built (JWCS). Other efforts include the installation of stone blocks that are covered by nets that create more shelters for eel prey such as shrimps. Farmers have also tried releasing adult eels back into the environment to increase the eel population. There also has been effort to try to farm female eels to release as well, as they are key to repopulation, but this has been met by some difficulties due to farmed eels being largely male.

While the efforts to preserve Japanese eels have been started and there are many promising results, we are still far from saving the species. Eel conservation is difficult due to it being an integral part of a culture's cuisine, and thus it requires cooperation with all of the stakeholders within the industry along with the environment. Investing in more research to truly understand the Japanese eel as a species appears to be the key to developing long term sustainable solutions to cultivating eels. While science has made a lot of progress in this regard, there are still many unknowns that cause challenges. The Japanese eel as a species is incredibly old, and the way it lives and develops is complex but fascinating

and needs to be explored further. A major issue that full cycle farmed eels are facing is that they are largely male eels that are being grown, which makes it difficult to continue to maintain the farm (JWCS). Moreover, even if labs have been able to grow the eels, closed system farming has yet to be implemented on a large commercial scale, which means that wild glass eels are continually being fished and driven closer to extinction. Proper legislation is also a major role in enacting effective change for the Japanese eel species. Though there has been an increase in international conversations amongst the Asian countries involved in the eel trade, upon closer inspection, their policies are still not enough. Using terms such as "considering more drastic legal measures" means that these policies have still yet to be made, and will require more pressure from constituents and the industries to get these crucial policies passed. Meanwhile, creating restrictions on the amount of eels that can be fished is also important, but illegal fishing and unreported catches are still flying under the radar. According to Japan Wildlife Conservation Society's data, 80% of Japan's eel stock is being imported from Hong Kong, which doesn't have an eel fishery of its own, making it highly likely that it was illegally fished. Moreover, the WWF has given the eel a score of 2.78 out of 3.0

of likelihood that the eel has been obtained unreported or unregulated, making it one of the highest scorer's out of Japanese seafood imports. In this way, due to a lack of more effective means of tracking and tracing these crucial, endangered products, legislative efforts can only do so much in order to prevent the extinction of the Japanese eel. Preserving and protecting the eel's habitat is also important, but these changes that are affecting the eel go beyond just this one species. These changes in the ocean, the changing in temperatures, the changes in its pH and much more are connected and caused by larger issues caused by humans. These issues don't just affect the Japanese eels, but all species that are living in the ocean and more, creating a chain reaction of issues that will ultimately prove detrimental to all organisms on Earth, including humans. In this way, the preservation of the Japanese eel is also part of a much larger global issue.

Understanding the Japanese eel's cultural importance is perhaps what can save this species most. As someone who personally holds a strong connection to Japanese heritage and culture, I don't want to lose a part of that. Sometimes the environment can feel so removed from daily life, but in reality, it is much more closely connected than we think. The Japanese eel is

part of its ecosystem, but it is also a crucial part of Japanese history and culture, and is in this way deeply connected to people and place. It is undeniable the joy it provides to those that eat the eel on those hot summer days, and the connection and relationships it builds as families have meals together. By appreciating and deeply valuing what this species has provided, there is no other solution than to give back and protect the Japanese eel, so that it can continue to be a part of our culture.

The Japanese eel is endangered, and it needs our support to stop it from going

extinct. Losing this eel species endangers much more than just the eel. It threatens the long established traditions and culture of the places that eat the eel. But, it also affects the ecosystems around it, and the problems that the Japanese eel face aren't unique to just this creature. There are many other species that face a similar struggle of grappling with culture, demand and survival, making it difficult to protect. Furthermore, the mass changes humanity has brought on the environment is affecting all organisms on this planet. By protecting the Japanese eel, we can ultimately protect other species, the planet, and ourselves.



WHAT GOES AROUND COMES AROUND

Consequences of society's plastic dependency require solutions that encompass research, policy, and individual behavior changes

Introduction

Every year, there are more reports of marine life washing up on coastlines with copious amounts of plastic waste filling their stomachs. Even if ingested trash was not the leading cause of death, the contents that researchers found are far from natural. In 2018, National Geographic

reported a pilot whale found in a Thai canal with over 17 pounds of plastic clogging the whale's stomach "in the form of 80 shopping bags and other plastic debris" (Zachos, 2018). Similarly, in the same year, a sperm whale was found dead in Indonesia having ingested a "horrifying collection of plastic trash, including 115 drinking cups, 25 plastic bags, plastic bottles, two flip-flops



Illustration by Ashley Chang

and a bag containing more than 1,000 pieces of string” (Parker, 2018b). The following year, a cuvier’s beaked whale was found in Davao City, Philippines with “more than 88 pounds of plastic waste jammed into its belly,” around eight percent of its total weight (Borunda, 2019). Across these examples, the cause of death was likely the same: the whales, having mistaken the trash for food, eventually fell victim to dehydration and starvation due to the accumulation of plastic in their internal systems (Zachos, 2018; Borunda, 2019).

These are far from the only examples, and the problem extends beyond the victims that wash up on our shores. Scientists estimated in 2015 that “around 90 percent of all seabirds have ingested some amount of plastic,” while UNESCO estimates about 100,000 marine mammals die every year because of plastic pollution (Borunda, 2019). But in the face of these grisly reports and staggering statistics, questions arise of how, if it is even possible, to undo the consequences of our plastic dependency. Given the increasing impact of plastic pollution on the natural environment and marine biota, including various whale and other cetacean species, solutions moving forward must encompass both public and private sectors, requiring research and education, supporting policy, and individual behavior changes in order to address the growing plastic waste problem.

Literature Review

Scale, history, and drivers of plastic production

Understanding the driving forces behind our increasing plastic dependence is necessary to create future solutions. In 2018, it was estimated that around “18 billion pounds of plastic waste is released into the oceans every year” (Parker, 2018a). About 40% of our demand for plastics is in packaging, of that being mostly single-use plastics that are immediately disposed of (Narancic and O’Connor, 2018; Parker, 2018a). On the other hand, only about 20-25% of the plastic products we produce are intended for long-term usage (Kedzierski et al., 2020). Despite the immense scale of our plastic production, the history of plastics in packaging is relatively recent compared to our anthropology (Kedzierski et al., 2020). In contrast to the short timeframe, the scale of our plastic production has increased exponentially; in 2015, an estimated 44% of all plastic manufactured since 1950 had been produced just after 2000 (Parker, 2018a). In other words, in those recent 15 years, we had matched nearly 50 years of plastic history.

One factor for the rapid increase in usage is the physico-chemical properties of plastics that allow them to be utilized in various applications (Kedzierski et al., 2020; Narancic and O’Connor, 2018). In many cases, plastic products involve easy, fast man-

ufacturing that contribute to higher quantities (Kedzierski et al., 2020; Narancic and O’Connor, 2018). Functionally, they provide advantages like better food preservation than traditionally used materials (Kedzierski et al., 2020; Narancic and O’Connor, 2018). They can also reduce energy expense and gas emissions in transportation through the production of parts that make more energy-efficient vehicles (Narancic and O’Connor, 2018). Other contributing factors to our increasing plastic use include urbanization, which allows for greater concentrations of populations, in addition to these populations having greater access to consumerism globally (Kedzierski et al., 2020). Fueled by functionality, demand, and relatively lower cost of manufacturing, we have created a problem of convenience that requires combined efforts to resolve.

Plastic pollution and impact

Although the issue of plastic pollution feels recent, the study of plastic waste in the natural environment and impact on marine organisms has been known as early as the 1970s (Kedzierski et al., 2020). It is even argued that the dangers of ingested plastic for marine megafauna has been known as early as the 1950s, with captive animals in aquariums also suffering from consuming indigestible objects (Roman et al., 2020). Ingestion of plastic waste is responsible for ma-

rine species' deaths whether directly lethal or related via decreased health and subsequent function (Roman et al., 2020; Borunda, 2019; Zachos, 2018). For example, plastic-related deaths might be more common as cetaceans that consume plastics tend to have trouble swimming, resulting in more ship strikes (Roman et al., 2020). Across taxa, film-like plastics are the most commonly ingested type of waste and are responsible for the most deaths among marine megafauna (Roman et al., 2020). This includes single-use or short service life products like bags, film-like packaging, and agricultural sheeting, also known as "plasticulture" (Roman et al., 2020). Flexible plastics increase in lethality as they accumulate and form blockages once ingested (Roman et al., 2020). Their buoyancy also makes them more likely to be mistaken as food, resulting in more of these blockages (Roman et al., 2020; Zachos, 2018; Borunda, 2019). Furthermore, while not all plastic items are immediately lethal, more items ingested increases the chances of a lethal item being consumed (Roman et al., 2020).

Plastics also interact with additives and chemicals, which include metals, endocrine disruptors, and persistent organic pollutants, which can transfer to organisms with ingestion of plastics (Kedzierski et al., 2020). Many traditional, oil-based plastics have been known to release hazardous chemicals

into the environment, whether on land or in water (Narancic and O'Connor, 2018; Save the Whales, n.d.). Though studies warn of related health risks, more research is needed to understand how long plastic particles remain floating on the sea surface and how the additives and chemicals they carry interact and change over time (Guerrini et al., 2019).

Microplastics and effects

The effects of plastic pollution on the natural environment extend beyond large debris, especially in the form of microplastics. Microplastics are plastic waste items under five millimeters, and they permeate oceans more than other plastic debris (Roman et al., 2020). These microplastics might source directly from consumer products, like in the form of microbeads, or they might be the result of larger debris breaking down into smaller pieces (Roman et al., 2020). Types of microplastics frequently ingested include "fibers, threads, and plastic fragments" which can sometimes become choking hazards to smaller species like certain seabirds (Roman et al., 2020).

The negative effects of microplastics are more apparent in higher concentrations (Narancic and O'Connor, 2018). On land, microplastics can affect the properties and subsequent functions of soil, resulting in impacts to terrestrial ecosystems (Narancic and O'Connor, 2018). In oceans, planktonic

organisms on the sea surface can also ingest nano- and microplastics, resulting in interferences with a "wide range of functions such as reproduction, growth or feeding behaviour" (Kedzierski et al., 2020). One such organism includes phytoplankton, microscopic plants which produce about half of the world's oxygen while accounting for the absorption of around a third of the carbon dioxide in the atmosphere produced by human activity (Whale and Dolphin Conservation, n.d.). Phytoplankton also have a role as the "main source of nutrition for higher trophic levels" (Guerrini et al., 2019). The health of these phytoplankton not only relies on non-contaminated waters, but also the health of marine species, such as whales, which produce fecal matter that help fuel the production of oxygen (Whale and Dolphin Conservation, n.d.). Thus, the repercussions of our plastic pollution affect not only species, but also the health of ecosystems around the planet.

Biodegradable plastics as a solution

Traditional plastics are oil-based, derived from fossil fuels, and used in a variety of applications (Narancic and O'Connor, 2018). In the packaging industry, which accounts for 40% of the world's plastic, common plastics include polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), and polystyrene (PS) (Narancic and O'Connor, 2018). Most of these traditional plastics

are resistant to biodegradation; thus, they are likely to accumulate and contaminate local waterways, eventually ending up in oceans and affecting species like whales and other marine fauna (Narancic and O'Connor, 2018).

As a potential component of management strategies for the growing plastic waste problem, researchers are looking to biodegradable plastics for better end-of-life waste processes (Narancic and O'Connor, 2018; Roman et al., 2020). For example, among the most common bioplastics is polylactic acid (PLA) (Narancic and O'Connor, 2018). PLA has high crystallinity, giving it more possible range in applications (Narancic and O'Connor, 2018). Additionally, research shows the possibility of PLA/PCL composites and home-composting, where individuals could be responsible for their own waste management (Narancic and O'Connor, 2018). However, careful attention is required because of specific conditions needed to biodegrade (Narancic and O'Connor, 2018). PLA/PCL composites, while home-compostable, will not degrade in soil- or water-based surroundings (Narancic and O'Connor, 2018). Incorrectly disposed biodegradable plastics might have the same effects as regular plastic pollution on environments if they cannot biodegrade (Narancic and O'Connor, 2018).

All biodegradable plastics, whether oil-

based or bio-based, require certain conditions in order to break down in their environment (Narancic and O'Connor, 2018). Also, the timeframe of biodegradability is important to potential benefits over traditional plastics (Narancic and O'Connor, 2018). Ultimately, thorough understanding and management of these conditions are crucial to prevent otherwise sustaining the accumulation problem of plastics (Narancic and O'Connor, 2018).

Prioritizing policies to reduce negative impact

A study by Roman et. al (2020) of the lethality of different types of plastic debris suggests that some are disproportionately responsible for megafauna deaths, and thus certain policies must be prioritized to reduce their impact quickly. While microplastics affect phytoplankton and are ingested by megafauna either directly or via bioaccumulation, they are not proven to be lethal when directly ingested; therefore, they might be considered lower priority in policy when compared to more hazardous plastic debris (Roman et al., 2020). The study calculated lethality of item types based on frequency of deaths over number of occurrences, in addition to commonness of items by taxa and frequency as proportion to total (Roman et al., 2020). Film-like plastics, plastic fragments, and ropes/nets were the items most

commonly ingested by cetaceans, with film-like plastics and ropes/nets resulting in the most mortalities, showing a high frequency of fatal blockages (Roman et al., 2020). Generally, the most hazardous types include plastic bags and balloons (though not common, highly lethal), followed by monofilament line and plastic utensils, general categories of film-like plastic, hard plastic fragments, and fishing debris (also most common) (Roman et al., 2020). The policies that Roman et al. (2020) suggest combine “legislative policies and practices with behavior change outreach” (Roman et al., 2020). For example, one type of policy argued to have had an effect in the past is the regulation of plastic bags, whether through restrictions on manufacturing and distribution, taxation, or consumer bag fees, or post-use disposal strategies (Roman et al., 2020).

Research of the movement and distribution of plastic waste in the ocean can also serve as a tool to prioritize action. In a study by Guerrini et al. (2019) in the Mediterranean sea basin, oceanographic modeling was used as a tool for mapping and monitoring the movement of plastic waste and the distribution and density of patches, as well as calculating risks to species, protected areas (MPA), feeding grounds, and other high potential habitat for target species. The model utilized particle tracking to identify movement of plastic particles from different sourc-

es, including coastlines, rivers, and shipping routes (Guerrini et al., 2019). While this particular model incorporated movement of fin whales and their potential to be exposed to plastic debris in their feeding grounds, data from modeling particle movement could also be applied to other marine biota to assess their potential risk of exposure and areas of high risk (Guerrini et al., 2019).

Individual behavior changes

Research and education can also inform better individual behavior choices, which are necessary to solve the plastic problem.

The common slogan of the “three R’s: reduce, reuse, recycle,” can help to inform individuals of more sustainable practices in everyday life. It is argued that the best option for preventing plastic pollution is preventing contamination in the first place (Roman et al., 2020; Narancic and O’Connor, 2018; Kedzierski et al., 2020). The cultural legacy of reuse has preceded plastic use but has been somewhat lost with the transition away from traditional materials (Kedzierski et al., 2020). The duration of use is also critical, as certain plastic products have the potential for long-term use or even limited reuse before disposal (Kedzierski et al., 2020). The longer we can prolong the disposal of consumer products through functional use, the less we contribute to the problem of accumulation (Kedzierski et al., 2020). Although solutions

like biodegradable plastics can be an option for better end-of-life waste management strategies, ultimately the “throw-away attitude” fueled by single-use plastics and consumerism will not be sustainable even with technological advancements (Narancic and O’Connor, 2018). Recycling as another informed practice is well-known but generally varies in effectiveness by country or region. Currently, less than 20% of all plastic is recycled globally, while the U.S. recycles only about 9% of its plastic waste (Parker, 2018a). A push for recycling, while not the only solution, can be a strategy for individual behavior changes through more responsible waste disposal practices (Kedzierski et al., 2020).

Education opportunities are also important to cultivating interest to change in the first place. For example, understanding the impact of whales, a fairly familiar group of species, on ecosystems and climate could be a motivating factor for saving their living environment (Whale and Dolphin Conservation, n.d.). Various cetacean species are linked to the health of marine ecosystems as they redistribute nutrients across the ocean (Whale and Dolphin Conservation, n.d.). Their benefits to the climate extend beyond their natural lifetimes; “whale fall,” or the process of a whale sinking to the bottom of the ocean after death, functions as major carbon storage as well as ecosystem support (Whale and Dolphin Conservation, n.d.). It

is estimated that rebuilding whale populations would lead to 145,000 tons of carbon absorbed into carcasses yearly, as well as support for up to 200 species by providing food and shelter (Whale and Dolphin Conservation, n.d.). Save the Whales, an organization aiming to “preserve and protect the ocean and its inhabitants,” cites education, especially to younger generations, as a key factor to ocean conservation (Save the Whales, n.d.). This next generation education can take on a variety of forms, including the organization’s “Whales on Wheels” marine biologist education in the classroom, and watershed education that enables kids to engage with water quality testing in order to bring attention to local water health (Save the Whales, n.d.).

Supporting individual action through policy and research

Policy change and behavioral change are both needed for waste management strategies, as programs that address both have been historically more effective (Roman et al., 2020). Ways that governments can support individual behaviors could range from economic support to enforcing policy to create individual accountability (Kedzierski et al., 2020). Often, the burden is put on local actors to manage and clean up waste, as well as deal with the proximity of waste collection sites (Kedzierski et al., 2020). Better support through funding and resources could en-

courage sustained action to solve the plastic waste problem (Kedzierski et al., 2020).

Solutions like biodegradable plastics also offer potential economic incentives through improved end-of-life waste management strategies (Narancic and O'Connor, 2018). Anaerobic digestion (AD) has potential with the production of biogas contributing to renewable energy targets (Narancic and O'Connor, 2018). There is also potential for a circular economy with production of CO₂ and methane through industrial composting, which serve as building blocks for polymers and chemicals (Narancic and O'Connor, 2018).

Additionally, funding of research across disciplines, such as in the social sciences might be beneficial to enabling the adoption of plastic waste management strategies (Kedzierski et al., 2020). Avoidance tendencies for waste materials are typically based on senses (smell, sight, touch) and concern for hygiene, while plastic waste might potentially be disassociated from its harmful effects (Kedzierski et al., 2020). Contaminants absorbed by plastic waste can make their way up the food chain, but it is often difficult to sensitize users of plastics to these risks, even if it is understood, because of how removed these effects are from everyday use (Kedzierski et al., 2020). Understanding the history of waste management and how we adopted harmful practices might help inform new

solutions relating to individual behavior changes (Kedzierski et al., 2020).

Discussion

Ultimately, the growing plastic waste problem necessitates programs that combine individual behavior and policy changes backed by scientific research and education in order to implement large-scale change. Individual action is necessary, and education opportunities should encourage users to extend the duration of product use and adapt to consumer behaviors that are more sustainable. Practices at home could take on a range of effort. One thing that can help reduce the accumulation of plastic is the reuse of otherwise immediately disposed plastics. Taking on a message of more than just one use could serve as an education tool for behavior changes that feel actionable by the general public, even if they feel less informed about the issue. A step beyond that, but still within everyday actions, could be changing consumer behaviors by encouraging people to seek out options that are more sustainable and have more potential for reuse.

Changes to individual behavior can only be facilitated by support through policy and infrastructure. In order to address the global issue, governments should allocate resources to set up infrastructure, fund programs that otherwise put the burden on local communities to sustain action, and fund research into

innovative solutions and their implementation. Even an individual informed of the dangers of plastic pollution could lack access to infrastructure that would enable them to engage in more sustainable actions. One example is the proper recycling of certain plastic products; in the U.S., infrastructure for recycling practices could be more prevalent and could better inform individuals on which products are recyclable and which are not. Furthermore, policies are necessary to regulate the production of plastics before they reach individual consumers.

Likewise, the private sector can also support individual behavior changes by investing into engineering solutions and industrial design, in addition to scientific research, to increase longevity of products and potential for reuse before they are put out into the consumer market. Better design practices have potential for more exciting solutions, but they need to be accessible by consumers in order to see actual progress. Consumers are also increasingly aware of environmental justice issues in the modern age, so innovative and accessible products that take on sustainable practices can be appealing to potential buyers.

Generally, education opportunities should also create a level of empathy and motivation to act, whether that be empathy for affected species like whales or understanding of direct effects to humans. Even with new solu-

tions, our plastic waste problem can only be solved if we are motivated to solve it in the first place. Consumerism is deep-rooted in our society, but we are also culturally empathetic to animals and nature through books, media, and stories. One issue with plastic pollution is the frequent dissociation of the harmful effects from our everyday use. If we can make the connections between the plastic waste problem to the issues that draw our attention, then more people might be encouraged to start changing their behaviors.

Conclusion

Reading through articles about whales washing up on beaches filled with plastic can be impactful but can also create a sense of helplessness. It is difficult to conceptualize the direct contributions we are individually making, and unsustainable practices are difficult to avoid with their prevalence through different parts of our daily lives. However, through education and research of these issues, we can establish more detailed, concrete plans of action that involve both the public and private sectors to encourage, rather than discourage, the actionable practices that combat excessive consumerism and reduce our negative impact. Furthermore, emotional connections to familiar species like whales and the impact of plastic pollution on their survival might motivate action, especially when paired with the cyclical effects

of environmental health on our own health and wellbeing. While research continues to uncover more on the impacts of our plastic dependence and as well as exciting potential solutions, our knowledge will only be effective if we as a society are willing to curb our plastic dependency.

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WHY BLAME BATS FOR EVERY DISEASE?

Bat Conservation as a Solution to Reduce New Human Virus.

Introduction

We humans have struggled with infectious diseases caused by animals for a long time. In the 1980s, HIV/AIDS originated from higher apes, with bird flu outbreaks between 2004 and 2007. In 2009, SARS was transmitted to humans through musk cats and bats, and the Ebola virus through bats. Now, we are fighting the coronavirus caused by bats. Dense breeding of livestock, habitat destruction due to humans' indiscriminate development,

hunting and killing, and ingestion of wild animals resulted in increasing the risk of infection of animal-borne viruses. The media planted negative images of bats in the public by giving misleading information that all bats carry viruses, blaming all the faults on bats, which led to a more severe persecution of them. Although it is true that some species of bats have a high risk of a viral host, bats also have tremendous ecological and economic values as pollinators or as powerful insecticides in nature. Therefore, we should rethink the root cause of the problems. Due to various anthropogenic factors, including habitat destruction, hunting and killing, bumping into the wings of a spinning wind turbine, buildings made of transparent glass or mirrors, light pollution from artificial lighting, global warming, pesti-



cides in agricultural land, and infections from fungus such as white nose syndrome, it is known that 20% of the world's bat species are at risk of extinction. By conserving bats, restoring their habitats, reducing factory farming, and rethinking about the food culture of eating wild animals, we can find solutions to coexist with bats and minimize the risk of new infectious diseases.

Key words

zoonotic diseases / ecological value / anthropogenic threats / habitat conservation & habitat restoration / factory farming -> viral reservoir / food culture (bushmeat)

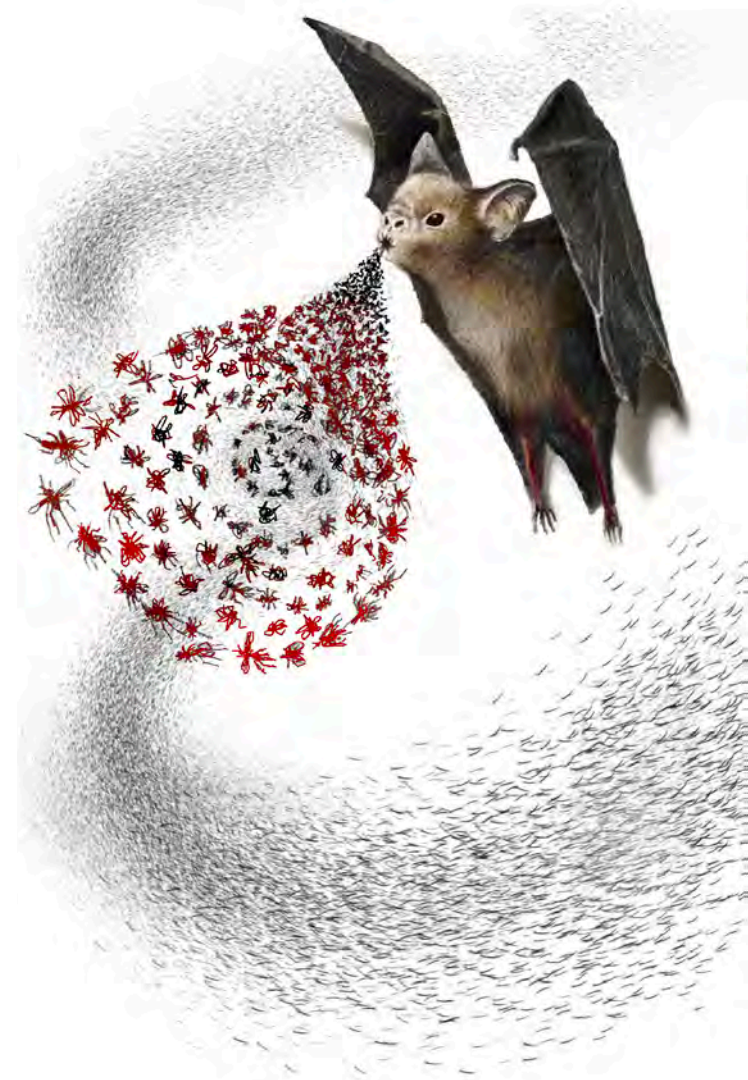
Literature Review

Ecological and Economic Importance of Bats (Order Chiroptera)

The article introduces the ecological role of bats, their economic benefits and harms. Bats, the second most diverse and abundant mammals after humans, were evolved 52 million years ago. They have played a crucial role in prey and predator, seed dispersion, pollination, material and nutrient distribution, and recycling. They constrained the population of arthropods by ingesting numerous pests, including crop

pests, with great ecological and economic benefits. Conversely, they became a prey for vertebrates such as fish, amphibians, birds, reptiles and mammals. Their special skin and hair morphology were suitable to be a host in defense against parasitic infections. The powerful wings of bats, which allow long-distance flight, and their habit of defecating or spitting seeds during flight, have been very beneficial in spreading the seeds of numerous tropical plants to a distance, enabling pollination in arid areas. Fruit-eating bats played an important role in forest regeneration, especially rainforest survival, and bat guano provided organic input to cave ecosystems that lacked food. In particular, the bats were the perfect ecological indicators showing the habitat quality and the impact of climate change on biodiversity. When bats were sick, it meant that their immunity was weakened due to environmental stress.

Bats also played a very important role for humans economically. They contributed to tourism, the significant reduction of pesticide use, and guano, the excrement of bats, was used as fertilizer for agricultural crops. Bats not only provided tropical plants such as bananas, breadfruits, and durians, but also bush meat, medicine, and various products made of plants. In particular, their echolocation enabled the technological



innovation in humans like the invention of sensors and biomedical ultrasound. It also had a positive influence on the field of biomimetics by developing sonar and anticoagulants. Although we cannot deny the harm that bats brought to humans, such as carrying disease or damage from bat strikes to airplanes, we must remember what we can



lose by killing bats. The writers point out that the importance of bats is overlooked, despite the fact that most bats have positive and only few of them have negative impacts on ecosystems, and argue that bat conservation is mandatory.

Bat conservation and zoonotic disease risk: a research agenda to prevent misguided persecution in the aftermath of COVID-19

The article talks about how misleading media and assumptions can be serious obstacles to bat conservation by linking the infectious diseases with all bats. Although bats are primarily thought to be the culprit of the virus outbreak, the underlying reason for the virus outbreak may lie within humans, destroying the bat's habitat and increasing the likelihood of contact. In addition, not all species of bats are involved in viral transmission, but only a few of them. Currently, one-third of more than 1,400 bat species are classified as endangered, or lack of data, and more and more bats are unjustly persecuted for wrong frames on bats around the world. However, bats, as pesticides and pollinators, play an important role in the ecosystem, human health, and economy. Therefore,

it is argued that clearer guidance based on evidence and action plans is needed to minimize the zoonotic health risks without limiting the bat conservation. The guidance includes identifying the ecology, evolution, and immunology of bats in relation to the spread of pathogens, the causes of zoonotic spill-overs and prioritization of conservation psychology for behavioral change, quantifying the ecological benefits of bats in relation to human health, and enhancing the interaction between bat conservation networks, etc. Lastly, the writer says that bat conservation is part of global conservation, and that symbiosis with bats requires an unbiased understanding of the health risks associated with bats and cooperation with stakeholders.

A review of the major threats and challenges to global bat conservation

Based on the data from IUCN Red List, this article provides an overview of the global status of bat conservation by looking at the anthropogenic threats that bats are facing and the challenges of bat conservation. Bats are a diverse group that occupies a fifth of mammalian diversity. Unfortunately, more than a third of bat species are classified as endangered or lack data, more

than half of the species are experiencing unknown or decreasing population trends, and 80% of bats require conservation and research attention. The lack of information on the status of the bat species makes it difficult to preserve them as they are classified as “unknown”, not “endangered” or “concerned”. Although there is a movement to build a database to monitor bats as more new bat species are discovered, monitoring and research on the bat population requires much more effort. By identifying the major anthropogenic stresses that pose a threat to the bat population, it looks for solutions to alleviate them. The ranking of threats introduced is as follows.

1. Logging and harvesting plants
2. Agriculture
3. Hunting and collecting animals
4. Human intrusions and disturbance
5. Urban development
6. Energy production and mining
7. Climate change and severe weather
8. Natural system modifications
9. Invasive species
10. Pollution
11. Transportation and service corridors
12. Geologic events

Caves or subterranean refuges are known as the most important habitat for bats, but forests also play an important role in that they provide food roosts, and high biodiversity. Islands are also of great value as

habitats for bats. One-quarter of bats are endemic to islands, and bats are the pollinators that contribute significantly to islands' ecosystem. However, unfortunately half of them are known to be endangered. With nearly 40% of terrestrial land being used for agricultural production, many bats have had to share habitats with humans, increasing the risk of disease transmission. In particular, the conflict between fruit-eating bats and farmers aggravated, leading many bats to ruthless hunting and persecution. However, culling animals to limit the spread of zoonotic viruses has proven to be ineffective. The indiscreet gas spray to eradicate bats has not only deprived the lives of bats, but also the lives and roosts of other species that share their habitat with bats. However, in 2006, the mass death of bats due to White Nose Syndrome (WNS) caused by a fungal pathogen increased public interest in bat conservation. Since wind turbines have killed many of the migratory bats, the solutions, such as limiting wind turbine operation at night or slowing down the turbine in the autumn when there are a lot of migrations, were proposed. Mining and quarrying activities have also threatened many bats by destroying their underground habitats, but inactive mines have emerged as an alternative to bats as critical roosts.

Radical eradication may seem to solve problems right away. But we should be mindful that this may lead to an unintended result, creating more serious problems. When implementing monitoring, a consistent system must be established in consideration of details such as colony size, season, roost use, and presence or absence of echolocation. To do this, building global and regional networks connecting various fields of experts, and creating open source where people can easily share information about the conservation status of bats will be of great help in bat conservation. Numerous threats and solutions to bats are already out there, and identifying the priorities of efforts is of paramount.

China has made eating wild animals illegal after the coronavirus outbreak. But ending the trade won't be easy.

Since the outbreak of the coronavirus, wild animal consumption and farming have become illegal throughout China. However, it seems difficult to completely ban the trade because in China, wild animals have great cultural and economic value as not only food but also traditional medicine, cloth-

ing, ornaments, and even pets. According to a report sponsored by the government in 2017, "China's wildlife trade was worth more than \$73 billion and employed more than one million people." However, there is a growing criticism of the wildlife market as there is a high risk of the virus spreading rapidly from one species to another. But the biggest hurdle to the complete ban on the trade is that they are also used as traditional medicine. The industry has tremendous economic value, with a current value of about \$130 billion, and the trade of wild animals for medicinal usage is still exceptional. The lack of strict standards for restrictions carries the risk of exploiting them, such as trafficking in animals or reclassifying certain wild animals as "livestock". For instance, currently, the eating of pangolins is prohibited while the medical use of their scales is not. Thus, some argue that wildlife trade should be completely banned, regardless of its use, but this can create a black market, which may pose a greater risk by making the market more difficult to control. It is difficult to change the culture at once. In order to prevent a larger side effect, not only law enforcement but also strict monitoring and a change in people's perceptions will be required.

The meat we eat is a pandemic risk, too.

The writer argues that the cause of pandemic cannot be attributed only to Chinese food culture, and that US factory farming is also a major risk factor for pandemics. When we talk about pandemic, there are two kinds: One is viral pandemic and the other is bacterial pandemic. “With factory farming, the opportunity to start a viral pandemic may be less, but the



opportunity for acquiring an antibiotic-resistant bacterial infection is greater.” The United States produces over 90 percent of meat globally, much of which comes from factory farms. Although CAFO (Concentrated Animal Feeding Operation) maximizes efficiency in that it breeds as many animals as possible in a small space, it optimizes the condition for virus spread. Overcrowded farms exacerbate animal stress, weaken their immunity, causing disease, and ammonia from decomposition waste burns their lungs. Because factory farmers choose and grow specific genes that are particularly superior among animals, this makes the genes identical, and the resulting lack of genetic variation accelerates the spread of the virus. Compared to small farms with fewer hosts, the risk of the zoonotic virus is amplified in factory farms because pathogens in factory farms do not kill the host quickly and try to remain there as long as possible. To make the matter worse, international trading of poultry and livestock spreads this risk worldwide. In addition, the abuse of antibiotics to compensate for poor industrial agricultural conditions evolves mutations, which in turn can be fatal in that it can lead to a situation where there is no cure even when new disease emerges.

Factory farming isn’t just about killing animals. Coronavirus cases have skyrocketed among workers working in meat factories, as their cramped working environment makes social distancing impossible. We have to reconsider whether our eating habits are worth all these costs. However, there are solutions for a better food system such as reducing long-distance movement of live animals, transporting only carcasses of animals, or creating smaller and less crowded farm environments. The abolition of factory farming reduces the likelihood of animal-borne infection, but to completely eradicate the possibility, a more radical change is needed to consume only vegetable meat. Luckily out of misery, during the pandemic, peoples’ demand for plant-based products surged. This is a positive sign that the public’s thinking about factory farming and meat consumption is gradually changing as it is linked to the spread of infectious diseases.

THE LOSS OF NATURE AND RISE OF PANDEMICS: Protecting human and planetary health

This text, written by the World Wildlife Fund for Nature, provides overall information on viruses and looks at case studies

of previous zoonotic diseases to see the humans' impact on biodiversity and ecosystems, which has led to the spread of the disease. Lastly, it introduces what we can do to minimize risk. Viruses have been recognized as negative images that carry viruses, but actually, they play an essential role in regulating the population of host species and balancing the ecosystem. There are two types of viruses, DNA or RNA, and coronavirus and SARS belong to RNA viruses. Another official name of CoVID-19 is SARS-CoV-2. This is because its genes show genetically high correspondence with coronavirus that occurred during the SARS outbreak. The similarity between SARS-CoV and SARS-CoV-2 is that both are zoonotic spillovers which used bats as their hosts. Zoonotic diseases account for 3/4 of human diseases, and 60% of them originate from wild animals. And it is likely that both viruses have been genetically altered through wild animal trade, leading to a greater spread of the disease. This is because RNA viruses mutate and adapt quickly when various species are mixed, increasing the likelihood of the appearance of new viruses.

In addition to risk of zoonosis, the article presents deforestation, species collecting and trafficking, and animal markets as

pathways for epidemics. Firstly, the surge in demand for wild animal meat (bush meat) has contributed to supporting the illegal international market, and the unsanitary and uncontrolled environment of animals has amplified the spread of the virus. After the pandemic, China has made a timely move that strictly bans illegal wildlife trade and markets, and the authors argue that such bans should be made globally. However, among the threats that bats are facing, the most serious one is humans' destruction and transformation of natural habitats. "three-quarters of land and two-thirds of the marine environment have been modified in a significant way, and around 1 million animal and plant species are at risk of extinction."

The writer argues that the land-use change is attributed to nearly half of emerging zoonoses, urging that we should consider the threat of animal disease when it comes to the land-use plan. For instance, logging in tropical rainforests increased mosquito-borne diseases, and biodiversity decreased due to deforestation, resulting in fewer predators, creating a favorable environment for pathogens. The writer also argues that the indiscriminate use of pesticides or killing infected livestock to reduce the number of host or vector species has limitations in preventing zoonoses by

increasing the resistance of viruses. In order to prevent the emergence of new viruses, we must strive to restore destroyed nature as well as preserve intact ecosystems, and remember the "One Health" approach that the health of all ecosystems including humans is interconnected. Calling for a more multidisciplinary and collaborative approach to address health risks, the writer urges governments to sign on to a New Deal for Nature and People.

Discussion

Some people predict that we might have to live with the virus in the future. So, could getting rid of all bats be a perfect solution to stopping the spread of the virus? It is true that bats have a high risk of a viral host, but they also have tremendous ecological values as prey and predator, pollinator, nutrient distributor, seed disperser and as powerful pesticides in nature. Their habit of defecating or spitting seeds during the flight is beneficial in spreading the seeds of numerous tropical plants to a distance, enabling pollination even in arid areas. In particular, fruit-eating bats play an important role in the regeneration of rainforests, and guano, which is the feces of bats, provides abundant nutrients to the cave ecosystem where

food is scarce, and because of their geographical advantage spread over a large area, bats are also suitable as an ecological indicator. Bats have important value not only ecologically but also economically. Bats watching served as tourist attractions, their role as insecticide and fertilizer significantly reduced the usage of pesticides and fertilizers, and echolocation has led to the innovation of technology.

However, their importance is easily overlooked because of the negative images of bats that are planted in the media and the hasty generalization of linking the cause of the virus to all bats. Not all species of bats are involved in viral transmission and only few of them have negative impacts on ecosystems. Through the case of Marburg virus, it is proved that bat persecution for controlling zoonotic diseases has been shown to be ineffective, and reckless extermination has also deprived the lives and roosts of other species that share habitat with bats. More than a third of 1200~1400 bat species are classified as endangered or lack data, more than half of the species are experiencing unknown or decreasing population trends, and 80% of bats require conservation and research attention. Mass culling events implemented by the government and public excessive hunting and

persecution have led to a serious population loss of bats, resulting in changing their status on the IUCN Red List from vulnerable to endangered. Therefore, reducing the number of bats alone cannot solve the problem. We should be mindful about the chain reactions that can be caused by killing bats.

We should rethink the root cause of the problems. Bats are threatened by various anthropogenic factors: Destruction of the bats' habitat, hunting and eating bushmeat, humans' intrusions and disturbances, and urban development has increased the likelihood of contact with bats that can carry the virus. Zoonotic diseases account for 3/4 of human disease, and 60% of them originate from wild animals. The wild animal market, where many wild animals of unknown origin are globally traded, has been banned in large numbers due to the risk of easily transmitting the virus. However, due to the lack of strict standards for restrictions, some trades of wild animals used as medicine are still allowed, and illegal markets have emerged.

Since black markets are not under control, it can create a greater risk. Factory farms that keep as many animals as possible in confined spaces may reduce the risk of the

virus by administering antibiotics to their livestock, but they may increase antibiotic bacterial infections, which may result in no cure when new diseases appear in the future. We humans should know that the cause of the spread of the virus is not only attributed to bats, but that we are the root cause. Based on the unbiased perception of bats, we should find solutions on how to preserve bats that are ecologically and economically beneficial while minimizing the risk of viral infection.

Conclusion

Although there are so many threats that bats are facing, there are various solutions for minimizing the risk of new infectious diseases. Examples include restoring bats habitat, reducing factory farming, banning the consumption of wild animal meat, using inactive mines as a habitat for bats, and developing a collaborative widespread monitoring system. However, it is important to prioritize these efforts. Since humans' destruction and transformation of natural habitats are the most threatening cause, which is attributed to nearly half of emerging zoonoses, specific bat habitats at high risk of viral transmission could be set as intact regions to reduce contact with them.

The pandemic has taught us how the health of ecosystems including humans is inter-related (One Health). People are changing. The concept of “Global Safety Net” has emerged to protect threatened animals and plants and to reverse biodiversity loss. The mass culling of the government which put many bats under threat, increased people’s interest in conserving bats. Public thoughts on wild animal markets and factory farming are changing. To minimize factory farming, more people are demanding plant-based meat, and the trade of wildlife is also being banned. The wrong actions we do to the environment often result from ignorance or misunderstanding of what is happening to nature. Still, the lack of data on bats remains a major obstacle to the conservation of bats. If we do not induce public behavior through biased information, but educate them with unbiased information so that the public has the right to make autonomous choices about their behavior, we can protect bats and minimize the risk of spreading the virus.

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MANMEET SODHI

CONSUMING BEYOND REPAIR

A dive into our habits

As we, humans, move into the new decade - we carry forward our knowledge and mistakes, aiming to be better in the upcoming years. Yet, we see more posts on social media about awareness and understanding the roots of the things we consume. As a species, we have spent decades advancing our technology towards compensating for an “average” human’s consumption.

Recycling, material innovations and environment friendly alternatives have come so far but the rate of consumption is a thirst that has yet to be quenched. With a pandemic still raging across America and the population consuming approximately 24% of the global energy production, it might be time to take a step back and think about



where a change is necessary - the mindset of the people or the things that they consume?

COVID-19 shed light on multiple issues within societies and taught the emerging generation plenty of things that they will take forward. It is well known that everyone’s lives changed drastically as a result of it. The idea of ethical consumption and bare necessities has always floated around, some people even adopting it but through this pandemic - everyone actually understood what it truly is. What does it take to

get through the day? How can corporations cut down on costs without affecting productivity? How can a person learn different “hacks” to reduce their waste footprint? Interestingly, these questions were answered through trends that arose within society on social media or observations we made in our own lives.

As the pandemic progressed, many studies showed how the restrictions lowered the CO2 emissions across the globe. There is a positive correlation between the decrease in CO2 emissions and the strictness of

restrictions placed by the governments in those areas. Populations were, for their own safety, asked to stay inside and only leave when necessary. The word 'necessary' is subjective, especially amongst the emerging generation in America. Yes, we all have basic needs like food, water and shelter but with economic power comes a growth in needs. The line between a want and a need gets blurred quickly when it is possible to acquire something without repercussions. Where do we stop? Is there even a way to stop?

“Stuffocation” is the cycle that people are trapped in, working to keep up with the ever expanding nature of consumerism. It was coined by British cultural forecaster James Wallman and it sums up how over-consumption affects us. For most, monetary values equate to happiness and satisfaction. Consumerism plays on the human desire to be satisfied, dangling something new and shiny in front of someone. Consumerism thrives because people who can't afford something strive to afford it. They punch hours into a timecard so that it can be translated into, usually, an object they “need”. With how society works, the ability to then display your satisfaction propels the justification further as others around you validate your purchases. “Stuffocation” isn't

an easy thing to counter because of how ingrained it is.

The first step to it, as many articles and researchers suggest, is to acknowledge that it is a problem. Acknowledge that you are caught in a vicious cycle, acknowledge that every little thing you do has an impact on things you cannot see. Leaving your cooling unit on, when opening the window can occasionally have the same effect, contributes to your entire housing's electricity consumption which has a major impact on carbon footprints. Realizing that products that make tasks 'convenient' are probably part of the 'stuffocation' cycle. Taking public transport to reach your destination, even if you own a car, can have a massive impact on your and the environment's health.

This first step is crucial, as every change comes with a shift in thought process. Taking it a step further, we arrive at the stage of observation. Finding things that create an unnecessary convenience is key to understanding how you can combat over-consumption. Research shows that these conveniences may create a sense of temporary happiness but it revolves around the physical object itself, not the person. Take away the object and the person feels hollow and disconnected, triggering an adjustment

period that depends on the severity of the connection with the object. This is why observation is key. Within your society you must observe what is actually necessary. A stable wireless connection might be one, not something that is blazing fast but one that gets you through zoom calls. It is all about identifying and catching yourself when you are justifying something that isn't required. It takes practice. The second step is the one that will take the longest and be the most frustrating. Finding faults within yourself is scary but many experts suggest that it leads to a better understanding of yourself in the long run. It is a good practice for college students, being able to catch yourself in the wrong and correct yourself.

The problem most people encounter is the definition of “correct” and that is something that is hard to standardize. With cultural differences, geological factors and the inevitable human nature of comparison - you cannot come to a conclusion that easily. Cutting down on consumption can mean completely different things when it comes to culture. For example, when you are in a culture that consists of meat alternatives in the cuisine, it is possible to find alternatives and reduce your overall impact on the wildlife. When alternatives aren't available, a person may struggle to find meaning in

observing their culture. Or they may beg the question, is it time to bring something new to the culture?

Battling overconsumption leads to innovation and reflection, two essentials for society to move in the right direction. However, on the current path - innovation might be taking place to compensate for the general mindset, not to change the mindset.

After observation, it is left to the individual to do what they will with the knowledge. As we learn more about ourselves and the world, the responsibility falls on us to repair the mistakes of those that came before us. With innovations that harmed the environment, there were also ones that will allow us to save it. We cannot just depend on others to solve problems that exist within our households and everyday lives. Overconsumption is a product of the desires that come from being human but they can be changed. Setting standards that involve countering overconsumption not compensating for it. It might be the inherent flaw of humanity as a whole, thinking that we as a species are at the center of it all. Accepting and fighting flaws within our society isn't a new thing, just more people do it now. We must cut down and save for

those who will come after because we are at the nexus of a graph that has begun to trend downwards. It is high time we stop making excuses through innovation and bring actual change.

ALEX WATSON

CLIMATE CONCIOUS CITIES

COUNTERING THE NEGATIVE EFFECTS OF URBANIZATION THROUGH INNOVATION AND COMMUNITY OUTREACH

Current models of urbanization and urban development fail to address a myriad of problems that contribute to the environmental degradation of the space. Urban spaces like buildings, parking lots and roads block water's ability to absorb into the soil, which in natural circumstances would act as a filter before the water reached larger waterways, but in urban environments the trapped surface water brings chemical pollutants, trash, dirt and oils directly into the larger waterways (Chaudry, Malik).

Though the cultural definitions for urban vary country to country, it's estimated that two-thirds of people worldwide will live in

urban environments by 2050 (Nat. Geo.) As the human population continues to grow and flock towards urban living, if cities and urban spaces are to meaningfully combat these concerns they will need to remain open to the wide array of innovative new technological and social solutions at their disposal. To actively anticipate and combat the negative effects of urbanization, urban planners will have to think outside what is standard, and consider many micro-solutions that value the participation and education of the community they serve. Solutions to these urban-based problems should approach the issues with

a strategy as multifaceted as the problems themselves, aiming to address both the problem directly, while engaging the reason for the initial issue: the human residents of that area. By simultaneously educating and inspiring those in the community to live more sustainably, the same people responsible for the issue can be turned into a tool for good.

MR. TRASH WHEEL

In Baltimore, Maryland's largest city, John Kellet had an idea that managed to create this type of dual- purpose solution. After seeing how much mismanaged waste from

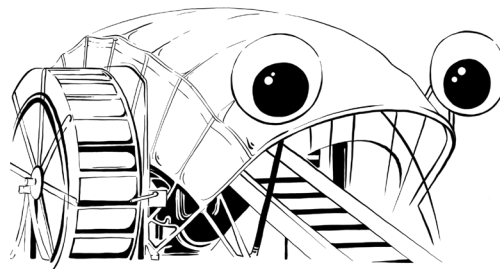


Illustration by ALEX WATSON

the city routinely flowed through the Jones Falls River, Mr. Kellet created a semi-autonomous trash wheel powered by a solar-water hybrid model with the goal of making the Baltimore Harbor fishable and swimmable by 2020 as part of the Healthy Harbor Initiative (Upworthy). Lovingly dubbed Mr. Trash Wheel and formally named the Inner Harbor Water Wheel, the machine made quick work cleaning up the Harbor. During a storm in May 2014, Adam Lunquist took a video of Mr. Trash Wheel's unusually large garbage meal. Admittedly, watching the wheel at work is like watching paint dry, it operates at a snail's pace, just fast enough to dutifully remove millions of pounds of trash, but slow enough to not harm or disturb surrounding wildlife. Somehow even still, the video went viral and won the hearts of people all over the world.

In the wake of the machine's virality, at least three local apparel and souvenir shops started to stock Mr. Trash wheel themed merchandise like t-shirts, plushies and pins. The local brewery, Peabody Heights, now sells three craft beers that support the project. Some of the profits from these products go back towards the operation of the original Baltimore Mr. Trash Wheel, but they also serve to support the project as a whole helping them financially to expand the technol-

ogy to other cities around the globe. Currently there are several other additions to the Mr. Trash Wheel family, with two other existing wheels in Baltimore, a third on the way, and projects being added in Oakland, CA, and Panama City, Panama. This expansion, and resulting vast amounts of waste removed from their respective waterways are in great part due to the internet-success of the project. It's initial social media storm led to features in the New Yorker, Wall Street Journal, National Geographic, PBS, CNN & NBC. The original Mr. Trash Wheel was honored in the Guinness Book of World Records for "Most Floating Debris Removed by a Trash Interceptor in One Month" for it's dinner of 63.3 U.S. Tons of waste in April 2017 alone, (source) about the weight of 30 Black Rhinos (source).



While this is a hefty feat, Mr. Trash Wheel's ultimate goal is to become obsolete, no longer necessary as locals learn about the brutal amount of trash pooling in their

water-ways and how they can take action at home to reduce it. Mr. Trash Wheel's many social media pages share updates, as well as information on how to properly dispose of trash waste, and reduce its creation in the first place. The photos shared online may oftentimes be packaged in a humorous facade, but the reality of the situation still hits as it's designed to. Witnessing the light-hearted, unofficial-mascot of the community drowning in garbage evokes a more persuasive empathic response than a non-personified trash interceptor would ever have been able to create, pushing its followers to lead more waste-conscious lives. The community has advocated for the character and engaged with the learning material it shares by showing up to other related environmental projects. On a Saturday morning, over 100 volunteers came to sort through the trash collected by Mr. Trash Wheel and 'audit' the contents, what's more, people actually bought some of the stuff when it was listed online, earning financial support for the cause. On "Trash-Free Tuesday, fans routinely share photos to Mr. Trash Wheel online of them picking up trash in their communities. When the second wheel, Captain Trash Wheel, was debuted, people showed up in kayaks with signs to welcome it to their home. All of this support from the general public of the

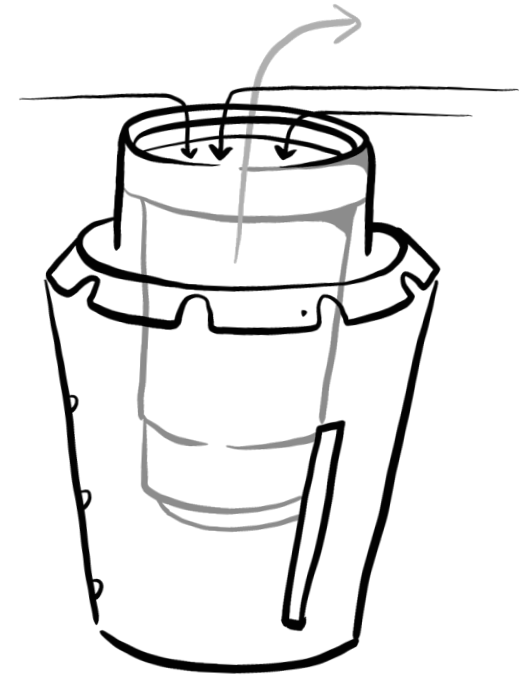
community would not have been generated had it not been for the project's strategy of utilizing a human tendency toward empathy for personified beings, and use of social media characterization. The anthropomorphization of this invention has made it notably more memorable in the public eye, allowing for a strange human - machine bonding that harnesses its own novelty as a tool for outreach, support, revenue, and ultimately change. If these wheels were to be commonplace in cities, we would be making significant progress in limiting the effects of urban mismanaged waste on our world's oceans and aquatic ecosystems. The tech exists, it's just not being adopted. This is where people, and a social media presence continue to come into play. People and communities can petition their local governments to allocate funding to build one of these machines in their area. When enough like-minded people speak out on an issue, change is made.

THE SEABIN

For those communities that potentially do not have the budget required to build one, there is a lower cost water waste management solution that is just as promising. The Seabin, a small machine that resembles a trash bin floating slightly under the waterline, uses a gentle vacuum flow to draw in surface water and filter out litter, debris and micro-plastics. Each Seabin

has the potential to remove 90,000 plastic bags, 166,500 plastic utensils, and 35,700 disposable cups per year along with plenty of other waste. That's a much smaller boast compared to Mr. Trash Wheel, but even these small vessels over time are capable of great impact, especially when they are placed strategically. There are 860 Seabins in use so far, which have collectively removed over 160,609,699 kgs from our world's waterways. The only thing is, the invention is somewhat visually unappealing. While it has growing popularity among the science community and earth advocacy groups, it is not well known by the average person. It is only through the involvement of everyone, especially including the large masses of people outside of the scientific community, that we are able to create lasting change and legislation. For this reason, the design could take a note from the Mr. Trash Wheel project, and add some humor or beautification to its now purely functional design in order to draw more attention to itself from the general public and build more of an online following. The original model is, in essence, a floating trash can with a remove-able inner filter (as depicted).

If they were, for example, created with some aesthetic adjustments that do not impede function such as re-designing the surface to mimic the appearance of

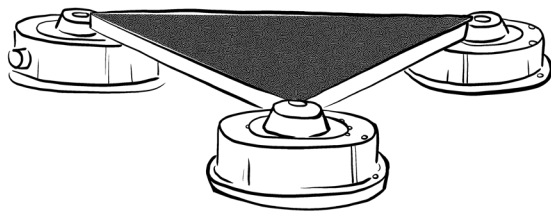


a cartoon-ishly large lily pad, or adding colorful LEDs that light up the harbors at night, folks might take more warm notice to them, and be interested in engaging with them in some way. If they were interesting enough, it could become a tourist location to see glowing Seabins, generating revenue to put towards upkeep and additional bins if needed. The company is already aware of the importance of community engagement, they organized a local project with the IES Bendinat school for school children between the ages of 12-17 with the goal of making environmental awareness fun for young people. As one of their activities, they cleaned the beach and picked up 84.7 kg of trash in one day. Excursions like these are important but they ultimately require plan-

ning, and only last a short time. Making learning and environmental involvement something that people notice all the time is a broader approach that has the possibility to impact more people.

PAVEGEN TILES

Another project paving the way towards green cities while valuing community engagement and education is a London based company, Pavegen, which self-describes its product as ‘a people powered, kinetic tech floor tile that creates clean electricity and captivates the imagination of anyone that steps on it’. When stepped on, its unique grid of triangular tiles compress small electromagnetic generators beneath the vertices of each tile, producing 2-4 joules of electricity per step.



Pavegen has been installed in 36 cities around the world, with case studies in London, Hong Kong, Romania, Mexico, the UK, Bangkok, and the US. Each of the installations has a slightly different focus depending on the community's needs, but

they all relate back to the company's mission to 'enable people to change the world for the better through the simple power of a footstep'. With their many case studies and over 200 installations, they seek to prove their tech can connect people to sustainability and smart cities, empowering them to directly engage with clean energy and increase their understanding of sustainability issues in the face of complex environmental and social challenges such as climate change and rapidly expanding cities. (Pavegen) One of their case studies created a running track that creates energy as its users exercise. Interactability like this is super important as it gives the people an opportunity to make an easy, unobstructed climate-conscious choice to help create green energy while doing something they already would have been doing on a normal track. It allows the common person to become involved in eco-efforts on a surface level interaction that hopefully can spark further engagement.

While these partial solutions by no means cancel out the large scale environmental effects of urbanization, seemingly small steps to reduce negative impact, and nudge people towards sustainable living can help us build towards a future of carbon neutral cities, with communities of climate conscious citizens.

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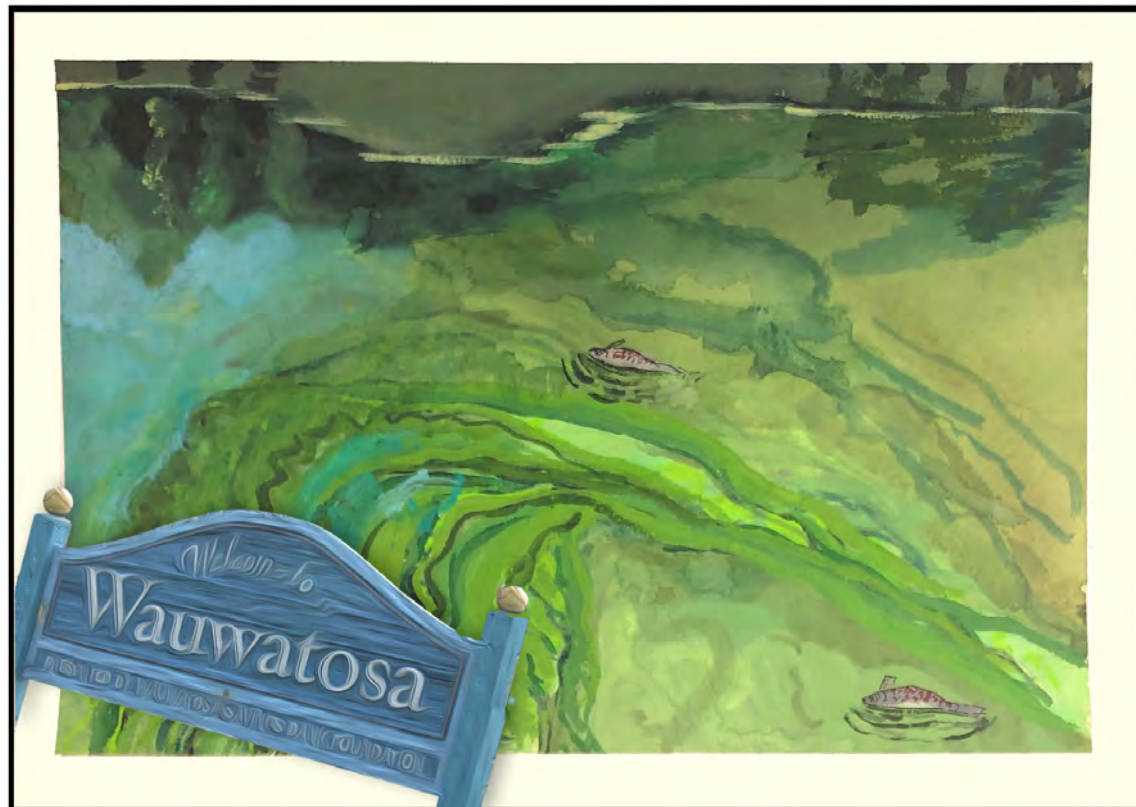
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Talia Garrido

MUCK IN THE SUBURBS

Generating education around harmful algal blooms



Introduction

During the summer of 2020 in Wauwatosa, Wisconsin was a major milestone for local climate change and its direct community impacts. This suburb is interrupted down the middle and throughout the entire county of Milwaukee by the Menomonee River. This river flows into several ponds and small lakes. Surrounding the river are small ecologically rich pockets of forests and prairies. The importance of the river cannot be understated given that people will invest in buying homes nearby and taxes for the suburb around the river increase yearly.

People go out of their way to run alongside it, take walks, ride bikes, go for picnics, and have field sports. Growing up here, I have noticed the river's changes over the course of 20 years. This past year in 2020 the large pond I pass every day was completely covered in green algae. Within days there were fish floating in great numbers. Local fishermen were perplexed. This was my first personal encounter with a harmful algal bloom.

In response to climate change and human activity, algal blooms are becoming greater in frequency. In order to slow down tox-

ic algae rapid and deadly contribution to mass extinction, a global awareness campaign must be created to kickstart change. The nuance of good or bad algae, effects of algal blooms, and what they are must be carefully shaped into digestible education for numerous ages to understand. This essay will fall back to the local ponds in Wauwatosa, Wisconsin as my experiential research.

Literature Review

In gathering references, the most clear and largely followed concept is that there are many possible solutions. To begin, an article

by Sellapan Ranjith provides a brief insight into an algal bloom begun by fertilization, "Excessive use of fertilizer in agricultural lands causes nitrogen and phosphorus fertilizer leaching from land to riverine system and leads to eutrophication (excessive algal growth)...Because of changing climate, ocean stratification occurs and it makes the conditions favourable for algal growth, and stagnant water are easily prone to algal blooms (Ranjith 2020)." The article provided a clear description of an algal bloom and also what could be a general key problem to the control of a bloom. The work to control it is usually done by attending to the affected segments of water and less attention is focused on what could be causing them upstream.

While algae in a body of water can also be a healthy sign in an ecosystem, there are many unfortunate effects when harmful algal bloom takes over. As mentioned previously when the conditions of warmer stagnant water are just right the bloom will cause oxygen depletion; killing native plants and wildlife. The water will become toxic as well, able to be harmful to any life that drinks or takes food from it. Any natural remediation is very difficult because an algal bloom will cause a sunlight shield also. Blocking any process of photosynthesis for the living organisms under the algal bloom

("Danger of Fertilizer Runoff for Lakes." 2014). All these signs have been present in the ecosystem in Wauwatosa in 2020. A neighborhood watch group was puzzled because there were reports of dogs getting sick after going swimming in the stagnant ponds.

In local neighborhoods it is difficult to find recognition from others of the problem and less so documentation to prove the problem. In Wauwatosa, Wisconsin there are no efforts being done to even control an algal bloom. It seems that the first step to the process is that documentation and research. In an article by Vishal R. and B. Meeta, a case study was done to biomonitor mainly stagnant and local bodies of water. This was done in Mumbai in places that were described as having typical suburban factors and large populations utilizing fertilizers and general chemical upkeep. The study was done to show that biomonitoring over time can help "form conservation strategy" and find the most reliable algae indices to observe water quality (Vishal, et al 2020).

The next references found contained various solutions; both old and new. Both the NCCOS Coastal Science Website and LG Sonic list various ways Algal blooms have been handled. The NCCOS works in water quality monitoring, detections, sen-

sors, and forecast models. This organization is putting effort into intensive prevention methods that can most importantly forewarn communities and keep them safe in the future, "We help states, tribes, and other monitoring agencies keep pace with the growing national HAB problem by providing them access to proven detection technologies, helping to validate these technologies, and assess benefits of incorporating existing methods ("MERHAB." 2020)." The LG Sonic group concurs that early detection is key to future solutions, but also that there are many ways to deal with a current bloom.

The group describes the solutions are ultrasound, chemicals, aeration, and mixing. The ultrasound frequency emitted into the algal bloom affects the buoyancy of the algae and it sinks to the bottom of the body of water. This will stop the growth of the bloom and the algae will die. The problems with this lie in seasonal changes requiring different frequency tuning. Another solution is chemical control. The algicides used can kill the entire bloom. The disadvantage is that it releases many toxins into the water and potentially throws off the ecological balance of the area. The technique of aeration involves a continuous supply of oxygen pumped into the water. It speeds up the decomposition process. This

technique requires a lot of energy and does not guarantee the algae will die off, only contribute when that process has begun. The last method is called mixing, "Mixing circulates water to achieve destratification in reservoirs. The process involves mixing water to eliminate stratified layers... The aim is to clear the surface water from iron, manganese, and anoxic odors that usually occur ...This makes conditions less favorable for algae growth..." ("How to Prevent Algal Blooms in Lakes and Reservoirs." 2020)." All techniques mentioned seem to also be commonly referenced in other articles trying to mitigate harmful algal blooms.

The last reference was just another technique that seemed particularly interesting because it was utilized in smaller suburban areas. This is a method using sand from local beaches. In this case study several sands were used. The work was done to find a sand type that would sink the algal cells. The ideal situation is to be able to use sand in the immediate area of the bloom because it would minimize environmental concerns. There seems to be great benefits to this technique with minimal interference, "Dispersal of sands or local soils... achieved high removal efficiency of marine HAB cells in a short time and prevented the escape of significant num-

bers of motile organisms from the algal flocs (Pan et al. 2011.)"

Discussion

The investigation into harmful algal blooms has showed that the issue will only persist and increase in frequency. This frequency will require more focus on both recognition and mitigation techniques. In Wauwatosa, the ponds are not as free flowing as they once were despite being connected to a river. These ponds have changed to more or less stagnant because the man made changes to the pond depth and shape. The summer of 2020 proved these changes were not for the better. If the algal blooms increase in these areas the local wildlife numbers will dwindle. So much remediation will be undone if nothing is done. Only 10 years ago did the parks service open a park nearby that would grow a prairie. The prairie has brought in so much wildlife and maintained a balanced ecosystem since. These bodies of water are crucial. My intention is to think about the possibilities for my community.

Many of the references agree that prevention and monitoring are preferable. The solution techniques are so different and require various amounts of energy and expenses. The clear consensus is that biomonitoring would greatly benefit many communities and would be a worthy in-

vestment. Biomonitoring could both save money in the long term and ensure ecological health in regards to the bodies of water the wildlife is living off of.

To promote biomonitoring techniques we have to bring awareness to the problem. This needs to start with getting the neighborhood involved. This can be done through signs posted around the water to inform what is happening. Another possibility would be to hold talks in local school for an environmental awareness segment. This could involve education about freshwater and algal blooms.

Conclusion

The most integral part of this is awareness. Education can't ever stop if we want to reach the goal. Intergenerational programming could be the solutions to this. In the past, I have done one of these programs about coral reefs; targeting the information to elementary students and senior citizens in a retirement community. This program made me learn that it's about the delivery of information and the ability to provide initiative. When people learn about the problems they feel inspired. So, why can't we share immediate solutions? With algal blooms in our community, this could be something positive and close to home the neighborhood could gather around.

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Kaitlyn Hui

Taking the Plunge Into Underwater Farming

The future of sustainable agriculture and its dependence on the expansion of aquaculture, or underwater farming.

Introduction

“Save the Planet and go Vegan!”, a slogan commonly used to promote a lifestyle free of animal products. But how much truth does this statement really hold? From a Western point of view, simply cutting meat or dairy from our everyday diets can apparently “save the planet”. However, the solution is not as straightforward. For many communities across the globe, a vegan lifestyle is unreasonable and not realistic,

especially for communities who rely on livestock for survival. Those communities do not have the luxury of being able to eat certain foods over others. While it’s true that “veganism” can significantly reduce one’s environmental impact, it does not get to the root of the problem. In order to make a lasting change we need to focus our attention on how we produce food in harmful ways instead of just trying to avoid

food that have harmful effects on the environment. We don’t need to make sweeping changes to our diets to make a positive impact. So maybe we should stop telling people to go vegan. Or rather, we need to propose an additional, more sustainable solution for climate change.

Food production is one of the main accelerators of global climate change. Our wasteful food production practices are



quickly transforming the most fertile places on earth into lands incapable of growing food at all. Not only is our climate changing because of our actions, but we are also affecting our own ability to grow food in the first place. In a global effort to solve food insecurity and combat climate change, we must change the way we view our food and how it gets to our plate. The sustainable solution for the future of agriculture depends on the expansion of aquaculture, or underwater farming, with focused efforts on newer crops like seaweed as well as traditionally wild-caught crops like mussels and bivalves.

Literature Review

We, humans, have taken great strides in the world of agriculture. We've evolved from prehistoric days as hunters and gatherers to the development of modern day, innovative farming practices expertly designed to feed our growing population more efficiently. What we've accomplished over the years is no small feat. However, as populations continue to rise at an unprecedented rate, a global food crisis looms in the near future. Even more concerning is the fact that we actually produce more than enough food to feed the world, yet in 2019 alone, 135 million people in 55 countries experi-

enced food crisis or insecurity. By 2050, our global population is predicted to reach 10 billion, which means we will have 3 billion more mouths to feed (Global Report on Food Crisis 2020). To meet these growing demands, it is imperative that we devise a more sustainable plan to feed the world. There are simply not enough resources left on our planet for us to continue cultivating and harvesting the earth the way we currently do. The world of agriculture must find a way to adapt, yet again.

In order to tackle an issue of such global scale, we must also think globally. With a truly global approach in mind, we need to consider an often overlooked and under-used, but readily available resource: our oceans, which cover around seventy percent of the earth's surface. It's time that we take a deeper dive and examine the ocean's potential for sustainable agriculture and its ability to counter rising global temperatures.

The transition to modern agriculture was one of great success—on land, that is. At sea, our methods of harvesting remain relatively unchanged as we continue to play the primitive role of hunters and gatherers. But just as on land, our resources are running dangerously low. Over fifty years of exploitation of our oceans at the hands of overfishing has led to the collapse of almost

ninety percent of large fish species, many of which you'd commonly find on your plate at dinnertime such as salmon, halibut, tuna, etc. Approximately thirty percent of wild fishery stocks are overfished, more than sixty percent fully fished and less than ten percent have remaining capacity (D. C. Little et al. 2021). But what if we could make that same transition to agriculture underwater? Rather than continue to over-harvest fish from the ocean, we could be nurturing and cultivating marine resources by modeling aquaculture after sustainable land agriculture. Just like land farming, ocean-based farming underwater can also become a climate mitigation tool. Aquaculture, the husbandry and farming of aquatic animals and plants, is our best and most universally sustainable solution for the future of food.

A key underwater crop is seaweed. Recent research has brought seaweed into the spotlight as a significant player in the battle against climate change. In terms of environmental impact, the cultivation of seaweed has countless advantages over terrestrial crops. For one, they are rapidly growing plants—some species can grow around two feet in just one day. Unlike terrestrial plants and trees, they do not have non-productive parts such as roots, trunks, and bark; therefore, the whole of the plant is mainly photosynthetic which

increases efficiency. Secondly, seaweed is a rather self-sufficient plant. Considered a “zero-input food”, it does not require resources like land, feed, fertilizer, pesticides, or freshwater to grow unlike land-based crops. Compare this to conventional agriculture practices employed on land, such as intensive tilling, high fertilizer inputs, and monocropping, needed to farm most crops we consume, all of which contribute as much as ten to twelve percent of global greenhouse gas emissions (P. Smith et al. 2021). With sufficient sunlight and seawater, seaweed thrives all on its own. Seaweed growth also benefits marine ecosystems by absorbing dissolved nitrogen and phosphorus, two pollutants that wind up in the ocean via agricultural runoff.

Perhaps its most remarkable quality, however, is its ability to counter the devastating effects of global warming through carbon sequestration. With greenhouse gas emissions on the rise, we are becoming increasingly more conscious of how much carbon dioxide we release into the atmosphere. While reducing carbon emissions is important, we also need to focus our efforts on the removal carbon dioxide itself from the air. According to the Intergovernmental Panel on Climate Change, the leading international body on climate change, we need to actively remove or sequester

away carbon dioxide from the atmosphere to achieve negative carbon emissions and prevent climate catastrophe. By 2050, we should plan to have net zero emissions, meaning that all carbon emissions need to be balanced by carbon removal (S. Hurlimann 2021).

Naturally occurring seaweed already plays a major role in oceanic carbon sequestration. In fact, wild, uncultivated seaweed is responsible for sequestering over a hundred million metric tons of carbon in the deep ocean every year. As they grow, they remove carbon dioxide from the water and turn it into biomass. Because they are often found in rocky coastal regions near the shore, they are subject to erosion. As they break apart, bits and pieces of macroalgae drift out to the open ocean and sink to the depths of the seafloor where carbon can be sequestered and stored for hundreds or thousands of years (S. Hurlimann 2021). According to a new study, which measures the global capacity of large-scale seaweed farming to offset carbon emissions on land and maps oceanic territories suitable for seaweed cultivation, it is estimated that having seaweed farms on just 3.8 percent of US West Coast waters could store 34.4 million metric tons of CO₂ (Froehlich et al. 2021). Researchers are currently exploring new ways for this

natural sequestration process to be recreated on a larger, more industrial scale. It was also found that raising macroalgae in just 0.001 percent of seaweed-growing waters worldwide and then burying it at sea could offset the entire carbon emissions of the rapidly growing global aquaculture industry which supplies half of the world’s seafood. By removing carbon from the ocean, seaweed farming presents another advancement against global warming as growing it can help solve ocean acidification.

In summary, seaweed cultivation can combat climate change by absorbing carbon emissions, regenerating marine ecosystems, and reversing ocean acidification. What’s more, the underwater plant is completely edible and packed with nutrients. Introducing seaweed into our everyday diet is yet another way to alleviate some of the stress placed on the terrestrial agriculture industry, and an incredibly healthful one at that. With growing concerns over the environmental impact of the meat and dairy industries, seaweed could be a possible alternative source of protein supplemented with other vital nutrients. A biologist by the name of Robert Osinga, who proposed the idea of “sea lettuce”, found that that a ‘marine garden’ of 180,000 square kilometres could provide enough protein for the entire world population. (R. Kleis 2021).

Beyond our own diets, seaweed as a dietary supplement is also being introduced into the feed of livestock like cattle. The cattle industry contributes 40% of all methane emissions from food production, the second largest contributor next to the rice industry. This is due to the microbes in a cow's stomach that release gasses rich in methane as they digest low-nutrient foods such as grass. While it might be easy to simply promote a vegan diet and get rid of cattle farming altogether, the solution is not as simple. For most, giving up beef is not realistic; many communities rely on cattle as a main source of food in order to survive. It may be more practical to question the methods of food production rather than the food itself. That's where seaweed comes in. It has been discovered that *Asparagopsis*, a warm-water seaweed species grown in Australia, contains a compound called bromofoam that when used to comprise as little as two percent of a cow's diet, reduces the animal's methane emissions by up to ninety-eight percent. Suppressed methane emissions from cattle could mean the emergence of a virtually carbon-neutral cow (R.D. Kinley et al. 2021).

Underwater cultivation of sustainable animal proteins can provide many climate benefits as well, especially when introduced in conjunction with seaweed

farming. The harmonious combination of marine flora and fauna, loosely replicates a natural marine ecosystem creating a form of agroecology within the ocean that could be used to replace traditional fish farms which are almost as resource-consuming as terrestrial farms. These self-sustainable "agroecosystems" would eliminate the need for fish feed, chemicals, and pesticides, the main sources of water pollution and carbon emissions due to aquaculture. Additionally, nutrients are effectively recycled in a closed food cycle. While ocean farming practices have long been established and put to use in Asia, it is just beginning in the US with groups like GreenWave setting the scene. GreenWave's regenerative ocean farming model promotes a polyculture farming system which grows a mix of seaweeds and shellfish that require zero input and produces a high yield with little to no carbon footprint. Its regenerative properties include acting as a carbon and nitrogen sink that simultaneously provides safe havens for marine life (J. S. Eklöf et al. 2021).

The power of a plant like seaweed lies within its versatility. It can be used across a variety of industries ranging from agriculture to even biofuel and food packaging. The high-energy carbohydrates that are found in seaweed are relatively easy to break down making it an ideal candidate for

the production of biofuel. Just as it is beneficial to the agriculture industry, seaweed is much more efficient, sustainable, and environmentally friendly than traditional biofuel feedstocks like soy and corn. Products made using biofuels can also benefit from seaweed. Recently, using non-food grade farmed seaweed to make straws, paper, and bioplastic packaging has gained interest as a cost-effective, viable alternative to fossil-fueled based plastic packaging.

Discussion

Securing the future of food production and agriculture to feed the world in the coming decades is a daunting task, but not an impossible one. It is one that will challenge the way we view our food and where it comes from. Harnessing the power of our natural earth systems rather than depleting its resources is crucial in our fight against climate change. Thus far, agricultural farming has taken center stage, but our ever-changing planet demands a new solution. However, this is not to negate the progress made by sustainable practices on land. In a race to outrun the ticking time bomb that is global warming, it is critical that we make use of all of our planetary resources to find climate solutions as soon as humanly possible. One solution is prepared to share the

spotlight alongside agricultural farming: the expansion of aquaculture, or underwater farming, with focused efforts on newer crops like seaweed as well as traditionally wild-caught crops like mussels and bivalves. The normalization of underwater farming concepts could lead to an expansion of seaweed and shellfish farming as a global effort.

GreenWave is a non-profit that is making great strides in the spread of ocean agriculture. Established in 2013, GreenWave trains and supports regenerative ocean farmers in the era of climate change. They seek “to provide training, tools, and support to a baseline of 10,000 regenerative ocean farmers to catalyze the planting of 1 million acres and yield meaningful economic and climate impacts.” They do this by “work[ing] with coastal communities throughout North America to create a blue green economy—built and led by regenerative ocean farmers—that ensures we all make a living on a living planet”.

Conclusion

How can innovative underwater farming techniques be introduced to a wider audience in order to make this transition as quickly as possible? A slight change in wording could make all the difference.

The term ‘aquaculture’ itself is an ambiguous term that alludes to many unfamiliar concepts and is associated with a several different meanings. It is also plagued with several positive and negative connotations leading it to be largely misunderstood by the public. Those who have come across the term often associate aquaculture with industrial fish farming and the undesirable diseases and ocean pollution that come along with it. To solve this issue, I propose the introduction of a new term: underwater farming. Rebranding the concept of ocean agriculture with a name rids it of predisposed stereotypes and ideas. After all, an innovative solution deserves and more fitting name. It also familiarizes the concept of aquaculture, making it much more easily digestible to the general public. People are much more willing to accept and adopt a concept that is uncomplicated and straightforward. Sometimes it’s the smallest changes that make the greatest difference. It is possible that this one minor change could become the catalyst of our generation’s underwater revolution.

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Marcella Sanchez

MOOVE AWAY FROM BEEF

educating on the benefits of a plant based diet to combat extinction and deforestation.

I have been a vegetarian for almost 5 years and I've always felt strongly about the fact that not many people seem to take the effects the beef industry has had on our planet as seriously as they should. In my paper, I wanted to explore how implementing new forms of public education and campaigning could be effective first steps to shifting the world's diet away from beef and preventing further deforestation/species depletion.

One of the most pressing concerns for conservationists today is deforestation. Being one of the leading causes of extinction, it displaces countless species from their homes, leaving them unable to adapt or move to a new habitat. Many people are aware of the crisis going on with deforestation, however, many are surprised when they find out the leading cause of this destruction, which is the beef industry. Attempting to feed the population sustainably

has proven to be extremely challenging, even during an age of rising global awareness. On a planet with nearly 8 billion people using up its resources, it should be impossible to ignore humanity's impact, and yet a lot of people have managed to do so, giving the beef industry the ability to cause such a mass amount of destruction and deforestation. So how do we fix it? The obvious answer to this daunting issue seems simple, eat less beef so that demand goes down. But the question that comes after this is, how do you convince such an enormous population to shift their diets away from beef, something a lot of people might go as far as considering a dietary necessity? And it's this "convincing" that is the underlying obstacle.

Around 2018, Brazil became the world's leading beef exporter, and this high demand for beef is what has allowed it to become the leading cause of deforestation



in the Amazon. "By the 2000s more than three-quarters of forest clearing in the Amazon was for cattle-ranching" (Butler, 2020). After having already taken around one million square kilometers of its forests, humans continue to clear acres upon acres of land from the rainforest every day to raise cattle

and grow feed. Beef production also has the most detrimental to the environment when compared to other meats, which is why focusing on it specifically should be a priority.

Whether or not someone wants to eat less beef is ultimately up to them, but there is no ignoring the fact that vegetarian meals have a significantly lower environmental impact compared to meals containing meat. A study done comparing the meals of meat-eating and non-meat eating participants showed just how drastic the difference is between the carbon footprints of the two. “Meatless meals always had more than a 40% reduction in environmental impacts for any of the indicators (carbon footprint, water use, resource consumption, health impacts of pollution, and ecosystem quality)”(Ernststoff, 2019). No matter what meal was being calculated, it always resulted in the meatless meals having less of an environmental impact than the meat containing meals. On average, the meat in the meat contains meals also only accounted for around a third of the full meal and it was still found to be the main contributor to the overall carbon footprint of the meal.

To understand the influence of meat type, a sensitivity analysis was performed using a 100% total of beef, pork, or chicken as

the meat type in each meal. This analysis demonstrated that meat containing meals that are 100% chicken have similar impacts related to the non-meat containing meals with respect to carbon footprint, whereas meals containing 100% beef are substantially higher. This finding underscores the large difference in impacts across meat types and not all “meat-containing” meals should be assumed to be more impacting than meatless meals—especially meatless meals containing other animal products (e.g., dairy). (Ernststoff, 2019)

Apart from meat being a large contributor to a meal’s environmental impact, the study always took into account the impact of different types of meat. They found that beef had a drastically larger impact compared to the other meats being eaten. “Furthermore, since we adjusted meatless meals in the overall quantity of food consumed to match meat-containing meals, the impacts of meatless meals would be even more profound if estimated by the reported food quantity”(Ernststoff, 2019). It was also found that overall, the meatless meals generally had a lower mass of food, so the portions were increased to evenly match those of the meat containing meals. Even with the vegetarian meals being made larger for the calculations, it was still found that

their carbon footprint was around 40% lower than those of the meat containing meals, which further emphasizes how much of an impact meat really has. The core reason for this study was to pinpoint traits that could lead to more commercial opportunities for advertising lower environmental impacting meals to the public, which is why it focused on individual meals and not overall diets. “The biggest advantages were observed for dinner meal occasions due to the greater consumption of meat during dinner than other meals”(Ernststoff, 2019). It was found that for all of the meals, dinner meals containing meat usually had the harshest impact on the environment. “To reach a wider proportion of the population beyond vegetarians and vegans, many stakeholders are investigating targeting meals (instead of overall diets) as an effective strategy to decrease meat consumption, for example, through mobile phone applications, menu designs, recipes, or meat-replacement products”(Ernststoff, 2019). Following the initial purposes of their study, it was concluded that to achieve optimal results when trying to advertise vegetarian options to the public, it would be wisest to focus on more dinner-oriented options, assuming that replacing those would have to most beneficial results.

While the facts presented may make it seem obvious that people should be motivated to eat more plant-based for the good of the planet, people's concerns about taste, health, and cost, as well as social stigmatism, still trump their concerns for the environment. In 2016, UCLA performed a survey on students to determine how many were willing to alter their diets for the good of the environment, and if not, what their concerns were. "Results found meat eaters thought a vegetarian diet would be less tasty, less healthy and more expensive than a meat-containing diet" (Ong, 2019). While some did admit to social stigmatism towards vegetarians/vegans being a factor, an overwhelming amount of students said their main reasons for continuing to eat meat were protein, taste, and cost concerns. One particular biochemistry student they talked to, Kyle Meador, provided helpful insight on the specifics he struggled with during his change to a vegetarian diet. He said that "initially the hardest part about switching to a vegetarian diet was the taste, as he felt that vegetarian food did not taste as good as an omnivorous diet... however, once he had experience cooking, vegetarian food taste was no longer a difficulty" (Ong, 2019). These interviews show the importance of focusing on implementing education and campaigns on vegetari-

an diets to begin combatting the effects of the beef industry. Once people realize how many options there are when eating plant-based, and what it can do for the environment, they'll be more open to embracing the change.

The base for most people's knowledge of the world around them begins in school. The current way of teaching climate change has followed a very knowledge-based course and most of the time it leads to students being left with all of this information on the climate but no room to discuss questions or research solutions. In an article published in Science Scope, two researchers discussed climate change education strategies with middle school teachers involved in the Next Generation Science Standards adoption process. These teachers were inspired to teach climate change to students due to their own interests, so the writers of the article felt they would be a good information source. After interviewing the teachers, they found that their insights fell into "three broad themes that showcase sound practices in climate change education" (McNeal, 2020). For the first theme, which was "Connecting students with local climate change impacts" (McNeal, 2020), the teachers emphasized that "although addressing climate

change regionally and globally is necessary, we need to connect students to local impacts of climate change to make it personally relevant to them" (McNeal, 2020). By showing students that climate change was affecting things close to them and within their communities, they could help the students developing a broader understanding of the seriousness of climate change and get them to care more about the topic. For the second theme, which was "encouraging students to collect, analyze and draw conclusions from their own data" (McNeal, 2020), the teachers stressed the importance of allowing the students to collect their own data in order to "use their intelligence in practical ways and not just rely on other people's opinions" (McNeal, 2020). By participating in data collecting and experiments students are able to make their own judgments on their findings and develop a stronger understanding of the process of collecting scientific data. The teachers all agreed that this was a "powerful approach to robust lessons in climate change" (McNeal, 2020). For the final theme, which was "fostering relationships between climate scientists, teachers, and students" (McNeal, 2020), many of the teachers in the focus groups had collaborated with climate scientists and professors when teaching their students. These practices allowed for "enhanced lessons

and created opportunities for students to work directly with researchers” (McNeal, 2020). The teachers shared that their students showed heightened excitement and enthusiasm during lessons with scientists and professors so it proved to be a very valuable approach. All of the teachers from these focus groups agreed that starting to teach climate change to students can be intimidating but it’s worth the awareness and development that comes from it. They also emphasized that by using interdisciplinary approaches that involved “applying reasoning, thinking critically, making claims, using evidence, and demonstrating the ability to communicate” students could learn important skills that cut across subjects and didn’t only apply to science.

For people who may not have access to enriching classroom environments, conservationists have looked to campaigns in order to increase public awareness and involvement in conservation solutions. A good example of a public campaign that was started to lower the world’s meat intake is Meatless Mondays. Meatless Mondays was a campaign started by Sid Lerner in 2003 that aimed to improve public health by lowering people’s excessive meat consumption. His idea behind using Monday was so that people could attach this habit

to a specific day of the week and sustain it over a long period of time. People could use the first day of the week as a sort of “restart button” for their health. The campaign had a huge impact when it was first introduced and with the help of celebrity incentives and media coverage, the campaign resonated extremely well with the public. (The Monday Campaigns) Although the campaign may not be as mainstream in media now as it was when it was first initiated, it is still influential in aspects of environmental action and policymaking. This was evident when the mayor of New York City, Mayor Bill de Blasio, decided to implement Meatless Mondays in all NYC public schools for the 2019-2020 school year, as both a health and environmental initiative. “Cutting back on meat a little will improve New Yorkers’ health and reduce greenhouse gas emissions. We’re expanding Meatless Mondays to all public schools to keep our lunch and planet green for generations to come.” (de Blasio) The fact that Meatless Mondays still has such influences after such a long period of time shows the potential that similar campaigns more geared towards combatting the effects of beef specifically could have.

While campaigns such as Meatless Mondays do have the potential to do a lot of good, many have argued that there needs

to be a shift in how campaigns are targeted at the public in order to inspire sufficient action. In 2019 a paper was published discussing research that was done on the effectiveness of implementing behavioral science into campaigns on global conservation outcomes. The study wanted to focus on using social marketing as a way to target human behavior in a way that would benefit the environment. “Conservation practitioners have struggled to influence behaviors through traditional awareness-raising efforts and been slow to adopt techniques from the behavioral sciences such as social marketing to change behaviors and improve conservation outcomes” (Green, 2019). The study critiqued conservationists for not using this technique that they believed was the most successful way to get the public behavior towards the environment to change, and pointed out that the mere act of providing information on the environmental crisis was not going to incite the necessary amount of action. In 2014, a viewpoint article published in Conservation Letters even stated that the field of conservation science “has largely failed to embrace the notion that the study of human choice about nature conservation is potentially the most important research topic in the world of today” (Green, 2019). The study hypothesized that “increased knowledge, supportive attitudes,

and greater interpersonal communication lead to pro-environmental behavior intention, which leads to pro-environmental behavior change” (Green, 2019), and in order to prove this they compared the results to a knowledge-only approach where they only provided baseline knowledge to subjects and applied no behavioral science to the way the information was shared. “When compared to a standard knowledge-only model or others employing just a couple variables, our findings demonstrate the importance of multiple points of intervention in achieving behavior change” (Green, 2019). The results of the full study supported the hypothesis that there was more success in changing behavior and action towards conservation in the experimental group compared to the baseline knowledge only approach groups, which further the point that simply providing knowledge without interaction is not going to achieve sufficient outcomes.

Discussion:

In this paper, I wanted to introduce the concept of implementing new forms of public education and campaigning as the first steps to shifting the world’s diet away from beef and preventing further deforestation/species depletion. The more I researched this topic the more I realized how

broad of an issue it is and how much it’s going to take to make an effective change. I still feel that the combination of efficient and interactive education along with successful campaigning to raise public awareness are the best options for beginning to combat these issues.

In the case of public education, simply providing students with information is not going to effectively alter students’ attitudes towards the environment or incite change. In order for public education initiatives to be successful students are going to have to be able to connect what they learn to the community around them, like in the classrooms of the interviewed teachers, in order to understand what’s going on and spread awareness. Younger people today are already more aware of the global climate crisis, so effectively implementing public education right now has the potential to make an extremely positive shift in action among students.

Also regarding Meatless Mondays, while this campaign was obviously very popular and successful with its influence, what it was lacking, from an environmental conservation standpoint, was that it didn’t prioritize environmental health. Its priority was mainly improving human health, and while this of course is not a bad thing to promote, the mass extinction going on has

made it imperative that more environmentally-centered campaigns are necessary for the survival of our ecosystem. With trends like the keto diet rising in some circles today, cutting out beef for human health isn’t as much of a concern as it used to be. This is another reason why reshaping a campaign to be more environmentally centered has the potential for a more effective outcome. By combining the effects of social marketing campaigns with already existing programs such as Meatless Mondays there is a lot of potential for growth and success. If campaigns like this are initiated efficiently enough we may even be able to progress to different levels that people could participate in, such as meatless weekends, or even meat Mondays, which would suggest that people only consume meat once a week if they want to do more for the cause. Assigning a sense of community to practices like this is extremely important when trying to motivate people.

I also understand that a lot of the information explored in this paper can be applied not only to combatting the effects of the beef industry but also to the issue of climate change in general. While this is true I feel that in order to start seeing an efficient change in conservation we need to narrow down efforts and start emphasizing specific, important areas. The effects of the beef in-

dustry are one of these, which is why these initiatives focused around that. Deciding what you eat is much easier than say, producing less waste, driving less, etc, and this is another reason why I felt like focusing on lessening beef consumption could be effective in improving conservation efforts.

Conclusion:

It's obvious that public education and campaigning isn't going to be a definitive solution to the effects of the beef industry, but it is a good starting point. Before real change can happen for anything, people need to become aware of what's going on around them and this logic is especially important when it comes to environmental concerns. It isn't going to be until people are educated and become genuinely interested in learning more about the health of the planet that we're going to start seeing significant change, so bases like these are something we as a population need to become invested in. and greater interpersonal communication lead to pro-environmental behavior intention, which leads to pro-environmental behavior change" (Green, 2019), and in order to prove this they compared the results to a knowledge-only approach where they only provided baseline knowledge to subjects and applied no behavioral science to the

way the information was shared. "When compared to a standard knowledge-only model or others employing just a couple variables, our findings demonstrate the importance of multiple points of intervention in achieving behavior change" (Green, 2019). The results of the full study supported the hypothesis that there was more success in changing behavior and action towards conservation in the experimental group compared to the baseline knowledge only approach groups, which further the point that simply providing knowledge without interaction is not going to achieve sufficient outcomes.

In this paper, I wanted to introduce the concept of implementing new forms of public education and campaigning as the first steps to shifting the world's diet away from beef and preventing further deforestation/species depletion. The more I researched this topic the more I realized how broad of an issue it is and how much it's going to take to make an effective change. I still feel that the combination of efficient and interactive education along with successful campaigning to raise public awareness are the best options for beginning to combat these issues.

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Conclusion:

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