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CS120G
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Group #1
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A. Group Thesis Statement

Conservationists should prioritize saving keystone species in their efforts to prevent the extinction of endangered species because they have a dramatic impact on many other species within their ecosystem.

B. Subject Headings and Keywords

Keystone species, endangered species, extinction, ecosystem, environment, conservation, ecology, habitats, animal species, environmental science, Endangered Species Act, Conservation Status, IUCN Red List

C. Full Sentence Outline

I. Introduction
   i. Due to society, there has been a huge decline in certain animal or species populations throughout the entire world. This also means that humans are responsible for making a change to help the endangered species and save them as best we can. Endangered species are species near extinction or disappearance and in need of being saved. The question is how do we do this, and where do we start?

II. The impact of keystone species on other species

A. Keystone species have a dramatic impact on other species within their ecosystem (Macdonald, 2020)

B. Importance of protecting keystone species for the survival of other species in the ecosystem(Amari Browne Johnson)

III. Keystone species play an important role in their ecosystem (Kyle Bennett)
   i. Keystone species maintain ecological balance.
      1. Keystone species have disproportionately strong interactions with other members of their ecosystem which results in a greater impact (Libralato, 2019).
      2. Their disproportionate influence over their ecosystem means that the removal of keystone species can lead to destabilization and the loss of additional species ("keystone species," 2020).
   ii. Identifying keystone species.
      1. The “keystoneness” of a species is determined by quantifying both the direct and indirect impacts on different parts of a food web as a result of small changes to the population of that species (Libralato, 2019).
      2. Common examples of keystone species include beavers due to their dams’ dramatic impacts on the surrounding habitat and species, and bison due to their unique grazing pattern’s effect on the biodiversity of grasslands ("keystone species," 2019).

IV. Conservation Status and how it relates to keystone species (Logan Bell)
   A. Defining Conservation Status

a. Conservation status is defined as the level of threat that a species faces in terms of its risk of extinction. Species can be classified into different categories based on their conservation status, ranging from least concern to critically endangered.

b. Conservation Status factors many different things when it came to the statistic like, the number of a certain species remaining, the increase and decrease of a population over time, etc. (Butchart 2009)

B. The importance of conservation status on maintaining keystone species

a. Conservation status is extremely important to helping keystone species stay alive because we have different types of conservation status lists (like the IUCN) which will tell us which species are not in danger of going extinct and which species are. (Hernandez-Aguero 2021)

V. (Kendra Blount)

The Importance of the Endangered Species Act, strategic plans of action it has taken towards threatened species, and how it can be beneficial in the aid of keystone species. (Kendra Blount)

A. How the Act is executed

1. Under the act, species are put into either two categories, “threatened” and “endangered”, in which they receive legal protection. The objective being to prevent species from reaching the point of being extinct and taking proper action towards a “recovery plan” (Bean 2009)

B. Practical plans of action based on habitat loss, climate change, and localized impacts

1. Group participants collection of information on Urban expansion and the negative impacts on threatened species (Noss 2021)
2. A particular case study of the northern spotted owl, in which conservatory plans were successfully implemented under the Endangered Species Act (Woodbridge 2019)

VI. Rebuttal- Saving keystone species is cheaper than saving Biodiversity Hotspots and should be a priority. (Rylie Barbee)

i. Many individuals argue that to prioritize saving endangered species,

the first step is protecting Biodiversity Hotspots as it is home to many endangered species. However, protecting Biodiversity Hotspots is way more expensive than saving keystone species, and in the end, is not the best way to prioritize saving endangered species.

1. For conservationists, it is projected to cost around "$70 billion dollars," to protect and save biodiversity hotspots. This is an issue, as their annual budget is roughly "$42.3 million dollars" (Gibbo 1992).
2. Saving keystone species is the best way to prioritize saving endangered species as it is cheaper and more effective.

ii. It is better and more efficient to save, specifically, keystone species than to look at endangered species or Biodiversity Hotspots as a whole.

1. It is much easier to find the most keystone species to our environment and start with them as it is more in the budget. Study shows that "in 1990, nearly $30 million was spent on just four species" (Gibbo 1992).
2. "Ecologists have long recognized that some species, by virtue of the key roles they play in the overall structure and functioning of an ecosystem, are essential to its integrity; these are known as keystone species. Similarly, in human cultures everywhere, there are plants and animals that form the contextual underpinnings of a culture, as reflected in their fundamental roles in diet, as materials, or in medicine" (Garibaldi, 2004).

VII. Conclusion

i. Saving keystone species is the best way to prioritize saving endangered species as it is cheaper and more effective.

Annotated Bibliography

Accepted Source 1 - (Amari Browne Johnson):

Song, Z., Wu, B., Xiong, W., Gao, L., & Li, Y. (2022). Quantifying the Evolution of Giant Panda Habitats
in Sichuan Province under Different Scenarios [Article]. Diversity (14242818), 14(10), 865-N.PAG.
https://doi.org/10.3390/d14100865

This article examines the evolution of giant panda habitats in Sichuan Province, China, under different scenarios, using a range of spatial models and analyses. The authors highlight the importance of habitat conservation for the survival of this endangered species, as habitat loss and fragmentation have been major drivers of its decline. The study finds that the area of suitable panda habitat has decreased significantly over the past few decades, with different scenarios projecting varying levels of further habitat loss in the future. The authors emphasize the need for proactive conservation measures, such as habitat restoration and landscape planning, to mitigate the impacts of habitat loss and fragmentation on the giant panda population. The article provides valuable insights into the complex interactions between species, ecosystems, and human activities, highlighting the urgent need for effective

Accepted Source 2 - (Amari Browne Johnson):

Jordán, F. (2010). Keystone species and food webs. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1558), 1747-1756.
https://doi.org/10.1098/rstb.2010.002

This article by Jordán explores the importance of keystone species in maintaining the balance of ecological systems, discussing the history and current use of the concept, empirical evidence of its effects on food web structure and function, and its potential applications in conservation and management. It is a valuable resource for researchers and practitioners in ecology.

Rejected Source 1 - (Amari Browne Johnson):

Thornton, T. F. (2021). Herring and people of the North Pacific [e-book] sustaining a keystone species. (odu Library) https://www.jstor.org/stable/j.ctv1d1qmqh

This e-book provides a comprehensive overview of the importance of herring as a keystone species in the North Pacific and the relationship between herring and people. The book discusses the role of herring in the ecosystem, including its impact on other species, and how the depletion of herring populations can have cascading effects on the ecosystem. It also examines the cultural, economic, and social significance of herring to the people in the region, including indigenous communities. The authors highlight the need for sustainable management practices to ensure the long-term survival of herring and the ecosystem it supports, emphasizing the importance of collaboration between scientists, policymakers, and communities in achieving this goal. Overall, this e-book provides valuable insights into the complex interrelationships between keystone species, ecosystems, and human societies, highlighting the need for a holistic and integrated approach to conservation and management

Rejected Source 2 - (Amari Browne Johnson):

Watson, J. E. M., Simmonds, J. S., Ward, M., Yong, C. J., Reside, A. E., Possingham, H. P., . . . Carwardine, J. (2022). Communicating the true challenges of saving species: response to Wiedenfeld et al
[Article]. Conservation Biology, 36(4), 1-3. https://doi.org/10.1111/cobi.13961

This article argues that the conservation community too often focuses on success stories and not enough on the true challenges of saving species, which can lead to a false sense of optimism and complacency. The authors highlight the complex and interconnected factors that contribute to species decline and extinction, including habitat loss, climate change, disease, and human activities such as hunting and trade. They argue that conservation efforts must address these underlying drivers of species decline, rather than simply treating the symptoms. The authors also call for greater transparency and honesty about the challenges of conservation, and for the conservation community to work more closely with other sectors and stakeholders to achieve meaningful conservation outcomes. Overall, the article provides a thought-provoking critique of the conservation community and calls for a more honest and collaborative approach to

Accepted Source 1 - (Kyle Bennett):

Delibes-Mateos, M., Smith, A. T., Slobodchikoff, C. N., & Swenson, J. E. (2011). The paradox of keystone species persecuted as pests: A call for the conservation of abundant small mammals in their native range. *Biological conservation*, *144*(5), 1335-1346. https://doi.org/10.1016/j.biocon.2011.02.012

This article seeks to address the eradication of small mammals that play the role of keystone species in their environments. These species are generally perceived as pests by humans due to their negative impact on agriculture, however they must be protected because of their key ecological role to ensure the stability of the ecosystem. The authors present a model for managing the populations of these species which allows for their growth and continual success in areas of high conservation value, while populations in areas of low conservation value can be reduced humanely.

This article is a valuable reference as it is well supported by experts in the field of ecological science and extensive research. While the article is not particularly recent, the major ideas on keystone species' impact on their ecosystem and the conservation model are still useful. It is these factors that ensure that the article is relevant to the topic of the project as it, like the article, seeks to illustrate the benefits of protecting keystone species for the entire ecosystem.

Accepted Source 2 - (Kyle Bennett):

Ka, M. (2021). Surrogate rearing a keystone species to enhance population and ecosystem restoration. *Oryx*, *55*(4), 535. https://doi.org/10.1017/S0030605319000346

This article details the reintroduction of a keystone species into its natural environment and the impacts it had on the ecosystem. Sea otters raised in captivity were released into Elkhorn Slough, a degraded coastal estuary connected to Monterey Bay in California. The sea otters' activity and the health and overall prosperity of the ecosystem was closely monitored by the researchers over a period of several years. The researchers found that the addition of the otters

was incredibly beneficial to the habitat, eventually resulting in the restoration of the once-impaired ecosystem.

This article is a very high quality reference thanks mainly to its abundance of supporting data and sources which help to ensure the accuracy of the information presented. Furthermore, the credibility of the authors and recency of the article add to its reliability as a reference. The focus of the article being a keystone species' impact on its ecosystem ensures that it is relevant to the topic of the project and thus a valuable resource.

Rejected Source 1 - (Kyle Bennett):

Thornton, T. F. (2021). Herring and people of the North Pacific [e-book] sustaining a keystone species.

This book explores the relationship between a particular fish species, herring, and the indigenous people of the Alexander Archipelago of Southeast Alaska. Historically, the presence of indigenous Alaskans in a particular area correlated with an abundant supply of both herring and the herring's predators in that area. The authors' explanation for this codevelopment of fish and humans is that indigenous fishers cultivated the spawning ground of the herring, thereby providing the fish with a place that it could consistently reproduce and allowing their numbers to dramatically increase.

This book is a good quality reference because it was created by experts and is well supported by extensive research and numerous sources. Furthermore, the information in the book is current as it was published in 2021. However, this book was rejected because it is largely irrelevant to the topic of the project. The book is quite narrow in its scope and it only briefly addresses the topic of the project, keystone species. It would not make a suitable reference for the project.

Rejected Source 2 - (Kyle Bennett):

Duchardt, C. J., Augustine, D. J., Porensky, L. M., Beck, J. L., Hennig, J. D., Pellatz, D. W., . . . Davidson, A. D. (2023). Disease and weather induce rapid shifts in a rangeland ecosystem mediated by a keystone species (Cynomys ludovicianus) [Article]. *Ecological Applications*, *33*(1), 1-19. https://doi.org/10.1002/eap.2712

This article examined changes in a grassland ecosystem in northeastern Wyoming over time after a disease wiped out significant portions of the black-tailed prairie dog population. The researchers observed a sharp decline in the activity of prairie dogs' predators, and this was followed by an unusually high level of precipitation which led to further changes among the various species inhabiting the grassland. The researchers ultimately concluded that changing disease dynamics and variations in climate could destabilize such ecosystems.

This article is well written and supported by thorough research. This accuracy is compounded by the recency of the article, which was published a few months ago. However this article was rejected because it lacks enough relevance to make it a valuable reference for this project. While it does concern a keystone species' impact on its environment, the article does so

in the context of other environmental factors, thereby limiting its relevance to the topic of the project.

Accepted Source 1 - (Logan Bell):
Hernández, A. J. A., Ruiz, T. I., Cayuela, L., & Maria Sabatini, F. (2022). What feeds on Quercus ilex L.? A biogeographical approach to studying trophic interactions in a Mediterranean keystone species. *Diversity & Distributions*, *28*(1), 4–24. https://doi-org.proxy.lib.odu.edu/10.1111/ddi.13413

Within the source at hand the look is place upon a certain keystone species in which is a plant (it is called the Holm Oak) and the authors take a look at the amount of species that rely on this plant as a source of food. It is found out within the source that 605 different species relied on this single keystone species as a source of food, though it also displayed that 90% of the species did not have a conservation status assignment done on them This not only shows the value of this type of keystone species, but it also emphasizes that more research must be done on these types of species.

The source is a very well done source all around. It is directly on topic for the type of research i was looking for in general. The authors are very knowledgeable in the field, and they are using lots of different types of references within their work.

Accepted Source 2 - (Logan Bell):
Tsang, S. M., & Wiantoro, S. (2019). Indonesian Flying Foxes: Research and Conservation Status Update. Treubia, 46, 103–113. https://doi-org.proxy.lib.odu.edu/10.14203/treubia.v46i0.3792

This article, the main purpose of it was to look at a certain species called the Indonesian Flying Foxes. They are keystone species in Indonesia, and they are currently being threatened by hunters as described in the article.

I found this article to be very helpful for my research on all areas of my topic. The authors themselves seemed to be very reliable with their information considering the number of references, the authors are also very well accomplished within their respective fields.

Rejected Source 1 - (Logan Bell):

Butchart, S. H. M., & Bird, J. P. (2010). Data Deficient birds on the IUCN Red List: What don't we know and why does it matter? Biological Conservation, 143(1), 239–247. https://doi-org.proxy.lib.odu.edu/10.1016/j.biocon.2009.10.008

In the source the main focus is the lack of information of certain birds provided throughout the IUCN Red list. It explains how the IUCN list has certain categories throughout their list and how their seems to be a lack of information on certain birds.

The source itself is not a good source for the research paper I am trying to put together. Now the source itself all together is reliable if what you are looking for is connected to lack of info on birds and conservation status lists.

Rejected Source 2 - (Logan Bell):

MIRES AND PEATLANDS OF EUROPE [e-book] Status, Distribution and Conservation;status, Distribution and Conservation. (2020). https://ebookcentral.proquest.com/lib/odu/detail.action?docID=6274311&pq-origsite=primo

Within this book Its main purpose is to give us a description of the terrain throughout the United Kingdom within a certain time period. Within the book they talk about the species that live within the terrain such as certain Conservation Statuses of certain species

I did not really find this book to be an acceptable source for myself. It does not really talk about the IUCN Red List nor does it go into Keystone species

Accepted Source 1 - (Kendra Blount):

Bean, M. (2009). The Endangered Species Act. Annals of the New York Academy of Sciences, 1162(1), 369-391. https://nyaspubs.onlinelibrary.wiley.com/doi/10.1111/j.1749-6632.2009.04150.x

This article discusses extensively the history of the Endangered Species Act, The agencies who started it, how it categorizes endangered and threatened species, and recovery plans. It concludes the controversy that the act faces, but also its key part is in the preservation of species. This article is very relevant to understanding the Endangered Species Act and how it was created. In addition, how it specifically works to save species

Accepted Source 2 - (Kendra Blount):

Dunk JR, Woodbridge B, Schumaker N, Glenn EM, White B, LaPlante DW, et al. (2019) Conservation planning for species recovery under the Endangered Species Act: A case study with the Northern Spotted Owl. PLoS ONE 14(1): e0210643. https://doi.org/10.1371/journal.pone.0210643

This article discusses a specific plan of recovery for species under the Endangered Species Act, particularly the northern spotted owl, which was classified as a threatened species in North America. The authors explored the concept of spatial conservation theory and developed models for the most ideal habitat networks. The solution they developed not only continues to gather information on the northern spotted owl population, but also how these conservation plans can be executed for other species.
I feel that this article was helpful in supporting my understanding of the conservation efforts through the Endangered Species Act and how it may be helpful in targeting keystone species.

Rejected Source 1 - (Kendra Blount):

Delibes-Mateos, M., Redpath, S., Angulo, E., Ferreras, P., & Villafuerte, R. (2007). Rabbits as a keystone species in southern Europe. Biological Conservation, 137(1), 149-156. https://www.sciencedirect.com/science/article/pii/S0006320707000572?via%3Dihub

This article identifies rabbits as a keystone species in southern europe, and drawn comparisons between the plethora of this species with the endangered imperial eagle. Furthermore, the article advocates for conservation efforts to occur.

While the article was very informative, I found it irrelevant to my research due to its lack of information on the involvement of the Endangered Species Act. The location, which is in Spain and other countries of southern europe, is also too broad for our research topic.

Rejected Source 2 - (Kendra Blount):

Zhao, L., Zhang, H., O'Gorman, E., Tian, W., Ma, A., Moore, J., . . . Woodward, G. (2016). Weighting and indirect effects identify keystone species in food webs. Ecology Letters, 19(9), 1032-1040. https://onlinelibrary.wiley.com/doi/full/10.1111/ele.12638

This article discusses the theoretical and empirical approaches to studying interactions among species that recognize that there is a bi-directional component to every interaction that gauges the separate impacts of one species on the dynamics of another. While the authors identify the issue with biodiversity loss and its effects on the overall ecosystem, I found it irrelevant to my research due to its lack of information on the Endangered Species Act and species specifically within our given region.

Accepted Source 1 - (Rylie Barbee):

Cosentino, B.J., Schooley, R.L., Bestelmeyer, B.T. *et al.* Constraints and time lags for recovery of a keystone species (*Dipodomys spectabilis*) after landscape restoration. *Landscape Ecol* 29, 665–675 (2014). https://doi.org/10.1007/s10980-014-0003-5

This article shows a strategy to help save and protect keystone species. When trying to help endangered species, it is not just about the weather that is harming them, but sometimes the land in which they live in. The grass, trees, and water. This article shows that not just the climate is important, but also their environment.

This can help me support my thesis by giving an example of how we can actually save and protect keystone species as a society.

Accepted Source 2 - (Rylie Barbee):

Garibaldi, A. and Turner, N. 2004. Cultural Keystone Species: Implications for Ecological Conservation and Restoration. *Ecology and Society*, 9(3), 1. http://www.ecologyandsociety.org/vol9/iss3/art1/.

This talks about how biological conservation and ecological restoration can be a way to improve the success in saving and protecting cultural keystone species. It talks about specific areas and shows just how important it is to prioritize keystone species. The article shows that there are certain species that are extremely important to the human species and should be prioritized over other species.

This can help me with the rebuttal as it proves the point of it being easier to protect and save keystone species before it is to save Biodiversity Hotspots. It helps to prove my specific thesis.

Rejected Source 1 - (Rylie Barbee):

Banks-Leite, C., Pardini, R., Tambosi, L. R., Pearse, W. D., Bueno, A. A., Bruscagin, R. T., Condez, T. H., Dixo, M., Igari, A. T., Martensen, A. C., & Metzger, J. P. (2014). Using ecological thresholds to evaluate the costs and benefits of set-asides in a biodiversity hotspot. *Science*, *345*(6200), 1041–1045. https://www.jstor.org/stable/24917328.

This article talks about the strategy that would be used to save and protect biodiversity hotspots. They say they set aside the amount of money it would take to pay landowners to set aside private land for the restoration process. They come to the conclusion that this is a cost-effective strategy to help save and protect biodiversity hotspots.

This is relevant to my topic as I am the rebuttal, arguing that saving keystone species is more cost-effective than saving biodiversity hotspots. It was written by experts in the field. This source does not appear to be biased.
The source goes against what I am saying. I want to say that saving biodiversity hotspots is not cost-effective, while this source says it is. This source is not beneficial to me.

Rejected Source 2 - (Rylie Barbee):

THORNTON, T. F., & MOSS, M. L. (2021). *Herring and People of the North Pacific: Sustaining a Keystone Species*. University of Washington Press.

In this book talks about the importance of one specific keystone species. It describes the Herring fish as being beneficial to the world and society. It does a great job of explaining why this species is keystone and important, but it is only talking about one specific species. It talks about saving a protecting a specific bird species. This is not beneficial to my thesis, as I am focused on multiple species, and not just one. I need more information on animals as a whole.

References

Delibes-Mateos, M., Smith, A. T., Slobodchikoff, C. N., & Swenson, J. E. (2011). The paradox of keystone species persecuted as pests: A call for the conservation of abundant small mammals in their native range. Biological conservation, 144(5), 1335-1346. https://doi.org/10.1016/j.biocon.2011.02.012

Garibaldi, A. and Turner, N. 2004. Cultural Keystone Species: Implications for Ecological Conservation and Restoration. *Ecology and Society*, 9(3), 1. http://www.ecologyandsociety.org/vol9/iss3/art1/.

Ka, M. (2021). Surrogate rearing a keystone species to enhance population and ecosystem restoration. Oryx, 55(4), 535. https://doi.org/10.1017/S0030605319000346

keystone species. (2019).

keystone species. (2020).

Libralato, S. (2019). Keystone Species and Keystoneness. 451-456. https://doi.org/10.1016/B978-0-12-409548-9.10570-6

Zhao, L., Zhang, H., O'Gorman, E., Tian, W., Ma, A., Moore, J., . . . Woodward, G. (2016). Weighting and indirect effects identify keystone species in food webs. Ecology Letters, 19(9), 1032-1040. https://onlinelibrary.wiley.com/doi/full/10.1111/ele.12638

Bean, M. (2009). The Endangered Species Act. Annals of the New York Academy of Sciences, 1162(1), 369-391. https://nyaspubs.onlinelibrary.wiley.com/doi/10.1111/j.1749-6632.2009.04150.x

Delibes-Mateos, M., Redpath, S., Angulo, E., Ferreras, P., & Villafuerte, R. (2007). Rabbits as a keystone species in southern Europe. Biological Conservation, 137(1), 149-156. https://www.sciencedirect.com/science/article/pii/S0006320707000572?via%3Dihub

Thornton, T. F. (2021). Herring and people of the North Pacific [e-book] sustaining a keystone species.https://www.jstor.org/stable/j.ctv1d1qmqh

Jordán, F. (2010). Keystone species and food webs. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1558), 1747-1756.https://doi.org/10.1098/rstb.2010.0026

Song, Z., Wu, B., Xiong, W., Gao, L., & Li, Y. (2022). Quantifying the Evolution of Giant Panda Habitats in Sichuan Province under Different Scenarios [Article]. Diversity (14242818), 14(10), 865-N.PAG. https://doi.org/10.3390/d14100865

Watson, J. E. M., Simmonds, J. S., Ward, M., Yong, C. J., Reside, A. E., Possingham, H. P., . . . Carwardine, J. (2022). Communicating the true challenges of saving species: response to Wiedenfeld et al [Article]. Conservation Biology, 36(4), 1-3. https://doi.org/10.1111/cobi.13961

Butchart, S. H. M., & Bird, J. P. (2010). Data Deficient birds on the IUCN Red List: What don't we know and why does it matter? Biological Conservation, 143(1), 239–247. https://doi-org.proxy.lib.odu.edu/10.1016/j.biocon.2009.10.008

Tsang, S. M., & Wiantoro, S. (2019). Indonesian Flying Foxes: Research and Conservation Status Update. Treubia, 46, 103–113. https://doi-org.proxy.lib.odu.edu/10.14203/treubia.v46i0.3792

Butchart, S. H. M., & Bird, J. P. (2010). Data Deficient birds on the IUCN Red List: What don't we know and why does it matter? Biological Conservation, 143(1), 239–247. https://doi-org.proxy.lib.odu.edu/10.1016/j.biocon.2009.10.008

MIRES AND PEATLANDS OF EUROPE [e-book] Status, Distribution and Conservation;status, Distribution and Conservation. (2020). https://ebookcentral.proquest.com/lib/odu/detail.action?docID=6274311&pq-origsite=primo