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Term Project Proposal

Ecology

Prof. Jensen

Biodiversity and Human Impacts

What effect is human activity having on marine biodiversity? In my final project studies I want to link together ecosystem services, biodiversity and human impact. In my term project I will explore the lasting impacts our actions are having on marine life and what this could mean for the future of marine ecosystems. Through this topic I will also work to uncover not only how human activities will harm these ecosystems, but also how they will affect and change the ecosystem services that we depend on. I plan to categorize the major ecosystem services that marine ecosystems provide for humans and then connect each service to its most crucial man-made threat. Some of the most important ecosystem services I found in my research are that marine ecosystems provide food, raw materials, cycling of atmospheric gasses, coastal recreation and tourism. The threats I will focus on are, unsustainable use of resources, marine pollution, introduction of invasive species, climate change and land-based impacts (Staples and Hermes). These topics will be and examples used to show the importance of marine biodiversity and the harmful ways humans are contributing to biodiversity loss.

Through researching this subject I have found that loss of marine biodiversity is not only characterized by extinction, but also by changes in ecosystem processes, destruction of habitat, and introduction of invasive species (Silvertown). It can be difficult to demonstrate the wide scale of biodiversity loss at a species level, because new species are continuing to be found, especially since a vast majority of the oceans have yet to be explored. As of 2010 the marine census published that there are as many as 224,000 species discovered, but by time oceans have been completely explored there may be as many as one million (Staples and Hermes 245). Evidence is found much easier when explored at a local or regional level since it allows researchers to operate with a more contained study with a control group. Studies at this level have shown that more than 90% of important species as well as around 65% of seagrass and wetland habitats have been destroyed by human activities. These figures show that it is not only marine life risk, but entire marine biomes and the systems they are built upon.

Most importantly what I have learned through this research is how truly important marine biodiversity is. Aside from the innate and ethical importance of biodiversity is also important for the services it provides to humans. Biodiversity is what allows for our environment to adapt and change to new conditions. The rate at which humans have and continue to alter the environment makes it increasingly difficult for marine organisms to adapt and evolve, creating less genetic biodiversity. This limits natural selection and can make adaptation impossible (Centre

for Marine Biodiversity). The introduction of invasive species to marine ecosystems is a huge contributor to the decrease in genetic diversity amongst marine life. According to one study done in Californian waters, invasive species have caused the degradation of native California oysters habitats. This study shows that native crabs contribute to maintaining the oysters habitat by consuming native whelks and changing their foraging behaviours. In contrast invasive whelks do not know to avoid native crabs, causing them to invade into area of native crabs and also causing “trait-mediated trophic cascades” (Kimbrow 563). These trait-mediated trophic cascades alter the behaviors of prey, indirectly causing changing and disruptions along the food chain. This study also found that replacing native crabs with invasive crabs that are smaller and unknowing of a foraging strategy resulted in density-mediated cascades, as the crabs could not effectively consume the bigger, adult whelk. Gathering these findings showed that trophic cascades may make it possible for native crabs, whelks and oysters to live together, but replacing native crabs and whelks with invasive ones causes serious depletion of oysters (Kimbrow).

Marine ecosystems provide us with food and raw materials through practices like fishing. Developed countries rely greatly on finfish and shellfish which provide as one of the greatest sources of protein. Conserving marine organisms will make it more possible to tap into unutilized resources in the future (Centre for Marine Biodiversity). Fishing is one of the biggest stressors in the most heavily impacted marine areas (Selig). Raw materials that marine ecosystems provide for us include medicines, building materials and food for livestock (Centre for Marine Biodiversity). Unsustainable use of resources such as, seaweeds, coral rock and sands, and sessile animals will result in detrimental consequences. By identifying priority conservation areas one could determine where places of high biodiversity might also be providing important ecosystem services (Selig).

They also provide us with other important services that are crucial to the health of our environment such as the cycling of carbon dioxide through phytoplankton. Preserving the diversity of organisms that help to regulate CO₂ levels could be crucial to slowing down the surplus amount of CO₂ that is put into our atmosphere (Centre for Marine Biodiversity). One study shows that pollution from leakage of fertilizers had major ecosystem effects on phytoplankton, zooplankton and other aspects of marine ecosystems. Between 1975 and 2010 Denmark saw increases in the amount of phosphorus in marine environments, showing a direct relationship to increased use of fertilizers on farms. The effect was shown to be even stronger in the winter months when precipitation was higher. The pollution from these fertilizers were shown to also have a great impact on population sizes of water birds and changes in temperature. In this case the addition of nutrients from the fertilizer leakage resulted in rapid growth of phytoplankton, changing the food web due to oxygen depletion and leading to dead zones, resulting in negative consequences for water bird populations (Møller).

Finding this information makes it very clear to me that humans depend on marine biodiversity and would struggle greatly without it. Even though biodiversity is disappearing rapidly humans may actually be becoming more dependent on biodiversity and ecosystem

services. By assessing the correlation between human well being provided by ecosystem services and global GDP growth, one study found that ecosystem services like roundwood production, hydroelectricity generation and tourism investment grew by 17.6, 116.2 and 121.2%, while at the same time GDP increased by 106% from 1980–2005. Through this time 105 countries rose roundwood production, 113 countries increased hydroelectricity generation and 125 countries expanded tourism investment. This goal of economic growth urges humans to use said ecosystem services. The profits from the use of ecosystem services increase GDP making economic growth dependent on ecosystem services (Guo). With these studies it seems reasonable to assume that these patterns of increasing dependency on ecosystems services will also be reflected on marine ecosystem services which we depend on to support our growing population and advancing technologies.

This research will guide my final project and help emphasize the point that humans are using marine resources at an increasingly harmful and unsustainable rate. My final will focus on human activities that are causing this harm like; introduction of invasive species, fishing, pollution due to fertilizer runoff, and extraction of raw materials. The project will include evidence that marine biomes and ecosystem services are at risk with 90% of important species and 65% of seagrass and wetland habitats being destroyed by human activities. I will also emphasise the importance of marine ecosystem services and how humans are becoming even more dependant on them as population increase and technology broadens. I will show how each harmful activity is directly depleting the services we depend on, like how invasive species cause a decrease in genetic diversity, how fishing causes decrease in marine species populations, and how fertilizer pollution causes dead zones and build up of CO₂ in the atmosphere.

In my project I want to highlight the case studies I have found as a way to backup my main idea. This research will guide me in creating a zine that focuses on showing the impacts humans have had on marine biodiversity. The zine will be made up of a collection of examples of ways that humans are impacting marine biodiversity and then go into more focus for each example with the specific case studies I have researched. The zine will be a collection of art I've created and information I've found to be the most telling of our current situation. I want to be able to spread awareness of these issues through the use of illustration and collage combined with excerpts and explanations pulled from certain case studies. I think a zine would be a useful in reaching an important audience, as it would be mostly aimed towards young adults and would encourage using art as a platform for spreading awareness about the state of our marine ecosystems.

Annotated Bibliography

Jonathan W. Silvertown. 2010. *Fragile Web: What Next for Nature?* Chicago and London. University of Chicago Press.

This book explains biodiversity and evolution past and present. It outlines why the future of earth's biodiversity matters to humans and the earth. This book examines the direct and indirect influences humans have on the the future of the natural world. It also outlines ways in which humans can help to conserve earth's biodiversity. This source included maps, graphs, and diagrams to make data clear and focused.

Selig ER, Turner WR, Troëng S, Wallace BP, Halpern BS, Kaschner K, et al. (2014) Global Priorities for Marine Biodiversity Conservation. *PLoS ONE* 9(1): e82898.

This source identifies the areas where marine biodiversity is most and least impacted by human activities. It combines data from global patterns of species richness with research on human impacts. The results from this study highlight the priority marine areas and shows that climate change and fishing were the biggest factors in biodiversity loss. These results can help to decide where investments could best sustain marine biodiversity.

Guo Z, Zhang L, Li Y (2010) Increased Dependence of Humans on Ecosystem Services and Biodiversity. *PLoS ONE* 5(10): e13113.

This study explores human's changing dependence on ecosystem services. This source measures roundwood production, hydroelectricity generation and ecotourism in 90 biodiversity hotspot and 60 non-hot spot countries. The results show that economic growth made humans more dependent on ecosystem services rather than biodiversity.

Derek J. Staples, Rudolf Hermes. (2012) *Marine biodiversity and resource management – what is the link?* Aquatic Ecosystem Health & Management

This source provides some general ideas on the depletion of biodiversity in our marine ecosystems and leaves room for connecting more specific case studies to general ideas and important facts. It outlines the ways in which humans are impacting marine biodiversity and how exactly these impacts are affecting the ecosystem resources that we rely on.

Centre for Marine Biodiversity. (2007) *Why Is Marine Biodiversity Important?* Plone Foundation, 17 Jan. Web. 7 Mar. 2017.

This study shows the impacts humans have had on marine biodiversity. It also outlines Why marine biodiversity is important and how biodiversity contributes to the many ecosystem services that we depend on.

Anders Møller, Einar Flensted-Jensen, Karsten Laursen, Willy Mardal. (2015) Fertilizer Leakage to the Marine Environment, Ecosystem Effects and Population Trends of Waterbirds in Denmark Vol. 18 Issue 1, p30-44. 15p.

This source is a case study of the effects fertilizer leakages have had on Denmark's marine ecosystems over the last 35 years. The increase in fertilizer uses on farms in Denmark's shows to directly correlate with decreasing population sizes of water birds. This can be contributed to a changing food web due to pollution of fertilizers creating dead zones of phytoplankton.

Kimbro, D. L., Grosholz, E. D., Baukus, A. J., Nesbitt, N. J., Travis, N. M., Attoe, S., & Coleman-Hulbert, C. (2009). Invasive species cause large-scale loss of native California oyster habitat by disrupting trophic cascades. *Oecologia*, 160(3), 563-575.

This source is a case study shows an example of how invasive species can cause a lack of genetic diversity in marine ecosystems. This study, done in California, focuses on the relationship between native crab, whelks, and oysters and how that relationship changes when they are each replaced with their invasive counterparts. The results show that replacing native crab and whelk with invasive crab and whelk leads to destruction of oysters natural habitat.