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Owl vs Owl: Examining an Environmental Moral Tragedy

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Abstract
In the United States, the northern spotted owl has declined throughout the Pacific Northwest even though its habitat has been protected under the Endangered Species Act. The main culprit for this decline is the likely human-facilitated invasion of the barred owl. The United States Fish and Wildlife Service conducted an experiment in which they lethally removed the barred owls from selected areas in Washington, Oregon, and California. In those locations, the northern spotted owl populations have stabilized and increased. Some have argued that we should kill the barred owl to protect the northern spotted owl. In this essay, I argue that the competitive displacement of northern spotted owls by the barred owl should not be addressed by killing the later to save the former. The most powerful objection to this conclusion is that we will lose old-growth temperate rainforest without an indicator species like the spotted owl protected under the Endangered Species Act. In response, I argue that we should directly conserve old-growth temperate rainforest independent of the northern spotted owl. In effect, we need legislation and policies that protects endangered ecosystems.

Keywords Ecosystem · Environment · Ethics · Extinction · Owl · Species

1 Introduction

Aldo Leopold wrote, "One of the penalties of an ecological education is that one lives alone in a world of wounds" (1948, 87). Regarding many environmental issues, this is true. With regard to biodiversity loss, it is most assuredly so. In the Pacific Northwest of the United States, a variety of scientific and ethical controversies surround the northern spotted owl (*Strix occidentalis caurina*). In this essay, I consider the recent interspecific competition between the northern spotted owl and the barred owl (*Strix varia*). The latter was mostly likely introduced by human activity

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into old-growth temperature rainforests where it outcompetes the former (Livezey, 2009). The northern spotted owl is a threatened subspecies of the spotted owl that is protected under the Endangered Species Act (ESA). It is also an indicator species of old-growth temperate rainforest, and thus its being listed under the ESA is thought to be crucial to protecting old-growth. In fact, it is this protection of old-growth temperate rainforest that provides the strongest reason for protecting the northern spotted owl. In the 2000s, the U. S. Fish & Wildlife Service conducted removal experiments killing the barred owl to conserve the northern spotted owl. These experiments have stabilized and sometimes increased the population size of the northern spotted owl (Diller et al., 2016). However, many people question the permissibility of perpetually killing members of one owl species to save another (Diller, 2013; Lynn, 2018). I argue that we should not kill the barred owl provided we can directly protect endangered ecosystems such as old-growth temperate rainforest. Additionally, I argue that this is something that is conceptually coherent and practically possible. This would have a side-effect of removing the need to kill the barred owl to save the northern spotted owl. It would prevent making a moral tragedy even worse.

2 Background

The northern spotted owl is one of three subspecies of *Strix occidentalis*, which also includes the California spotted owl (*S. occidentalis occidentalis*) and the Mexican spotted owl (*Strix occidentalis lucida*). This northern subspecies is territorial, monogamous, and lives exclusively in old-growth coniferous forests in the Pacific Northwest (i.e., Washington, Oregon, and Northern California). These forests are at least 150 years old with canopies with many layers, snags, and space for flying between trees to hunt for prey (Norse, 1989). Unlike other birds, the northern spotted owl does not build its own nests; rather, it lives in holes in dead trees, which are at least two feet wide.

Logging, wildfire, and forest clearing have reduced the northern spotted owl's habitat to less than 10% of the original area since 1950. This owl is especially important since it is an indicator species. An indicator species serves as an index for the presence and condition of habitats, communities, or ecosystems. Ecological studies have shown that northern spotted owls are almost exclusively found in old-growth forests (Ripple et al., 1991) Given this is so, when we protect the owls along with their habitat, we protect old-growth forests too. Since the early 1990s, populations of the owl have declined by more than 70% (Dugger et al., 2016). In Washington they have declined by 55 – 77%; in Oregon they have declined by 31 – 68%; and in California they have declined by 32 – 55%.

When we turn to policy that has addressed the decline of the owl, two pieces of legislation stand out.[1] First, the Endangered Species Act (ESA) of 1973

[1] For a history of laws and policies regarding the northern spotted owl, see Yaffee (1994) and Layzer and Rinfret (2019).

characterizes an endangered species as one "in danger of extinction through all or a significant portion of its range," and a threatened one is "likely to be endangered." Second, the National Forest Management Act (NFMA) of 1976 requires the United States Forest Service (USFS) to "maintain viable populations of existing native and desired non-native vertebrate species in the planning area." A viable population is defined as "one which has the estimated numbers and distribution of reproductive individuals to ensure its continued existence is well distributed in the planning."[2] In 1989, the U. S. Fish and Wildlife Service (FWS) argued that the northern spotted owl should be listed as "threatened" under the ESA. Thereafter, there were lawsuits, protests, and Congress directed the FWS, the USFS, National Park Service (NPS), and the Bureau of Land Management (BLM) to put together what was called the "Interagency Scientific Committee" (ISC). They were tasked with creating a "scientifically credible conservation strategy" for the owl. This would eventually become the Northwest Forest Plan (NWFP). Their approach was to create habitat conservation areas (HCAs) that were adequate to make sure the owl persisted, and these HCAs would be monitored and evaluated through time. A network of such HCAs that were close enough together and with enough acreage where logging was not permitted could protect the owls. In 1990, the northern spotted owl was officially listed by the USFWS, and in 1992 they released a draft of their protection plan. The plan designated 6.9 million acres of federal land in Washington, Oregon, and California; however, it was not finalized.

President Bill Clinton held a Forest Summit in 1993 bringing together stakeholders of all sorts.[3] As a result, the Forest Management Assessment Team (FEMAT) was created to devise a plan for the northern spotted owl's management. In 1994, the NWFP was completed. The fundamental components of the NWFP are a system of reserves to protect ecosystems, an aquatic strategy for conserving salmon and connecting protected areas, management of sustainable harvesting of timber, employment programs for rural communities and tribes in restoration work, and guidelines for adaptive management of the forests across the region (Tuchmann et al., 1996). As a result, old-growth forest increased though northern spotted owl populations decreased more than scientists expected. The reason is most likely the barred owl invasion of the Pacific Northwest. Over the last 80 years, it has expanded its range to the west and finally made contact with the northern spotted owl.

3 Owl vs. Owl

The historic range of the barred owl was largely in eastern North America. However, as noted, it has expanded its range into the Pacific Northwest. This migration is probably human-facilitated. Native Americans burned much of the Great Plains;

[2] This "viability standard" was removed by President George W. Bush's administration.

[3] For a fascinating history of these events, see the autobiography of Jack Ward Thomas (2004). He was the Chief of the USFS at the time.

however, Europeans stopped the regular burns. New forests appeared, and this created a land bridge for the barred owl (Livezey, 2009).

The problem facing the northern spotted owl is one of interspecific competition with the barred owl (Gutiérrez et al., 2007). When two or more species share the same resources, occupy the same habitat, are similar in the body sizes, they will compete. According to ecological theory, when two species occupy the same niche, at least one of them will tend to be excluded (Mittelbach & McGill, 2019). The barred owl is a superior competitor. It can live in old- or new-growth forests. It is a food generalist and consumes all that the northern spotted owl does and more besides. They also are aggressive towards their smaller evolutionary sibling. Though hybridization occasionally occurs, it is relatively uncommon (Hamer et al., 1994). Thus, the two owl species cannot stably coexist in old-growth forests, and forest ecologists predict that the northern spotted owl will eventually go extinct as the result (Kelly et al., 2003).

There is observational evidence that these predictions are being borne out. Northern spotted owl declines are greater where they overlap with the barred owl. Importantly, this decline has occurred even though the species is listed under the ESA with logging restrictions on millions of acres of federal forests. The USFS, USFWS, BLM, and the U. S. Geological Survey decided on conducting a removal experiment. They would kill barred owls found in the Cle Elum area of Washington, the Oregon Coast Range and Klamath-Union-Myrtle areas of Oregon, and Hoopa Valley tribal land in Northern California. The FS began killing them with 12-gauge shotguns, and where the lethal removal occurred, northern spotted owl populations have grown (Wiens et al., 2020). Similarly, where they are not removed, the barred owl populations increase and the northern spotted owl decreases. As of August 31, 2020, 502 barred owls have been killed in Hoopa, 1269 have been killed in the Oregon Coast Range, 578 have been killed in Cle Elum, 768 have been killed in Union/Myrtle (Klamath) for a total of 3315.[4] Thus, the lethal removal has been successful, and many see it as a foundation for a long-term conservation strategy for the northern spotted owl (Diller et al., 2016). However, it is clear that killing the barred owl to save the northern spotted owl raises serious moral issues. Biologists themselves have expressed their reservations about this lethal removal strategy (Gutiérrez et al., 2007). There are currently no alternatives for preventing the extinction of the northern spotted owl. Let me expand on this point.

In the Environmental Impact Statement prepared by the USFWS, they provided two protocols for removing the barred owl.[5] The first is the lethal removal strategy already mentioned. In this protocol, barred owls are lured through calls and are shot provided that they don't have juveniles that will be orphaned and are not within 300 yards of an active northern spotted owl nest. The second is a non-lethal alternative in which calls are used along with a decoy and the barred owl is netted. However, this alternative requires that the bird either be released in the wild or that it be placed in a facility temporarily or permanently. The USFWS decided against relocating the

[4] https://www.fws.gov/oregonfwo/articles.cfm?id=149489616

[5] https://www.fws.gov/oregonfwo/Documents/BarredOwl-FinalEIS.pdf

birds in the Pacific Northwest since they could still displace the northern spotted owl. They considered releasing the birds in their pre-1900 historical range; however, no state that was contacted would take the birds since they either lacked habitat, were concerned about the transmission of disease, or were concerned with diluting gene pools. Finally, the USFWS also considered either temporarily or permanently relocating them to zoos, zoological parks, or other facilities. Temporary relocation requires that the birds eventually be released, and this can be extremely difficult for the birds. Often, they die from stress or disease, and even if they live for the duration of the experiment, they cannot survive in the wild. With regard to permanent relocation, USFWS contacted a variety of facilities, and they could get a commitment to house only five barred owls. They reasonably concluded that the non-lethal alternative was not a genuine option. Let's turn to the moral issues.

One important moral issue raised concerns individual animal suffering. Many ethicists claim that insofar as an entity is sentient, then it has morally considerable interests (Bernstein, 1998; Korsgaard, 2018). Moreover, when two or more organisms have the comparable capabilities for experience, then their interests are comparable. That is, their interests should be given similar moral weight (Varner, 2002; Regan, 2004; Taylor, 2011). The northern spotted owl and barred owl are in the same genus *Strix*, and thus they are extremely similar. If two or species extremely similar, then they will have comparable capacities for experience. Thus, insofar as individuals of both species in the genus can suffer, their suffering is both morally considerable and comparable.[6] Since their interests are comparable, then we should harm – or more specifically kill – fewer owls rather than more. Therefore, we should kill barred owls to prevent the extinction of the northern spotted owl. This argument though powerful is unsound. According to Defenders of Wildlife, there are approximately 4520 northern spotted owls and according to the International Union of the Conservation of Nature, there are approximately 8557 northern spotted owls.[7] As of 2021, biologists have already killed 2485 barred owls (Franklin et al., 2021), and the global breeding population of barred owls is three million. Thus, if the northern spotted owl's extinction is to be averted, we will have to kill far more barred owls than northern spotted owls, which contradicts the principle we should harm the few rather than the many.

One might object to the above argument that the suffering from being killed by a shotgun versus starving to death are not the same morally speaking. The latter is far worse than the former.[8] This point seems exactly right to me, so let's assume that on average the suffering of northern spotted owls as the result of this competition is much worse than the suffering of the barred owl. To oversimplify for illustrative purposes, suppose on average the suffering of the former's death is ten times worse

[6] For the purposes of this paper, I will not try to examine what sorts of experience owls can have. The important point is whatever they are, they are likely to be very similar given how closely related they are. For some very interesting work on animal minds, see Tye (2016), Carruthers (2019), and Andrews (2020).

[7] https://defenders.org/wildlife/owls; https://www.iucnredlist.org/species/22689089/180937862

[8] I am indebted to Katie McShane for raising this objection.

than that of the latter's death. Thus, to save 8557 northern spotted owls, we would be justified in killing 85,570 barred owls and no more. This argument would increase the number of barred owls it is permissible to kill, but my criticism will still apply eventually since there is no end in sight in killing the barred owl to save the northern spotted owl.[9]

Another important thought is that the argument above would also imply that the removal experiment was unethical as well.[10] In essence, the number of northern spotted owls saved would still be fewer than the number of barred owls killed as the result of the experiment. In the treatment areas, there were 819 non-juvenile spotted owls banded since 2002. The removal experiment indicates that in those removal areas, the annual rate of population changes stabilized at 0.2% decline per year, but control populations continued their reduction at 12.1% decline per year (Franklin et al., 2021). Thus, approximately 97 northern spotted owls survived that would have otherwise died due to the presence of the barred owls. Additionally, nesting pairs of northern spotted owls typically have between one and four fledglings (though they do not reproduce every year). Let's assume that there were $97/2 = 48.5$ nesting pairs and they all produced a maximal number of four fledglings. Thus, under the most optimistic assumptions, roughly 194 juveniles were born that would not have been by virtue of the removal experiment. Thus, 291 is an educated guess at how many northern spotted owls were saved by the removal experiment. Since the number of barred owls that were killed in the experiment was much greater than northern owls saved, one might rightly conclude that the experiment was morally unjustified. There are two important caveats worth mentioning. First, there is tremendous uncertainty surrounding these numbers and hence we cannot confident in my conclusion. Second, it was not evident until after the experiment how many northern spotted owls might be saved as the result of the experiment. Thus, one could reasonably have thought more northern spotted owls would have been saved than barred owls killed prior to the experiment.

We might consider the issue from the point of view of species themselves (Sandler, 2012). For example, some ethicists think we have obligations to protect species, and our obligations to threatened or endangered species is greater than those species which are neither threatened nor endangered (Rolston, 1985; Johnson, 1993; Bradley, 2001; Smith, 2016). This line of argument is unhelpful for several reasons. First, the USFWS has listed the northern and Mexican spotted owl as threatened, but the California spotted owl is not listed as threatened or endangered. Moreover, the spotted owl is not listed at all. The IUCN suggests that the spotted owl is "near threatened," which is not a formal listing.[11] Second, even if we grant that species

[9] It is worth noting that if the number of barred owls killed is fewer than the morally relevant number of northern spotted owls, then my criticism is turned back. However, there is nothing in our knowledge of the population ecology and demography of these owls that suggests this is so.

[10] Thanks to an anonymous referee for raising this issue.

[11] One might insist that we should prevent the decline of species even if they are not formally recognized as threatened or endangered. However, there are two problems with this claim. First, a recent report argues that one third of the United States' wildlife is vulnerable to extinction (Stein et al., 2018). They suggest as many as 12,000 species merit conservation action. It is unclear how we prevent the decline of so many species one-by-one through some federal or state level policy. Second, I worry that this leads to

have intrinsic value and endangered species have even more value in virtue of their rarity, very few people would regard species as the *only* thing that has such value. For example, sentient organisms have value distinct from the intrinsic value of their own species or other ones. Likewise, very few would think that killing *any* number of sentient beings is morally justified in conserving an endangered species. This is precisely what is at stake here since to protect the northern spottled owl (and may be the spotted owl more generally) we will have to kill barred owls *indefinitely*. One does not have to be compassionate conservationist to see that this requires a moral justification which we currently do not have.[12] Thus, even if species have moral standing themselves, this does not address the issue under consideration.

Finally, we might remind ourselves that the northern spotted owl is an indicator species. Since it is listed under the ESA as threatened, we are protecting old-growth temperate rainforest as well. This includes other bird species such as the goshawk, Vaux's swift, Hammond's flycatcher, Townsend's warbler, Pacific wren, pileated woodpeckers, the flammulated owl, white-headed woodpecker, pygmy nuthatch, and Bald eagles. It also worth noting that old-growth forests sequester enormous amounts of carbon (Luyssaert et al., 2008). By protecting them, we are partially averting global climate change. Suppose then that we should protect old-growth temperate rainforest. If we are to protect it, we must protect the northern spotted owl. Therefore, we must protect the northern spotted owl. This I think is the strongest argument for protecting the northern spotted owl, and as a corollary, killing the barred owl to do it.[13] However, this argument has a serious flaw as well. We can protect old-growth temperature rainforest *without* protecting the northern spotted owl. Practically speaking, protecting the latter under the ESA is a very powerful way of ensuring that the former is protected too. But we could do it independently of the habitat listing requirements of the ESA. Given that this is so, we can also protect old-growth temperature rainforest without killing the barred owl as well.

One might concede that in principle we can protect old-growth temperature rainforest independent of the ESA. However, given the political realities in the United States, there is little chance that this will actually happen.[14] We should use existing

Footnote 11 (continued)
a radical form of "policing nature" where for example humans try to settle every instance of competition, predation, and parasitism through a utilitarian calculus (Cowen, 2003). However, some are committed to such radical interventionism (Johannsen, 2020). Thanks to an anonymous referee for raising pressing this issue.

[12] It is worth noting that that if species and subspecies have intrinsic value and we have to kill a larger number of sentient organisms to save the focal species, this might be morally justified. The crucial problem we face in the case under discussion is that the killing of barred owls to save the northern spotted owl would continue with no end in sight. Thus, if a large number of barred owls needed to be killed, but this number was well short of the entire barred owl species, then I would be more likely to endorse killing them to save the northern spotted owl. Thanks to an anonymous referee for pressing me on these points.

[13] It is also worth noting that my criticisms of applying the principle that we should harm the few rather than the many in this case probably lose force. We are considering killing many barred owls to protect organisms of many, many different species.

[14] Thanks to an anonymous referee for encouraging me to think more deeply about this objection.

legislation to protect this rare biome even if it is at the expense of barred owls. This is an instance of environmental "dirty hands" (Chicago Walzer, 1973). I find this response unpersuasive for two reasons. The purported justification of perpetually killing barred owls now rests on the moral failings of American politicians and citizens. Their moral failings are not inevitable. After all, we passed the ESA, the NFMA, and many other powerful pieces of environmental legislation. Thus, we are capable of doing so again. Second, it is dangerous since it treats the moral failings of others as non-negotiable and thereby incentivizes dirty hands solutions. The claim that, "Democrats and Republicans will not support a piece of legislation or policy; therefore, we should abandon the pursuit of such legislation or policy," will ensure a race to an ethical bottom for all sorts of moral and political issues. Nevertheless, practically speaking, we should attempt to buy more time to defend and enact ecosystem-level legislation and policies. One way to do this is list the northern spotted owl as endangered and not merely threatened (along with the marbled murrelet (*Brachyramphus marmoratus*)), and we should also include other plausibly threatened species such as the red tree vole (*Arborimus longicaudus*). If after all of this effort, it is practically impossible to protect ecosystems, endangered or otherwise, then we can decide whether we should dirty our hands with the blood of barred owls.

In the end, we have found no good all things considered reason for killing the barred owl to save the northern spotted owl. I agree that *if* the only way to protect old-growth temperature rainforest was to protect the northern spotted owl *and* the only way to do that was to kill the barred owl, we would be morally justified in doing so. But I don't think the antecedent is true. However, my proposals regarding ecosystems and their protection requires that we explore these issues. Are ecosystems the sorts of things that can be conserved? Can they be endangered? It is to these questions I now turn.

4 Conserving Endangered Ecosystems

As I said in the previous section, I think we should conserve ecosystems especially when they are endangered. There are a variety of reasons one might think this. One might think that ecosystems are intrinsically valuable in one of the many senses of that term (Rolston, 1987, 1988; Johnson, 1993). For example, some think we should promote ecosystem health. However, if ecosystems can literally be healthy, then presumably they have interests that have moral standing. If they have moral standing, then presumably they have intrinsic value.[15] Likewise, one might think that they are instrumentally valuable; for example, we should protect the food webs and abiotic environments that sustain sentient beings more generally (Jamieson, 1995). For example, as mentioned above, old-growth forests sequester enormous amounts of carbon, and thus by protecting them we help mitigate global climate change. For our purposes, we needn't decide between these sorts of positions. There are some very

[15] For relevant work on the foundations of ecosystem health, see Cahen (1988), Norton et al. (1992), Callicott (1995), McShane (2004), Odenbaugh (2010), and Rohwer and Marris (2021).

practical reasons for conserving ecosystems directly. First, there are far too many threatened and endangered species to list and provide habitat plans for through the ESA. The magnitude of the extinctions that we face is much larger than the drafters recognized. Currently, there are more than 128,500 species on the IUCN Red List, with more than 35,500 species threatened with extinction, including 40% of amphibians, 34% of conifers, 33% of reef building corals, 26% of mammals and 14% of birds. The number of species listed as threatened or endangered is the United States is also very large. There are 2244 species listed as threatened or endangered with 1618 of those occurring in the United States.[16] Second, the preparation of individual recovery plans for each and every one of these species consumes time and money. Ecosystem recovery plans would aggregate the individual plans in a way to reduce the expenditure of time and money. Thus, protecting ecosystems is a much better means by which to protect large assemblages of species. And of course, indicator or umbrella species can still play an important role for identifying the relevant biomes for protection. Third, if the protection of endangered ecosystems is exclusively attached to endangered species, then the fate of these ecosystems is wholly dependent on protecting those species. Though we may be optimistic about how species who are listed under the ESA fare (Greenwald et al., 2019), we do not want this to be the sole means by which endangered ecosystems are protected. As we have seen, it creates the very sort of moral dilemmas we were just discussing.[17] Thus, there are good reasons for conserving ecosystems both for the sake of those that reside in them but also for practical reasons as well. However, we also need to think about what ecosystems are and whether they can be endangered.

An ecosystem is a group of biotic and abiotic components that are related at and through time. More specifically, they are composed of populations of species and abiotic entities like phosphorous, carbon, and nitrogen where the latter flow and are cycled through the former. You might think to yourself for any group of biotic and abiotic components you pick, there are *some* energetic flows and nutrient cycling between them. This makes the existence of ecosystems trivial. You would of course be correct that there are such flows and cycles, but this doesn't imply their existence is trivial. Thus, to be even more precise, the boundary of an ecosystem is the largest grouping for which average strength of interaction is higher within the group than outside (Odenbaugh, 2007, 2010).[18] A good example of an interactivist ecosystem so described is a watershed. A watershed is an area of land in which water,

[16] Of the listed species in the United States, 884 are plants; 307 are invertebrates, including insects, mollusks, and others; 163 are fishes; 95 are birds; 96 are mammals; 36 are reptiles; 35 are amphibians; and two are fungi – lichens, actually. There are 26 species that are candidates for listing under the ESA.

[17] It is interesting that the ESA is defined in such a way to protect ecosystems as well. In Section 1531(b) is states that the purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved."

[18] The term 'interaction strength' comes from food web theory (Mittelbach & McGill, 2019, 185 – 187). But we can generalize the concept to include abiotic components as well. One interesting thing to note about this causal interactionism is for any given region, only some of the biotic and abiotic components will be parts of ecosystem. The interactions between components might be too weak. This accords with food web theory since there often only a few strong interactions and many weak ones in a given ecological community.

sediment, and dissolved materials drain to common body of water or outlet. The physical boundaries of a watershed begin at the major ridgelines and meet at the bottom where water flows into various bodies of water. Watersheds provide physical boundaries that shape interactive ones.

One might object that many so-called ecosystems are "social constructions." That is, they are conventionally defined and thus don't exist. For example, Allan Fitzsimmons writes,

> The problem starts with the idea of an ecosystem itself. The term was coined by Arthur Tansley in 1935, who described them as physical systems encompassing living and nonliving things and their interactions. Ask the Forest Service, the Environmental Protection Agency, the Fish and Wildlife Service, and the Sierra Club to show you their maps of the ecosystems of the United States. They differ greatly. The so-called Greater Yellowstone Ecosystem can cover anywhere from 5 to 19 million acres, depending on who is defining it. These discrepancies occur because the human mind fabricates ecosystems. Nature does not put ecosystems on the land for researchers to discover. Ecosystems are only mental constructs, not real, discrete, or living things on the landscape. (Fitzsimmons, 1999, 3)

There are several problems with this argument. First, the fact that a single object can be multiply mapped does not imply that the object is not real. After all, there are political, topographic, climatic, economic, and road maps of Oregon to mention a few. Fitzsimmons presumably would not want to deny that Oregon exists. Maps are perspectival – we represent certain features and not others depending on our interests. Second, an object can be a social construction *and* real. Yellowstone National Park came into existence in 1872, which was meant include all of the geothermal basins in the area. However, due to the recognition of the grizzly bear (*Ursus arctos*) range, the Greater Yellowstone Ecosystem (GYE) was recognized including approximately 16,000 km^2. Over the years a variety of national parks were created by the National Park Service (NPS), a variety of national forests were created by the USFS, along with many wildlife refuges by the USFWS. It also includes ten distinct National Wilderness Areas. Lastly, the gray wolf (*Canis lupus*) was reintroduced into the GYE in 1995. All of these activities can change and strengthen a web of interactions and thus create a new object including an ecosystem as characterized above.[19] Third, suppose a region is demarcated as worth protecting and yet it isn't an ecosystem in the sense that I have characterized above. It still doesn't follow that it isn't real or not worthy of conservation. We simply would not be protecting an interactive ecosystem. Things other than interactive ecosystems, including ecosystems in a more general sense, can and should be conserved.[20]

So far, I have characterized *token* ecosystems. There are particular things that have a beginning and an end and occupy space. However, there are also *types* of

[19] For discussion of the history of the Greater Yellowstone Ecosystem.

[20] To be clear, I think the term 'ecosystem' refers to many different groups of abiotic and biotic components, and interactive ecosystems are one type of groupings, but they are not the only type.

ecosystems as well. These are biomes. They are the major ecosystem types found over large geographical areas and typically have characteristic flora and fauna. Additionally, biomes are characterized with major climatic zones. One famous way of capturing biomes comes the work of Robert Whittaker (1970). For Whittaker, biomes are defined in terms of temperature and precipitation. A biome then is a set of terrestrial ecosystems (often on a given continent) that are similar in their animals, vegetation, and abiotic features. There can also be convergent biomes too (in effect, they have multiple instances). Following Paul Alaback (1991), a temperate rainforest of North America is one that has between 1400 and 3300 mm of annual precipitation and a mean average temperature between 4 °C and 12 °C. Northern spotted owls of course live a more specific sort of biome – old-growth temperature rainforest. It occurs at a latitude between 40° and 60° in which its dominant vegetation are large coniferous trees like Douglas fir (*Pseudotsuga menziesii*) that are at least 150 years old. There are various sub-types of old-growth temperature rainforest such as coastal fog zone and Redwood, Douglas fir, Lodgepole pine, Mixed conifer, Oregon white oak, and Ponderosa pine.

Given how we have characterized ecosystems and biomes, in what sense can they be endangered? If we consider a bioclimatic approach that Whittaker offered, temperate rainforests are those ecosystems that have a mean annual precipitation between 1400 and 3300 and an average temperature between 4 °C – 12 °C. Thus, then a biome goes extinct when there are no longer instances of that type. The same is the case when we consider old-growth temperate rainforest since it must meet the above criteria along with having trees that are at least 150 years old. We can even anchor biomes by specific taxa like Douglas fir trees, which add additional criteria determining when instances of the biome are present (Slater, 2018). Rodríguez et al. (2007) offers a way of empirically assessing when ecosystems are critically endangered, endangered, and vulnerable. For example, an ecosystem or biome is endangered when an observed or estimated reduction greater than 70% of the original extent of the ecosystem has occurred and there is evidence that the threat(s) still exists.[21] Another interesting approach is the ecoregions framework where an ecoregion is a relatively large units of land with a distinctive assemblage of communities and species (Olson et al., 2001; Dinerstein et al., 2017). They can be ranked for conservation on the basis of their species richness, species rarity, unusual biological phenomena, or global rarity of habitat type. It also can be coupled with the Nature Needs Half movement through categories such as half protected, nature could reach half, nature could recover, and nature imperiled (Wilson, 2016).[22] For example, temperate conifer forests are 2.8% of the Earth's terrestrial area, 2% are half protected,

[21] Though Rodriguez operationalizes notions of endangerment for token ecosystems, we can easily adopt their notion to apply to biomes. For example, if (a) every instance of a given biome has been observed or estimated to be reduced by more than 70% and (b) the threat(s) continue to exist, then it is endangered.

[22] The Nature Needs Half movement proposes to conserve at least 50% of 846 ecoregions by 2030. The beginning of the movement can be traced to Eugene and Howard Odum when they wrote, "It would be prudent for planners everywhere to strive to preserve 50% of the total environment as natural environment" (Odum & Odum, 1972, 183).

16% could reach half, 19% could recover, and 10% are imperiled (Dinerstein et al., 2017, 537).

In the United States, there is little legislation for protecting ancient forests. The Wilderness Act, NEPA, the Northwest Forest Plan, the Roadless Area Conservation Rule, and the ESA have been used to do so. However, each has their own limitations. Importantly, some have called for legislative protection of ecosystems. As one example, Rep. Bruce Vento (D-MN-4) proposed the Ancient Forest Act of 1991 (H. R. 1590). If enacted, it would have given the power of designating lands for an ancient reserve system to the Secretaries of Agriculture and the Interior. Secretary of the Interior Bruce Babbitt like argued that the ESA should be amended to protect ecosystems (Babbitt, 2007). Others have called for a Northern Rockies Ecosystem Protection Act (H. R. 3334) that would protect more than 24 million acres of roadless lands and connect this land by corridors. It would also create 2300 jobs through restoring old roads and clear cuts.

In this section, I have argued that directly protecting endangered ecosystems makes conceptual and practical sense. My proposal that we should not kill barred owls to save the spotted owl in fact only makes sense if we can find ways independent of the fate of the northern spotted owl to protect old-growth temperature rainforest. If I am right, it would help us avoid a moral tragedy of our own doing.

5 Conclusion

Lowell V. Diller is one of the wildlife biologists who has carried out the lethal removal of the barred owl. In a powerful essay entitled "To Shoot or Not to Shoot," he writes,

> For me, the issue of lethal removal boils down to a sort of "Sophie's Choice." Shooting a beautiful raptor that is remarkably adaptable and fit for its new environment seems unpalatable and ethically wrong. But the choice to do nothing is also unpalatable, and I believe also ethically wrong. If human actions—including major alterations of spotted owl habitat and paving the way for the invasion of its eastern cousins—have put spotted owls at risk of extinction, don't we have a societal responsibility to at least give them a fighting chance to survive? (2013, 57)

We sometimes think of a moral tragedy as involving a choice in which no matter what we do, we are doing something wrong. Regardless of what we do there is some reasonable regret. Through our past actions, we have harmed the northern spotted owl. Additionally, we have encouraged the arrival of a superior competitor the barred owl, which harms it still further. One proposal is to kill one owl because it threatens another, but we are the ones who created that very threat. Here is where I part ways with Diller. We do have a societal responsibility to give northern spotted owls a fighting chance, but not when it involves the killing of many, many more barred owls. If the only chance of protecting ancient forests and their denizens was to eliminate the barred owl from those forests, then this choice might be defensible. However, this truly is not the choice we face. Surely those ancient forests can be

protected regardless of the fate of the northern spotted owl. We cannot change the past of course, but we should also not add to the wrongs already done.

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