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ENTITLED

The Endangered Species Act and Its Effect on Birds in the United States

BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR DEPARTMENTAL HONORS IN ENVIRONMENTAL BIOLOGY

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The Endangered Species Act and Its Effect on Birds in the United States

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Chapter One: Introduction

In the field of environmental biology, there is one piece of legislation that stands out as the most influential and controversial piece of environmental policy in the United States: The Endangered Species Act (ESA). Passed in 1973, it has drawn the attention of lawmakers, presidents, protesters, and proponents. The ESA is hailed as a species-saving necessity by conservationists while being criticized as a business-choking nuisance by opponents. This is in part due to the way it prioritizes saving threatened or endangered species over the rights of property owners.

The ESA has been described by the Supreme Court of the United States as "the most comprehensive legislation for the preservation of endangered species ever enacted by any nation" (TVA vs. Hill, 1978). Others have gone on to say that it is an extremely comprehensive and successful expression of American environmental ethics (TVA vs. Hill, 1978). However, many critics of the ESA claim that the act has been given too much power. They also say that it places more importance on the well-being of endangered species than on the well-being of the citizens of the United States, and that it uses too many resources to save those species when it isn't producing substantial results.

The act begins by declaring, "various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern and conservation" ("Endangered Species Act as amended," 1982). Not only does Section 2 define the problem, but it states that the United States will take ownership for this issue and "conserve to the extent practicable the various species of fish or wildlife and plants facing extinction" ("Endangered Species Act as amended," 1982). The following sections expand on this declaration and pledge,

outlining how to determine whether a species is endangered or not and how endangered species should be treated.

The ESA is divided into eighteen sections that outline regulations for dealing with endangered species. While the ESA lays out several goals in those eighteen sections, the overall purpose of the act is to protect species that are in danger of becoming extinct, and ultimately, to help those species recover to the point that they no longer need to be monitored ("40 Years," 2013). The Endangered Species Act protects listed species in several ways. For instance, section 9 of the act prohibits people from harming or harassing the listed species, and section 11 outlines possible penalties for not complying, which could include up to six months in jail and/or a fine of up to $25,000 for a threatened species ("Guidelines for management," 1994).

What does it mean for a species to be endangered or threatened? According to the ESA, the term "endangered" means "any species which is in danger of extinction throughout all or a significant portion of its range" ("Endangered Species Act as amended," 1982). A species is listed as "threatened" if it is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" ("Endangered Species Act as amended," 1982). After a species is listed as endangered or threatened, management is usually given over to the two departments that administer the ESA: The United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service. They primarily monitor terrestrial and freshwater organisms, and marine organisms, respectively ("40 Years," 2013).

Species are listed bases on their biological status and threats to their existence, and the USFWS determines whether or not a species should be listed based on five factors:

> "1) damage to, or destruction of, a species' habitat; 2) overutilization of the species for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) inadequacy of existing protection; and 5) other natural or manmade factors that affect the continued existence of the species" ("40 Years," 2013).

The Fish and Wildlife Service uses these factors and the best scientific information available in order to make decisions on what species to list.

Once a species is listed, the USFWS protects that species by conserving habitat and preventing "takes". It conserves habitat by designating critical habitat and protected habitat and by regulating what people do on properties that listed species reside on. Critical habitat is a specific geographic area that has features that are vital to the conservation of an endangered or threatened species. Critical habitat may require special management and protection. "Take" is defined in the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" ("Endangered Species Act as amended," 1982). However, the act provides permits for scientific research to be done on a listed species under section 10. This is because in order to get close to the listed species and conduct meaningful studies, researchers and biologists may pursue, capture, or disturb that species, which is technically prohibited.

The ESA is a broad-reaching piece of legislation that has the potential to affect lots of people and businesses. Because of this and other reasons, political opinions surrounding environmental issues have become increasingly negative during the past five

years, in part due to a changing political climate and a new head of the Environmental Protection Agency. According to F. C. Rich, environmental issues are some of the most divisive topics that Republicans and Democrats continue to battle over (Rich, 2016). However, there has not always been such a boiling conflict over the Endangered Species Act. In fact, the act was passed with a whopping bipartisan vote of 92 to 0 in the Senate and 390 to 12 in the House (Ketcham, 2017). Why have these attitudes changed? Is it because the ESA isn't effectively preserving species? Is the legislation outdated since it was created in 1973? Does it unfairly put the needs of endangered species above the needs of humans?

In order to answer these questions, it is important to look at case studies that illustrate the success or failure of protection efforts, to examine the law and how it treats species compared to the rights of American citizens, and to discuss ways that the law could be improved if it isn't catering to a modern society. Currently, the ESA protects over 1,400 species in the United States, including mammals, birds, reptiles, amphibians, and plants, however most people believe that as few as 100 animals are listed ("Americans Greatly Underestimate," 2018). Reviewing case studies for all species listed in order to determine the validity of the Endangered Species Act would take a considerable amount of time, and because species are constantly being listed or delisted, it wouldn't be practical. Focusing on a particular taxon and how it has been affected, however, is much more manageable.

How should one determine the taxon that should be studied? The taxon should have representatives throughout the entire United States so that all habitats can be examined; it should have a large pool of representatives so that enough studies have been

done to provide the basis for an argument; and ideally, representatives should be good environmental indicators so that if the ESA was helping to improve the habitats of these species, their numbers would show an improvement. The ESA helps recover species both directly and indirectly. The effects of indirect actions, such as designating critical habitat or protecting a piece of land might not be showcased by species that aren't as integrally tied to their habitats. By choosing a taxon that is particularly responsive to changes in the environment, the indirect effects of the ESA can be seen. This is especially important because if the taxon can show that the ESA is having a positive effect on the environment, it is likely that the ESA is positively affecting other animals in that environment as well.

Birds are a good focal point for an analysis since they are widespread across the United States and have listed representatives in a variety of habitats across the country. They have also been shown to be good environmental indicators (Hill, n.d.). This means they do a good job of showing researchers what environmental factors could be negatively or positively affecting endangered species, and whether or not designating critical habitat or protecting pieces of habitat is positively affecting the species. Data on their presence or absence can help researchers evaluate habitat quality. This in turn can affect the delineation of critical habitat which is an important part of the ESA. They have been shown to indicate habitat quality by both population density and the diversity of species in an area (Chambers, 2008; MacArthur et al. 1962). Higher numbers of certain bird species, such as specialists who rely on certain habitat characteristics to stay the same, may indicate a healthy environment. For instance, birds like the red-cockaded woodpecker, northern spotted owl, and Kirtland's warbler are very particular about their

habitat requirements and will only nest in areas that have a particular kind of tree or a forest with mostly young or mostly old-growth trees (Lay and Russell, 1970). If specialists such as the red-cockaded woodpecker are absent from a certain area, it could be a clue that some part of their habitat is lacking. Higher numbers of overall bird species as well as plant and other animal species also indicate a healthy environment (Kati et al. 2004).

Birds can also act as environmental indicators by responding negatively to pollution in the area (Hill, n.d.). One well-known instance of bird species indicating the presence of pollution occurred in the 1960s when raptor reproduction began to decline because of the use of DDT. This issue was thrust into the spotlight when researchers discovered that the nation's emblem, the bald eagle, was suffering a severe population decline because of eggshell thinning due to DDT (Stokstad, 2007). Congress banned DDT in 1972 in response to the crisis, and the example bald eagles provided inspired Congress to pass the Endangered Species Act in 1973. Forty-five years later, DDT is found in considerably lower concentrations in the wild and the bald eagle is no longer on the endangered species list. There are over 10,000 breeding pairs now compared to the meager 400 breeding pairs left in the 1960s before the ban of DDT (Stokstad, 2007). Researchers can detect pollutants non-invasively by collecting bird feathers and non-viable bird eggs, which can accumulate heavy metals and other toxins (Hill, n.d.). This is desirable because non-invasive methods disturb the study subjects and the environment less than more invasive methods. Heavy metals such as mercury, lead, and cadmium have been known to have harmful effects on birds and other animals in general, including people (Tchounwou et al. 2012). It is beneficial to study birds as environmental

indicators and to prevent these species from going extinct because they can alert researchers to issues that could affect human health as well.

Therefore, because birds are connected to the health of a particular environment, they are widespread across the United States, and they have representatives in different habitats, they are a good candidate for a study of the effectiveness of the Endangered Species Act. Many bird species are in decline because of habitat loss, destruction, or quality change, so in order to protect those species, often the ESA must be used to improve the habitat. Because of this, it is likely that if the ESA is helping a bird species prosper, it is also helping protect other species in that area as well. Several species of interest that will be investigated in this study are the piping plover and least tern, the northern spotted owl, the bald eagle, and the Kirtland's warbler. These species illustrate the success of the ESA as well as issues that the public and corporations have had with the act. The purpose of this thesis is to use the stories of these birds to determine what effect, if any, the Endangered Species Act has had on birds in the United States.

Bald eagles are one of the most recognizable bird species in the United States due to their position as the emblem of the United States of America (Holden, 1982). However, in the 1950s, birdwatchers in American began to notice that bald eagles were becoming scarcer. Because of this, the National Audubon Society began surveying bald eagles in the 1960s, and after finding low adult numbers and poor nesting success, the bald eagle was listed as endangered under the Endangered Species Preservation Act of 1966 ("Post-delisting Monitoring Plan," 2009). The bald eagle wasn't listed under the ESA until 1978, when it was listed as endangered in the 48 contiguous states except for Michigan, Minnesota, Wisconsin, Washington, and Oregon. It was listed as threatened in

these states ("Post-delisting Monitoring Plan," 2009). Pesticide use also negatively affected bald eagles as well as other bird species such as brown pelicans and peregrine falcons (Abbitt and Scott, 2001). Thankfully, because of recovery planning and listing under the ESA, the bald eagle was delisted in 2007. I chose to analyze the effects of the ESA on bald eagles because they were officially delisted and they are a well-known bird. I chose to focus on the bald eagle population in the southeastern United States because the other birds that I chose to analyze are located in the northern and western United States.

One example of how bird species are protected by the ESA is the monitoring program for piping plovers and least terns in North Dakota, South Dakota, and parts of Nebraska. Because of a 2003 biological opinion and the current 2018 biological opinion, the United States Army Corps of Engineers (USACE) has been charged with conducting productivity monitoring and an adult census of both bird species along the northern part of the Missouri river ("Biological Opinion," 2003). Piping plovers and least terns are shorebirds that nest along the beaches of the Missouri river, and the USACE is in charge of the dams along the Missouri and how much water is being let out, therefore, it was logical that they be given the responsibility of monitoring those species since they directly affect them. The USACE monitors productivity by surveying nest sites and tracking their success over the summer, and they prevent takes by signing sandbars to deter human activity, caging nests to limit predator disturbance, and raising nests on sand platforms to prevent nests from being inundated. I chose to analyze the effect of the ESA on piping plovers and least terns because these birds live in a unique and constantly changing habitat, I have personal experience monitoring them with the USACE, and their

case study will illustrate both positive and negative characteristics of the ESA. I am analyzing them together since they live in the same habitat and are often lumped into the same monitoring programs.

Piping plovers were put on the Endangered Species List in 1986 as threatened, except for certain states where they were listed as endangered (Hecht et al. 2009). This species was listed because of habitat destruction due to water development in places like the Missouri River (Farrell et al. 2018). Man-made reservoirs such as Lake Sakakawea in North Dakota and Lake Oahe in South Dakota flooded potential nesting habitat when they were built, and as floodwaters from the Rocky Mountains flow downstream during the spring and summer, dams are forced to release more water which inundates nests (Farrell et al. 2018). Least terns were listed for similar reasons in 1985. Recovery efforts for piping plovers and least terns include habitat restoration, predator removal, and monitoring programs during their nesting season in the summer, the effects of which will be discussed later.

Another bird that has been affected by the ESA is the northern spotted owl. Northern spotted owls are secretive birds residing in the old growth forests of the Pacific Northwest. Even though they are elusive birds, the controversy surrounding their listing has developed into one of the most bitter standoffs between environmentalists and timber interests in North America (Bonnett and Zimmerman, 1991). This battle stemmed from questions over how much protection should be given to listed species and whether businesses and the economy are being hurt because of the protection given to listed species. The birds were listed as an endangered species by the state of Oregon in 1975 and by the state of Washington in 1988, due to habitat loss because of timber harvest.

They were listed as threatened under the Endangered Species Act in 1990 (Buchanan, 2016). I chose to look at the effects of the ESA on northern spotted owls partially because of the controversy surrounding them, and partially because the birds inhabit a different habitat and area in the United States. The case study for northern spotted owls will also illustrate the possible need for a different view toward the dichotomy of recovered versus not recovered.

The Kirtland's warbler was considered endangered in 1967 and was included in the first list of species protected under the Endangered Species Act (Kelly and DeCapita, 1982). Their case is unique because they have a very restricted breeding distribution; in fact, 85% of the population can be found in five counties in Michigan ("Removing the Kirtland's Warbler," 2018). The small grey and yellow bird was listed because its niche habitat was changing and because of the parasitism of brown-headed cowbirds (Fitzmaurice and Case, 1995). The programs for aiding in the repopulation of the Kirtland's warbler were so successful that the population far surpassed the recovery goal of 1000 breeding pairs and in 2015 there were 2,383 singing males documented ("Removing the Kirtland's Warbler," 2018). There have been proposals to delist the bird, which should be cause for celebration. However, there are concerns about delisting the bird due to the warblers being dependent on human aid. Since the ESA is the main source for management efforts for conservation reliant species, if they are delisted, the support will be withdrawn and in turn, the population might drop again (Bocetti et al. 2012). I chose to analyze Kirtland's warblers because of their specific habitat requirements, small range, and because their case study will support the theory that recovery might best be seen as a spectrum.

Chapter Two: How the Endangered Species Act has affected Bald Eagles

Bald eagles are one of the most recognizable birds in the United States. This may be one reason they were thrust into the spotlight as their numbers plummeted following World War II (Bowerman et al. 1995). The primary cause of the bald eagle's decline was determined to be DDT, a common insecticide used on crops in the mid-1900s ("Post-delisting monitoring plan," 2009). DDT was causing the eggshells of bald eagles and other raptors to become thin and fragile, which led to a very low success rate for hatching and raising chicks. Peregrine falcons and ospreys were also listed, but without the same fame as bald eagles, their recovery stories fell under the radar. After the bald eagle was listed and DDT was banned in the 1970s, the population began to climb again until they were delisted in 2007 (Saalfeld et al. 2009). While the ESA didn't play a part in banning DDT, it did help bald eagles recover after it was introduced in 1973. Bald eagles represent an Endangered Species Act success story and they can now be found in nearly every state except Hawaii.

There are three main factors that negatively affect the bald eagle population: sufficient habitat, human disturbance, and contaminants such as DDT (Bowerman et al. 1995). The surrounding habitat must provide enough food for the eagles and have adequate nesting trees. Humans and bald eagles often want to inhabit the same area. Bald eagles nest near waterways such as rivers or lakes; these are also prime real estate areas, which can cause conflict with humans (Webley, 2007). The ESA reduced this threat by designating critical habitat, acquiring land that is protected so that the eagles have enough food and space to live, and preventing the development of areas where bald eagles have been spotted.

Human disturbance can be an issue in some areas where bald eagles nest since nesting habitat also happens to be where people go to boat, fish, and hike. If the disturbance is too great or people come by too often, the eagle could potentially abandon the nest (personal observation). Once an animal is listed, the ESA prohibits people from disturbing, harassing, or killing the animals. Other precautions such as signs and patrols can help minimize human disturbance. DDT and other environmental contaminants have been an issue for bald eagle productivity since the mid-1900s, but their influence has lessened with the ban of DDT. Since these three things were effectively managed by the Endangered Species Act, the bald eagle population rose in the lower 48 states. Figure 1 shows that in 1963, there were a little over 400 breeding pairs that were successfully raising offspring, but in 2006 that number had risen to 10,000 (Stokstad, 2007).

Fig. 1. Data from state surveys shows the increase in bald eagle population after DDT was banned. Data was not collected for every year (Stokstad, 2007).

The decline of bald eagle populations was first noted in the southern United States, and both studies and recovery programs focused in southern states like Florida, Georgia, and Alabama have produced encouraging results. Researchers discovered that the population of bald eagles in the southeast had dropped dramatically and, pursuant to

the ESA, they developed a conservation program and began restoration efforts involving hacking. Hacking is an ancient falconry technique that was used successfully to restore peregrine falcons and other birds of prey (Simons et al. 1988). It played an important role

Table 1. Data for the eggs that were collected, hatched, and hacked by Simons et al. between 1984 and 1987 (1988).

	Annual breeding season			*Total*	
	84–85	*85–86*	*86–87*	*84–86*	*84–87**
Eggs collected	18	34	35	52	87
Viable eggs**	17	33	32	50	82
% Eggs collected that are viable	94.4	97.1	91.4	96.2	94.3
Chicks hatched	17	30	24	47	71
% Viable eggs that hatched	100.0	90.9	75.0	94.0	86.6
Chicks reared to hacking age	13	28	20	41	61
% Hatched chicks reared to hacking age	76.5	93.3	83.3	87.2	85.9
Chicks that were hacked successfully	12	28	19	40	59
% Hatched chicks that were hacked	70.6	93.3	79.2	85.1	83.1
% Viable eggs resulting in hacked birds	70.5	84.4	59.4	80.0	72.0
% Collected eggs resulting in hacked birds	66.7	82.4	54.3	76.9	67.8

* 1987 was an atypical breeding season in Florida because of unusually warm, wet weather during the incubation period. These conditions apparently fostered the growth of bacteria in the birds' nests and the infection of many developing embryos (Sherrod et al., in press). The result was an abnormally low hatching success in eggs reared both in the wild and in captivity. Therefore, the 84–86 statistics are probably more typical of the results that can be obtained under average conditions.

** Viable eggs are fertile eggs that showed some sign of development.

in reintroducing bald eagles back into regions that they had disappeared from due to habitat loss, human disturbance, and DDT. For this program, eggs were acquired from chosen nests and the nests were monitored to make sure the eagles would "recycle" eggs. Egg recycling occurs when a female loses a clutch of eggs and produces a new one in the same nesting season. In the study by Simons et al. the egg recycling percentage averaged at 78.5%, meaning that most of the eggs that were taken for restoration purposes were replaced by the female bald eagles (1988). Table 1 shows that of the viable eggs that were collected, between 75-100% hatched and that resulted in 59 chicks being hacked

from 1984-1987 (Simons et al. 1988). The study goes on to say that at the time the paper was written, several of those chicks had already been seen migrating back to the area that they were hacked in, meaning that the hacking was successful and that hopefully those birds would establish nests in the area and increase the southeastern bald eagle

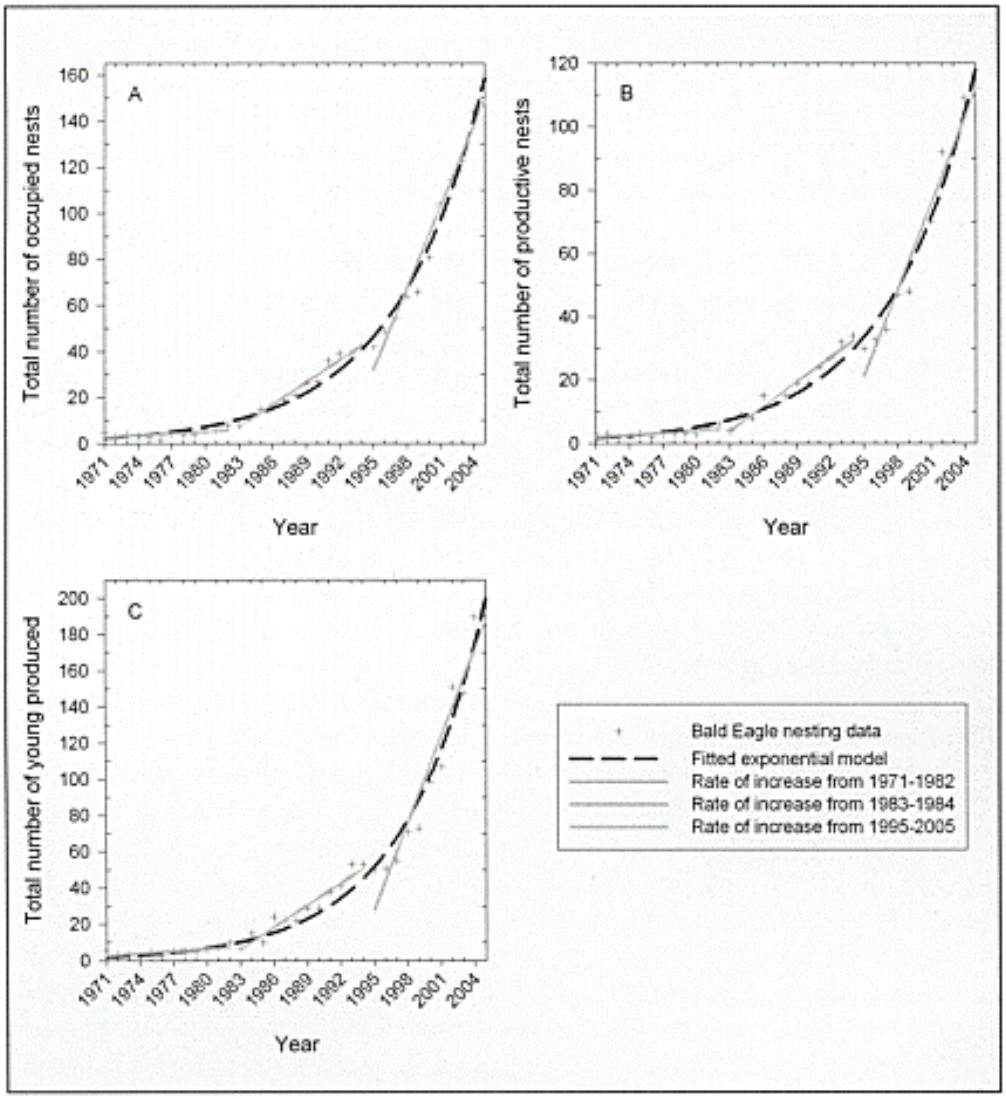


Fig. 2. Total number of occupied nests (A), productive nests (B), and young produced (C) for bald eagles in Texas in 1971-2005, as well as fitted exponential models and rates of increase from 1971-1982, 1983-1994, and 1995 (Saalfeld et al. 2009).

population. The rest of the successfully raised birds dispersed to other areas of the United States and were tracked with radio transmitters (Simons et al. 1988).

Another state that saw a dramatic decrease in bald eagles was Texas. Although bald eagles were delisted in 2007, they were kept on the Texas threatened list since the population in that particular state was still low (Saalfeld et al. 2009). The ESA says that states can implement their own conservation and monitoring programs, and that even after a species has recovered, the states, along with the federal government, should monitor a species to make sure the population doesn't decline again. Section 6 of the ESA describes how individual states can declare a species threatened or endangered so that even if that species isn't protected federally, it can be protected by state programs.

In Texas, studies were done on population, productivity, density, and distribution to track the eagles' recovery progress. By the early 90s it appeared that bald eagle populations had been restored in eastern Texas, and the research done by Saalfeld et al. supports that claim (2009). Figure 2 shows that nesting activity increased exponentially between 1971 and 2005, with nesting activity being defined as the number of active and productive nests that were successfully producing offspring (Saalfeld et al. 2009). Texas saw an increase in the total number of occupied nests, the total number of productive nests, and the total number of young produced. The research team was able to observe 482 bald eagle nests in over 60 counties over the duration of the study (Saalfeld et al. 2009). While bald eagle populations across the country increased after DDT was banned, populations in Texas grew at a higher rate than in other parts of the country. Some speculate this is because either bald eagles had already recovered from DDT poisoning before this study was conducted, or because they weren't greatly affected by DDT in that area of the country (Saalfeld et al. 2009).

The Endangered Species Act protected bald eagles and positively affected their recovery by bringing attention to their needs and the fact that they were declining in the first place. This sparked research opportunities, conservation plans, and state monitoring programs which identified threats to the population and helped the population to increase. Without the ESA to regulate human disturbance and habitat destruction, as well as to implement and organize recovery efforts, it is unlikely the bald eagle would have recovered as fast.

Chapter Three: How the Endangered Species Act has affected Piping Plovers and Least Terns

Since being listed, piping plovers and least terns have been monitored and studied by several different organizations and departments, including the United States Geological Survey (USGS), the U.S. Fish and Wildlife Service (USFWS), and the United States Army Corps of Engineers (USACE).

The relationship that the USACE has with piping plovers and least terns is interesting and unique. Throughout the United States, the USACE is in charge of managing dams and the water levels of reservoirs and rivers. By building dams and reservoirs, humans have changed the geography of many rivers and tributaries, and because the nesting sites of piping plovers and least terns depend on the level of the water, they can be negatively affected if the Corps releases more water than normal (Catlin et al. 2013). However, that can't always be avoided. The Missouri River starts in Montana and cuts through North and South Dakota on its way south. Along the way, it passes through several dams and reservoirs that are managed by the USACE. If Montana gets more snow than usual, then the runoff from the snowpack melting will raise water levels, forcing the Corps to release more water to prevent major flooding. Balancing the needs of people and the needs of listed species is a common theme and one that will be discussed in case studies of other birds as well.

Besides affecting the nesting habitat of shorebirds by controlling the water levels, the USACE, as well as other groups such as Virginia Tech, conduct monitoring programs and surveys of the birds throughout the nesting season ("Least Tern," 2009). These programs operate in accordance with the recovery plan that the ESA requires every listed

species to have. While the USFWS is generally in charge of listed species, the USACE monitors piping plovers and least terns since they work closely with the dams and the level of the river on which the birds nest. They serve to help protect the nests from human impacts and predators and to study the population trends of the birds. Crews monitor the birds from the time they lay eggs around mid-May to the time all of the chicks are fledged, and they are migrating south in early August ("Status of the Species," 2017). The Endangered Species Act discusses the importance of monitoring a species while it is a candidate to be listed, while it is on the list, and even after it has been delisted ("Endangered Species Act as amended," 1982). USACE crew members fulfill that need and monitor the species by finding nest sites and visiting them throughout the nesting season to observe productivity and reproduction.

Both piping plovers and least terns nest on open shorelines, which makes them vulnerable. Sandy beaches attract people for outdoor recreation such as hiking, swimming, and boating. Birds can be flushed from their nests by pedestrians or their dogs, and if the pedestrians aren't aware that they're keeping the birds off of their nests, the eggs can become too hot or too cold, rendering them unviable ("Guidelines for management," 1994). Because the nests are so cryptic, beach users may crush eggs accidentally as well. Since the nests are in the open, they are a target for predators as well. Cages put in place by USACE crew members in accordance with the ESA prevent humans and predators such as gulls, raccoons, coyotes, foxes, and crows from interfering with nests. In the Great Lakes population, using predator exclusion cages increased hatching success to 85% (Hecht et al. 2009).

As well as using cages to exclude predators, USACE crew members also place signs on sandbars with a lot of bird activity and human traffic to alert beach-users to stay off of that particular sand bar. The effectiveness of using the signs has not been quantitatively researched, and in some cases, signs of human activity have been found on sand bars where signs were placed to keep beach-users away. However, it is thought that

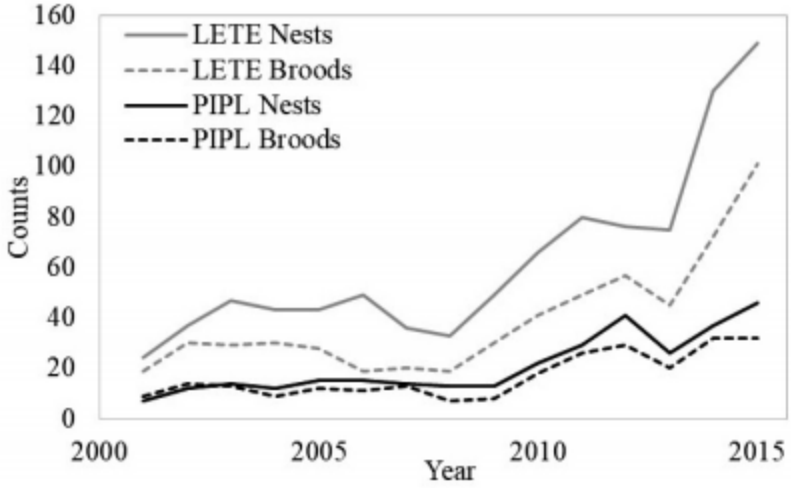


Fig. 3. Yearly brood and nest counts for piping plovers (PIPL) and least terns (LETE) along the Platte River in Nebraska between 2001–2015 (Farrell et al. 2018).

because those sites are regularly monitored by USACE crew members, people seeking to use the beaches for recreational purposes are being discouraged from using them (personal observation).

Another organization that has produced data on piping plover and least tern reproduction is the Platte River Recovery Implementation Program (PRRIP). They used other monitoring and management techniques such as moat-building, tree removal, and herbicide application in order to facilitate better nesting habitat for piping plovers as well as least terns (Farrell et al. 2018). Their study found that overall, nest and brood numbers for both least terns and piping plovers increased on managed sandbars on the Platte river in Nebraska over the course of fifteen years (Fig. 3). This suggests that monitoring and

protection programs being implemented because of the ESA were having a positive effect on the birds. However, because of constantly fluctuating water levels and sandbar sizes, it can be difficult for piping plovers and least terns to find good nesting habitat with the necessary vegetation level and substrate (personal observation).

Some preferred sandbar characteristics found in a study by Faanes (1983) of plovers and terns on the Platte river include a low percentage of woody or herbaceous vegetation, a high percentage of bare ground, and a sandbar length of over 250 meters (Table 2). While there were some similarities on nesting preferences, there were also some differences to note. Least terns preferred areas with a with a greater height above river stage and with a greater depth to moisture. This means least terns prefer higher and drier nesting sites (Faanes, 1983). While they may have preferences that could help their nests survive the influx of water that is common along the river, their nests still get inundated because there is limited habitat to choose from. It's difficult for piping plovers and least terns to find suitable habitat because a sandbar that is above water in the

Table 2. Average values for sandbar and nest characteristics. Number of samples in parentheses (Faanes, 1983).

	Least tern	Piping plover
Sandbar characteristics		
Distance to nearest riverbank (m)	104 (5)	161.9 (28)
Sandbar length (m)	259 (5)	285.9 (28)
Width at nest (m)	58.9 (17)	55.4 (39)
% woody vegetation	9.6 (5)	7.3 (28)
% herbaceous vegetation	18.4 (5)	18.1 (28)
% bare ground	72.05 (5)	74.6 (28)
Nest characteristics		
Height above river stage (cm)	33.0 (9)	19.6 (14)
Depth to moisture (cm)	2.6 (17)	1.0 (39)
Distance to nearest river channel (m)	18.9 (17)	16.4 (39)
Depth of nearest river channel (cm)	30.8 (17)	26.0 (39)
Width of nearest river channel (m)	19.5 (17)	14.1 (39)
Diameter (cm)	1.2 (23)	1.1 (41)
Depth (cm)	0.3 (23)	0.2 (41)

beginning of the summer when they choose their nesting spot may be below water later in the summer, forcing them to produce another clutch.

These characteristics are hard for management programs and the ESA to control. For instance, changing the size or height of a sandbar requires a lot of labor and funds which the ESA may not be able to provide. Additionally, placing sand on top of an already existent bar may negatively affect the foraging habitat of piping plovers ("Status of the Species," 2017). The added sand may smother insects and benthic fauna, which piping plovers rely on for food. Therefore, it's hard to properly help the species to thrive when so many aspects of their survival are difficult for monitoring programs to control.

Overall, population trends for plovers and terns have been increasing since they were listed. Some years were better for nesting than others. For instance, starting in 2005, there was a sharp dip in both populations, which could have been because of weather

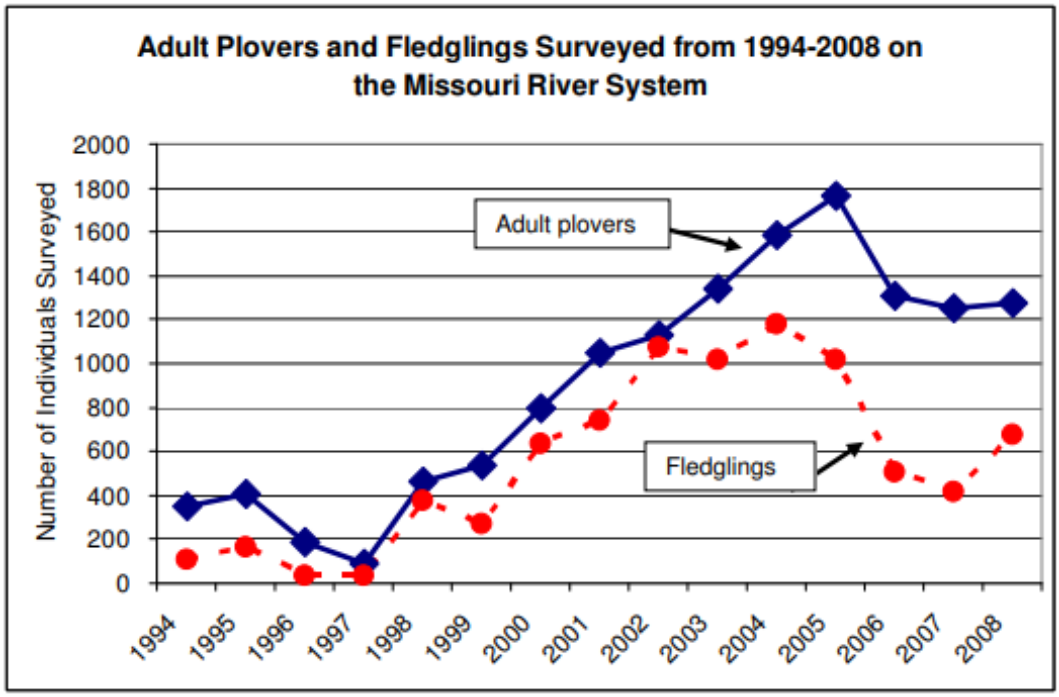


Fig. 4. Number of adult plovers and fledged young counted on the Missouri River system between 1994 and 2008 (Hecht et al. 2009)

events or the temperature, but is likely connected to the amount of water in the reservoirs in the Missouri River system (Hecht et al. 2009). The plovers represented in Figures 4 and 5 account for about half of the entire piping plover population in the United States. One reason the number of adult plovers spotted could have gone up is that the monitoring groups have studied the birds long enough that they know where to find the most birds, and another is that they have new technology such as GPS units and previous data so they can better locate the birds and their nests. However, it is unlikely that these factors could account for such a large increase in the number of birds spotted.

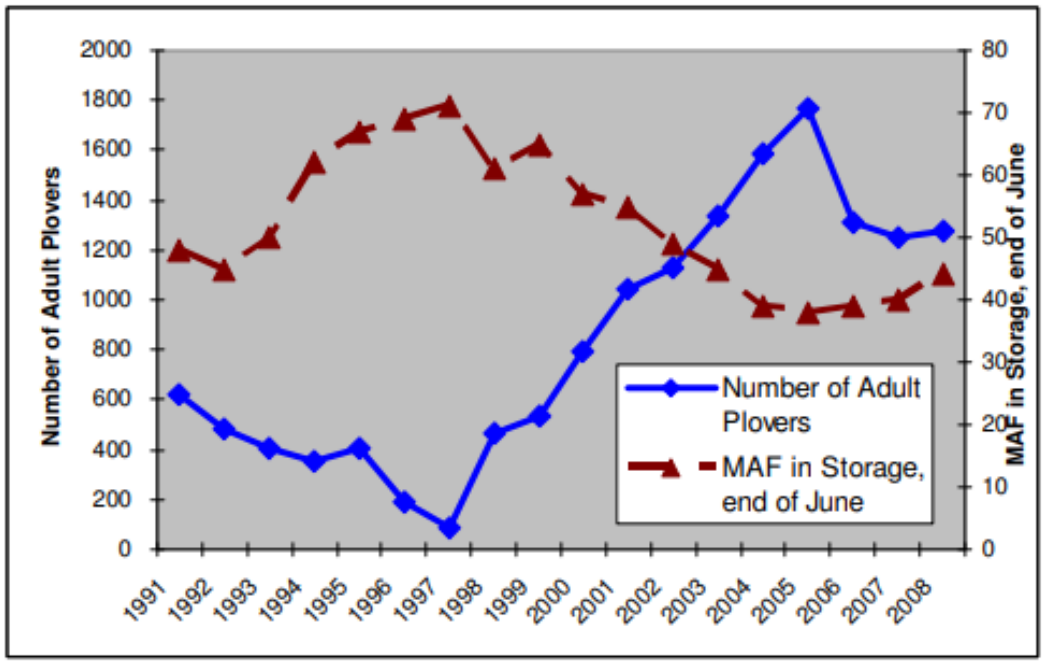


Fig. 5. Amount of water in storage on the Missouri River at the end of June (million-acre feet) and the number of adult plovers counted annually (Hecht et al. 2009).

One major factor that affects the populations of piping plovers is water level. This is shown in Figure 5, which depicts the inverse relationship between adult plovers spotted on the Missouri River system and the amount of water in storage in the system (Hecht et al. 2009). The number of adult plovers reached its lowest point in 1997 when less than 200 individuals were spotted along the Missouri river. This coincides with a near-record

high of water in storage in the same year (in million-acre feet, MAF). Additionally, during 2005-2007 there was a record low of MAF in storage, resulting in an increase in exposed shoreline, which is ideal habitat for piping plovers and least terns. As a result, the number of plovers spotted increased, as did the fledge ratio. At Lake Oahe, the fledge ratio (the number of young able to fly divided by the number of adult pairs) increased from 0.49 to 1.28 (Hecht et al. 2009). The inverse relationship also includes the number of fledged chicks that were found on the Missouri River, and the two factors were consistently related from 1991 to 2008.

This study relates to another research project done by Catlin et al. (2013) which shows how the survival rate of chicks is inversely related to the flow of water in the area. This can be seen in Figure 6. As the flow increases, the daily survival rate of the piping plover chicks decreases. This shows that the survival of plover chicks is linked to the

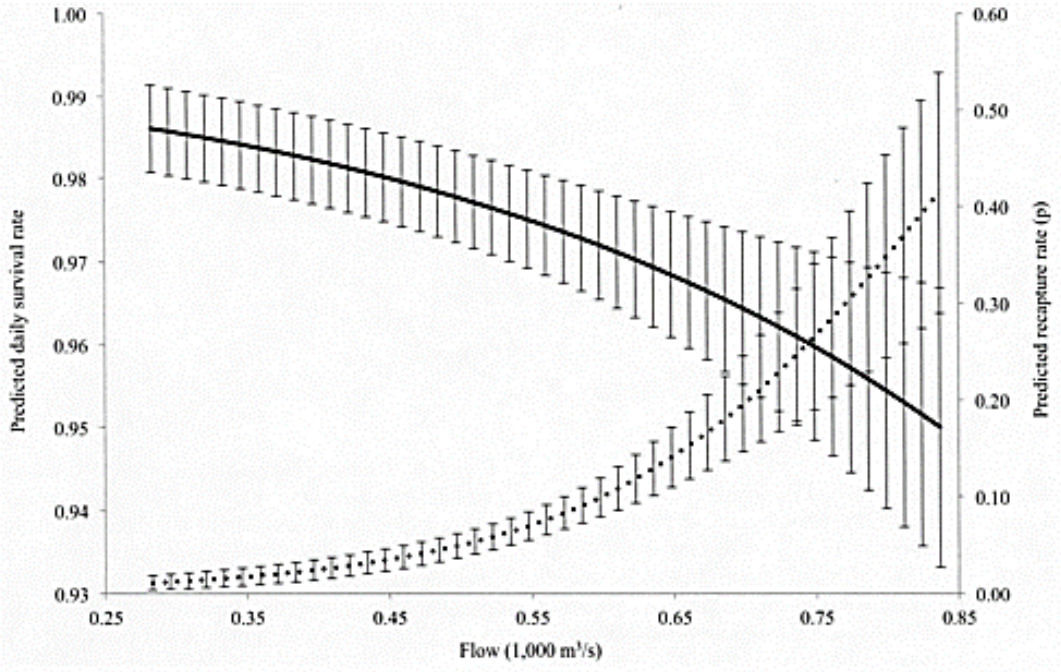


Fig. 6. Average predicted daily survival rates (solid line) and recapture rates (dotted line) for piping plover chicks on the Missouri River relative to river flow from the Gavins Point Dam, 2006–2009 (Catlin et al. 2013).

amount of water moving through the river system. The USACE has to balance the needs of the plovers and terns with the large amount of water moving through the system as the snowpack in Montana melts. This is pursuant to the ESA, which states that the economic harm and impact to a community must be taken into consideration when taking actions to manage or conserve a species ("The Endangered Species Act as amended," 1982). In order to prevent flooding both upstream and downstream, the amount of water being released from each reservoir is carefully monitored so that properties and houses stay flood-free. Occasionally parts of the river flood no matter how meticulously the dams and spillways are maintained, and this affects both humans and shorebirds. Unfortunately, people tend to blame the Corps for favoring wildlife above flood prevention even when that is not the case. This creates more tension between the Corps and the ESA and citizens.

The Endangered Species Act has affected piping plovers and least terns in several ways. By acknowledging that the birds were in need of assistance, the federal government opened the door for management, monitoring, and habitat protection programs to take place. Simply being listed discourages people from harming, killing, or harassing the birds, and people face hefty fines and possible jail time if they are caught doing one of those acts ("The Endangered Species Act as amended," 1982). The act also allows organizations and departments like the United States Fish and Wildlife Service, the United States Geological Survey, and the USACE to study and monitor the birds to make sure their population isn't declining too rapidly. If the population is in peril, those groups are usually the first to begin management efforts to try and recover those species. The ESA has also affected the way that organizations such as the USACE implement

other management efforts, such as flood control. When changing the water level of reservoirs along the Missouri River, they have to weigh the effect that it will have on the birds.

Management programs approved by the ESA have also positively affect piping plovers and least terns by excluding predators from the bars and placing predator exclusion cages over piping plover nests. In some areas, cages have helped raise the hatching success to 85% (Hecht et al. 2009). Signs are also placed by the monitoring crews to discourage people from using those particular sand bars; however, the effectiveness of using the signs hasn't been quantitatively researched. The PRRIP found that nest and brood numbers for both least terns and piping plovers increased on managed sandbars on the Platte river in Nebraska, showing that efforts to aid the plovers and terns were working (Farrell et al. 2018). Population trends have been increasing since the late 1990s but the number of plovers being spotted is inversely related to the amount of water that is in storage in the Missouri river system (Hecht et al. 2009).

Overall the Endangered Species Act has aided piping plovers and least terns by spurring the implementation of monitoring and research programs which in turn increased their populations and their hatching success rates. The effect that certain organizations or departments, such as the USACE or the PRRIP, have had on piping plovers and least terns is easier to measure than the effect that the ESA has had on those two species. This was different from what I originally expected to find. The ESA indirectly affects the birds by controlling which monitoring programs are implemented and by approving or nixing conservation plans. It still positively affects the two bird species, just in a broader and less direct way. While neither species has been delisted,

their populations are on the rise and they are closer to being recovered now than they were when they were first listed.

Chapter Four: How the Endangered Species Act has affected Northern Spotted Owls

Norther spotted owls are secretive birds that nest only in the old-growth forests of the Pacific Northwest. These same forests attract timber companies with their more profitable trees and wood. One cannot examine the plight of northern spotted owls without also examining the plight of timber companies in the Pacific Northwest. Environmentalists and timber companies have been locked in a struggle for rights for decades. On one hand, there are the needs and wellbeing of an endangered species, and on the other, there are the needs and wellbeing of companies and by extension, the economy. Since the owl was listed under the ESA in 1990, there have been legal battles and research done by both sides. Mistakes were made in designating critical habitat for the owl, further complicating the issue. This section will examine how the ESA has affected the owls. It will do so by keeping the interests of both conservationists and timber companies in mind.

According to a 2011 revised recovery plan for the owls done by the United States Fish and Wildlife Service,

> "…the most important range-wide threats to the spotted owl are competition with barred owls, ongoing loss of spotted owl habitat as a result of timber harvest, habitat loss or degradation from stand replacing wildfire and other disturbances, and loss of amount and distribution of spotted owl habitat as a result of past activities and disturbances."

These concerns will be considered in this section as well as ways that the ESA and research groups have sought to combat these threats.

One way the ESA has affected northern spotted owls is by funding research and management programs. The ESA sparks research opportunities by directing attention to a species that is declining. The Cooperative Endangered Species Conservation Fund under section 6 of the ESA provides grants to states and territories to participate in conservation projects and species and habitat conservation actions. Species Recovery Grants, another form of federal funding, can be used for management, monitoring, outreach, and research projects ("NOAA", 2018).

Some of these monitoring programs and research opportunities might involve the take of an endangered species, so they must submit a conservation plan before they can implement their monitoring program according to section 10 of the ESA. Conservation plans are an important part of a species' recovery because they outline the ways in which agencies or other organizations are aiding that species. They also must be approved before monitoring or research can begin which helps the federal government regulate what is being done to an endangered species.

There are a lot of groups that study the northern spotted owl including universities and colleges as well as government-headed groups such as the United States Fish and Wildlife Service, the United States Department of Agriculture, and the Forest Service. These organizations have done extensive research since the owls' listing to determine population trends, reasons that they have become endangered, factors affecting their ability to reproduce, and factors that are keeping the population from growing. Logging companies continue to question the legitimacy of owl research and if it is necessary. These criticisms and the contentious environment push scientists to produce better work

and better-defensible results (Gutiérrez, 2008). Therefore, these studies have trustworthy information that will shed light on how the owl has been affected by the ESA.

Perhaps the greatest effect the ESA has had on northern spotted owls is that its requirements sparked the writing of the Northwest Forest Plan (NWFP), which sought to balance timber harvesting and the needs of the owls (Thomas et al. 2006). The plan was adopted in 1994 and has been successful in stopping harmful actions toward old-growth forests, but it has not been as successful in meeting restoration and economic goals (Thomas et al. 2006). The NWFP was written after conservationists challenged the programs in place to protect the northern spotted owl since its habitat was disappearing.

Noon and McKelvey (1996) state that by 1950 nearly all of the old-growth forests in western Washington and Oregon and northwestern California had been harvested, and the approximately 10% that remained were located on public lands and in parks. This was bad news for the owls, which require old-growth forests to nest in. After the northern spotted owl was listed, measures were taken to protect the forests. In 1989 Congress established the Interagency Scientific Committee which was given the responsibility to develop a conservation plan for the owls (Noon and McKelvey, 1996). Agencies involved include the Forest Service, the Bureau of Land Management, the National Park Service, and the USFWS. States and other interested parties are encouraged by section 2 of the ESA to develop conservation programs.

The ISC came up with a strategy that called for the designation of 2.4 million ha of federal lands as habitat conservation areas. This was in addition to the land that was already set aside for national parks and wilderness areas, a formidable proposition given the sentiments of timber companies in the area. However, section 5 of the ESA clearly

states that land acquisition through purchase, donation, or other means can be used to protect species that are listed. There is no limit to the amount of land that can be acquired. The designation and protection of forests has had an impact on spotted owls, but not as big of an impact as researchers were hoping.

Table 3. Estimated amount of northern spotted owl nesting and roosting habitat, how much land has been harvested, and the total percent loss due to timber harvest ("Revised Recover Plan," 2011).

Land class	Baseline (1994/96[2])	Harvest	Total Percent loss[3]
Federal reserved			
Washington	2,274,200	7,900	0.3%
Oregon	2,699,600	6,100	0.2%
California	1,214,000	2,500	0.2%
Range-wide total	**6,187,800**	**16,500**	**0.3%**
Federal non-reserved			
Washington	470,200	4,800	1.0%
Oregon	1,561,400	23,800	1.5%
California	634,400	8,700	1.4%
Range-wide total	**2,666,000**	**37,300**	**1.4%**
Non-federal			
Washington	1,258,900	234,200	18.6%
Oregon	1,382,400	301,200	21.8%
California	1,556,700	90,200	5.8%
Range-wide total	**4,198,000**	**625,600**	14.9%
Range-wide total	**13,052,000**	**679,400**	**5.2%**

Table 3 ("Revised Recovery Plan," 2011) lists how much potential northern spotted owl habitat was lost because of timber harvest in Washington, Oregon, and California. From 1994 to 2007, the total percent that was lost for the range-wide total was 5.2%. Some individual stats are alarming, such as a 21.8% loss of non-federal land in

Oregon, but overall there is less land being harvested now than there was before the owl was listed.

Table 4 shows that compared to the 0.6% habitat loss from natural causes such as fire, insects and disease on non-federal land, timber harvest still plays a major role in the habitat loss that spotted owls are experiencing. However, range-wide on federal lands, natural causes made up 2.8% of the habitat loss while timber harvest only made up 0.6% between the years of 1994 and 2007 ("Revised Recovery Plan," 2011). Figure 7 shows a map of the spotted owl's range and which parts have been affected by timber harvest,

Table 4. Spotted owl nesting and roosting habitat loss from natural disturbances on non-federal lands ("Revised Recovery Plan," 2011).

State	1994/96 habitat	Fire	Insects and disease	Total	Percent habitat loss[2]
Washington	1,258,900	2,400	6,000	8,400	0.7%
Oregon	1,382,400	5,100	2,700	7,800	0.6%
California	1,556,700	5,600	1,900	7,500	0.4%
Total	4,198,000	13,100	10,600	23,700	0.6%

wildfires, or that haven't been disturbed from 1994 to 2007 (Davis et al. 2011). While it seems like there is quite a bit of habitat, most of the northern spotted owl's range isn't adequate habitat in the first place. That makes the effects of old-growth timber harvest and wildfires even more severe. Several large, condensed sections of red are shown, indicating that fires played a major role in the habitat loss in all states depicted. Timber harvest was more spread out, but it was still prevalent in all three states as well. Vegetation disturbances attributed to insects or disease were not as prevalent as either wildfires or timber harvest. The ESA allows for the acquisition of land and the designation of critical habitat, but neither of those can prevent forest fires. When

designating critical habitat, the Secretary must also consider the economic impact, as stated in section 4 of the ESA. This may prevent some land being designated since timber companies are making money harvesting some of the same forests that northern spotted owls require for nesting. The needs of the owls and the economic interests of the people have to be weighed, causing conflict. While the ESA has caused timber harvesting to decrease in areas that spotted owls are present, it has a harder time regulating natural disturbances such as wildfires, insects, or disease.

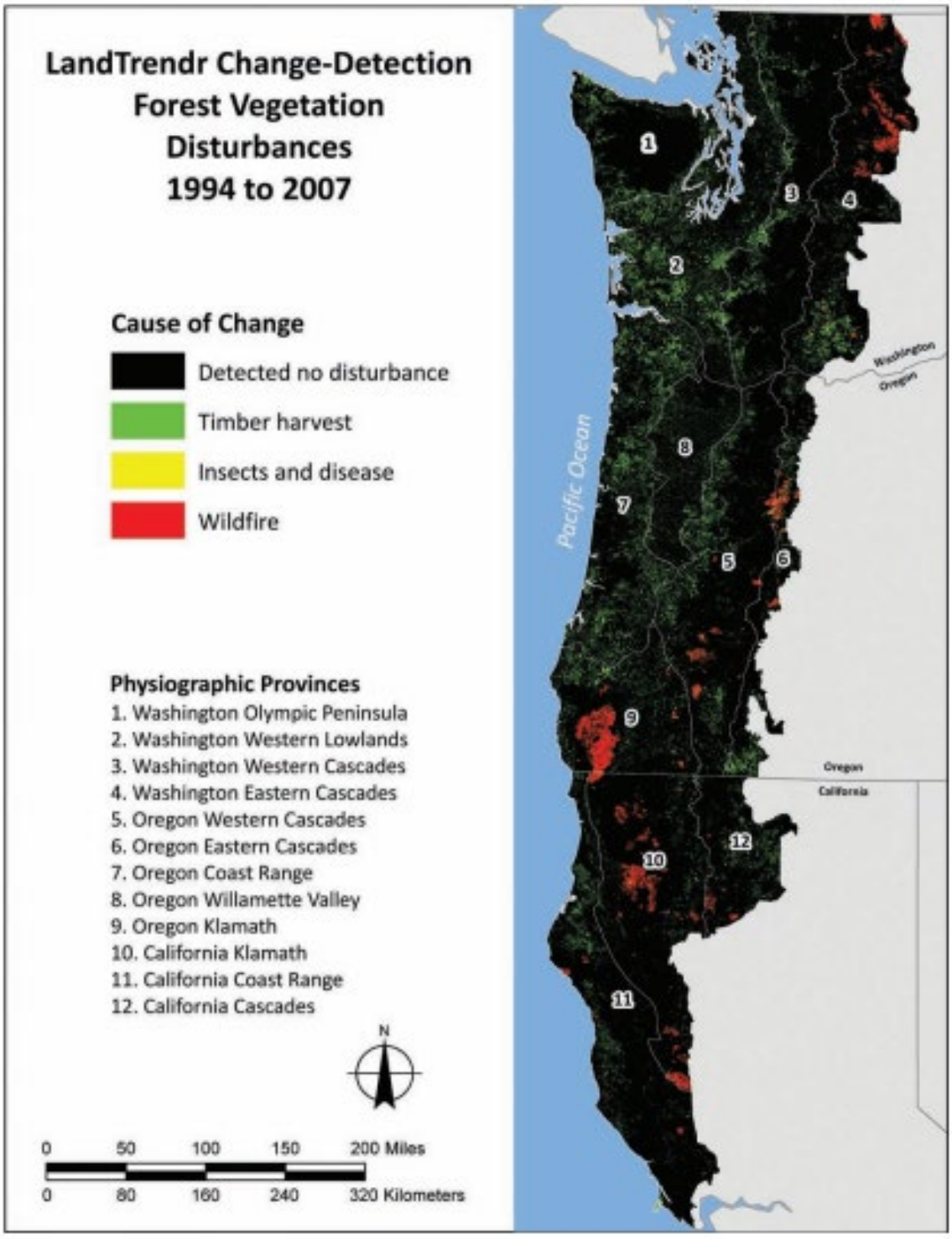


Fig. 7. LandTrendr change-detection data showing vegetation disturbances due to timber harvest, insects and disease, and wildfire, and areas that had no disturbances (Davis et al. 2011).

A threat to the survival of spotted owls that rivals old-growth timber harvest in magnitude and complexity is the barred owl. While the amount and the quality of available habitat is important to the recovery of the species, other emerging issues such as competition with barred owls pose just as much of a threat. It is not exactly understood why or how barred owls are having such a profound effect on northern spotted owls, but an increase in barred owl numbers has been correlated with a decrease in northern spotted owls. According to Davis et al. (2011), the barred owl is now found at high densities throughout the spotted owl's range, and the prevalence of the barred owl was not an issue when the spotted owl was listed. For decades, the barred owl has been expanding its range; it was not historically found in the Pacific Northwest. The presence of barred owls has been linked to a decrease the detection of spotted owls. Buchanan (2016) argues that this is because the barred owl has a competitive advantage; it is not picky about what it eats or its habitat. Figure 8 shows how all throughout the spotted owl's range, barred owls have been detected in areas that they did not inhabit previously (Davis et al. 2011). They have been found in Washington, Oregon, and California in areas where spotted

owls have also been detected. Organizations like the USFWS are attempting to develop removal programs to deal with the barred owl issue in the Pacific Northwest; however, they could require a large, coordinated effort, which may not be possible ("Revised

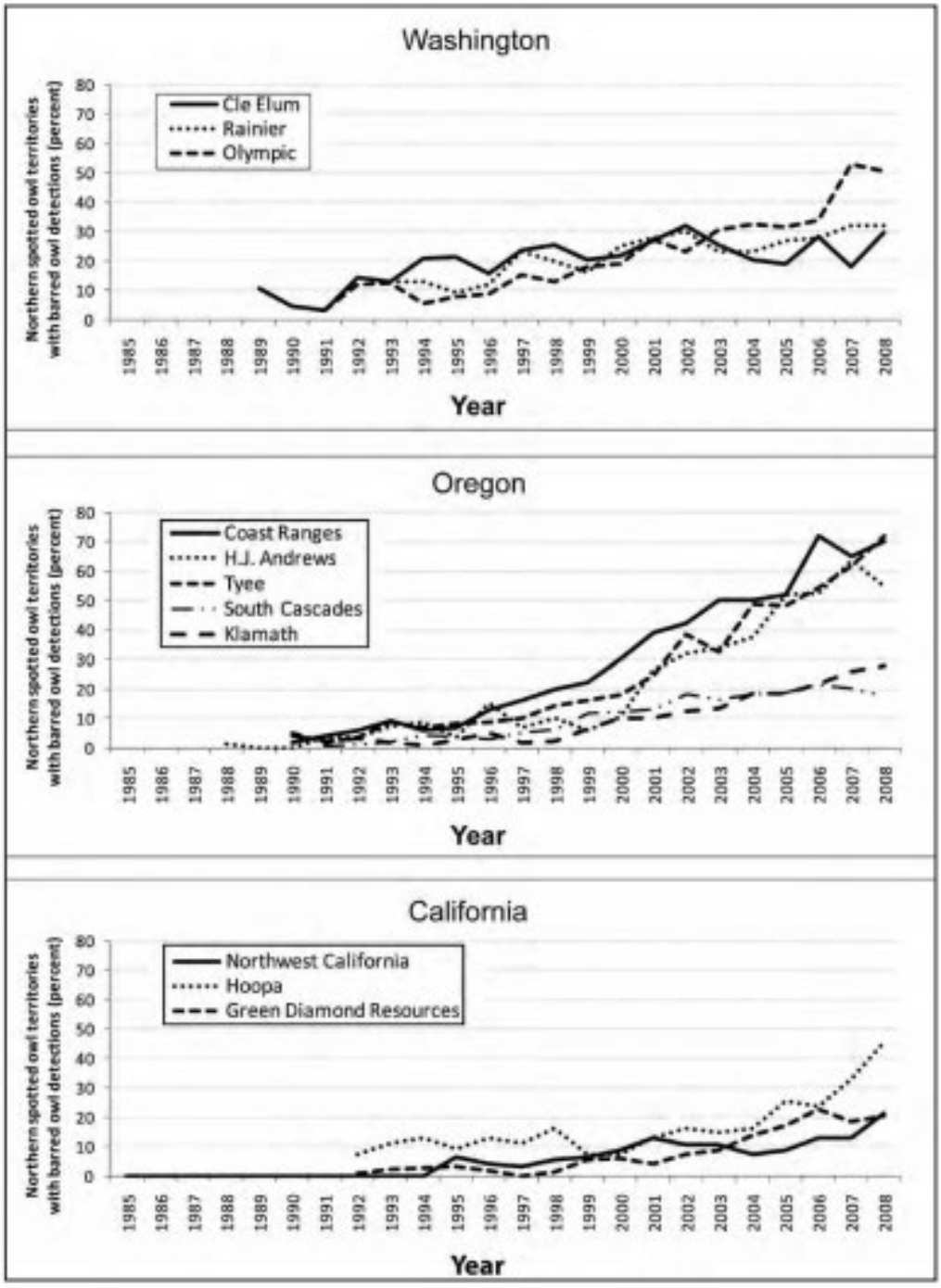


Fig. 8. Annual proportion of northern spotted owl territories where barred owls have also been detected on study areas in Washington, Oregon, and California (Davis et al. 2011).

Recovery Plan," 2011). The ESA does not discuss removal problems for nuisance species or species that are negatively affecting a listed species. Historically, removal programs have been disliked by the public and could result in more negative opinions of the ESA. The difference between removing owls and removing, say, brown-headed cowbirds which caused an issue with Kirtland's warblers, is the scale of the removal program. Kirtland's warblers inhabit a very small range, making it easy to concentrate efforts. Northern spotted owls have a much larger range, and it would be difficult to remove enough barred owls from that range to make a significant difference.

Even though old-growth timber harvest has been greatly reduced on federal lands that have spotted owls, experts still agree that habitat loss is still an issue ("Revised Recovery Plan," 2011). This may be evidence that the owl may have to be listed for a long time before they can fully recover, or that the owls may not be able to fully recover as long as humans are disturbing old-growth forests. The ESA does not limit how long a species can be listed. Other threats to spotted owl survival such as wildfires and the presence of the barred owl are difficult to prevent and even more difficult to recover from. While the Endangered Species Act can be used as leverage to pass legislation that designates more protected land, protection against wildfires and competition from barred owls may be out of its scope and power. The biggest effect the ESA had on northern spotted owls was inspiring the writing of the Northwest Forest Plan, under which management and monitoring programs have taken place (Thomas et al. 2006). Still, since spotted owl populations are declining even with aid from the USFWS and other organizations, it is likely that the population would be suffering heavier losses or perhaps extinction without government intervention. One can therefore say that the spotted owl

has been positively influenced by the Endangered Species Act, even though the population has not fully recovered yet.

Chapter Five: How the Endangered Species Act has affected Kirtland's Warblers

The Kirtland's warbler is unique in that the population is very concentrated and they require specific habitat to breed and nest in. They prefer young stands of jack pine that grow in dense patches punctuated by small openings, and nearly the entire population breeds and nests in only twelve counties in northern Michigan (Kepler et al. 1996, Fitzmaurice and Case, 1995). In fact, 30% of the entire population can be found in Ogemaw county alone. Kirtland's warblers have been spotted periodically in Wisconsin and Ontario since the 1900s, but the sightings are sporadic and no large population has been established in either ("Removing the Kirtland's Warbler," 2018). There were 502 singing males censused in 1951, which dropped to 167 in 1974 and 1987; this was discovered to be in response to a reduction in suitable habitat and an increase of nest parasitism by brown-headed cowbirds (Kepler et al. 1996, Kelly and DeCapita, 1982). When this drastic drop in population was discovered, the bird was listed in 1967 ("Removing the Kirtland's Warbler," 2018). While the small population and habitat size may seem like an obstacle to conservation, they made it easier to concentrate management efforts.

Brown-headed cowbirds are generalist nest parasites and were a major threat to the survival of the Kirtland's warbler. They would lay their eggs in warbler nests, and the warblers would unknowingly take care of the cowbird's offspring, who, once they hatched, would sometimes kick the warbler chicks out of the nest. Warbler parents would also waste resources caring for offspring that weren't their own and not have enough to care for their own chicks. Cowbirds were restricted to short grass plains and in agricultural areas, but they began moving north in the early 1900s when land in Michigan was being cleared for farming and settlement ("Removing the Kirtland's Warbler," 2018).

Fig. 9. Number of fledged chicks per nest (solid line) relative to the percent of nests parasitized by brown-headed cowbirds (dashed line) (Kelly and Decapita, 1982).

A study by Mayfield (1961) showed that nest parasitism was going on several decades before management programs began to remove brown-headed cowbirds from the counties where Kirtland's warblers were present. His research supported the research of Kelly and DeCapita which stated that 59% of warbler nests were affected by parasitism

before the removal program (Figure 9); in Mayfield's study, 55% were affected. He also showed that the number of warbler eggs per nest was reduced when the nest was being parasitized (Table 5). These results show that brown-headed cowbirds were having a negative effect on Kirtland's warblers, and that these birds are particularly prone to nest parasitism.

Table 5. Data showing the effects of brown-headed cowbirds on Kirtland's warbler nests and eggs (Mayfield, 1961).

	Parasitized	Not parasitized
Nests	75	67
Warbler eggs	205	310
Warbler eggs per nest	2.75	4.63
Cowbird eggs	125	0
Cowbird eggs per nest	1.67	0

Mayfield also showed how nest losses are affected by the cowbirds. In parasitized nests, 41% of all eggs laid were removed by cowbirds, and 23% of all eggs laid were removed by cowbirds in all nests (Mayfield, 1961). Those percentages are large enough to make a change in the population number, especially if warbler nests continue facing heavy parasitism for several years in a row. Nestling losses attributed to the presence of cowbird nestlings were also an important part of Mayfield's study. He shows that 31% of nestlings in parasitized nests were lost due to cowbird chicks, and 17% in all nests were lost. Overall, Kirtland's warblers experienced a 78% loss of potential offspring in parasitized nests which was equivalent to a 43% loss in all nests surveyed (Table 6).

Since 1972, the USFWS has implemented a brown-headed cowbird removal program in response to the birds' listing and in accordance with the ESA, resulting in over 33,000 birds being removed from Kirtland's warbler habitat between 1972 and 1981 (Kelly and DeCapita, 1982). The ESA funded programs such as this after it was passed in the 1970s (Kepler et al. 1996). The birds were caught in decoy traps that were spread out

in square-mile increments over several counties in Michigan. Before this program, 59% of nest were parasitized, and after the program began, only 6% were parasitized (Kelly and DeCapita, 1982). As well as a lower parasitism rate, there was a higher rate of fledging warblers. A lower percentage of nest parasitism correlates with a higher number of fledged warblers per nest. This shows that the removal program, which was started because the bird was listed and concern was raised, had a positive effect on the Kirtland's warbler.

Table 6. Results of a study by Mayfield that show how many eggs and nestlings were affected by brown-headed cowbirds (1961).

	In parasitized nests	In all nests, of which 55% were parasitized
Eggs removed by cowbirds	41	23
Hatching loss attributed to presence of cowbird eggs	6	3
Nestling losses attributed to presence of cowbird nestlings	31	17
Total	78	43

The data appear to connect brown-headed cowbirds to the decline of Kirtland's warblers, but do they justify eliminating cowbirds from that area? Controversies over cowbird control have been around ever since the removal program was first implemented, and doubts peaked in the 1990s (Ortega et al. 2005). Cowbirds have long been disdained by humans, who have called them lazy, immoral, social outcasts, and pests. Critics wonder whether the extermination of cowbirds is being fueled by a distaste for this particular bird and not by actual facts. In order to justify taking this many members of a species, researchers should be sure that the species in question is in fact doing substantial damage to the listed species. One species should not have to suffer because the public doesn't like it as much as another species. While there were other factors causing the

decline of the Kirtland's warbler, it is possible that brown-headed cowbirds were focused on first since they appeared to be having such a profound effect on the warblers and because implementing a removal program would be relatively easy.

Another reason that warbler populations were decreasing was the practice of forest fire prevention. While that may seem counterintuitive, Kirtland's warblers prefer young stands of jack pine, ranging from 6-24 years old (Kepler et al. 1996). These patches of young trees separated by small clearings usually develop from somewhat frequent forest fires. Studies show that in Michigan, forest fires occurred around every 30 years, and that the amount of suitable habitat began to decrease as people started practicing forest fire prevention and fire suppression techniques evolved (Kepler et al. 1996). This was especially detrimental to the Kirtland's warbler since their suitable habitat is so limited. The young jack pine stands that they prefer are typically found on a

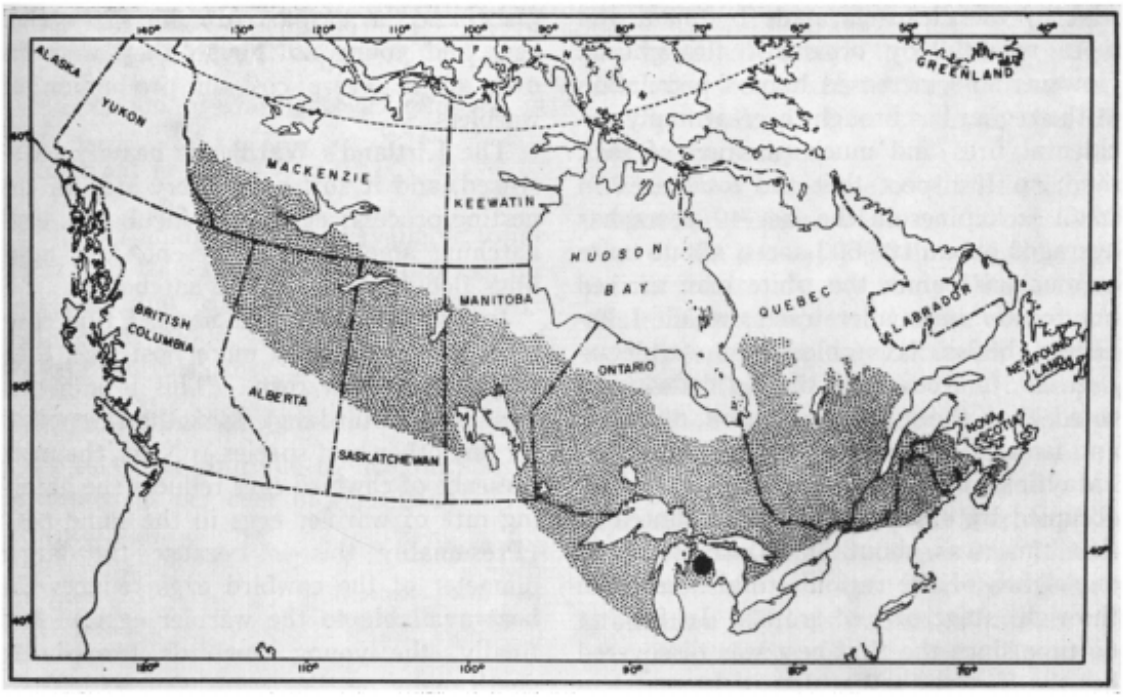


Fig. 10. This map shows the breeding/nesting range of the Kirtland's warbler (black dot) compared to the range of jack pines. This shows how small the Kirtland's warbler range is compared to how large the range of jack pines is (Mayfield, 1961).

specific sandy soil type; those specifications can't be found anywhere else in North America except for northern Michigan. Figure 10 shows that jack pines range from the northern United States all the way through several Canadian provinces. The dot in Michigan shows how restricted the warbler's range is compared to the range of the jack pine (Mayfield, 1961).

The practice of modern fire suppression in the Great Lakes region has changed the landscape and the habitat where Kirtland's warblers live, as well as land use change and loss of forest. Before people began preventing forest fires, the fires happened every 30-60 years and burned about 85,420 hectares (ha) of land ("Removing the Kirtland's Warbler," 2018). This allowed jack pines to flourish, and they made up approximately 53% of the land cover. This also kept the forests relatively young, which was perfect for nesting Kirtland's warblers. Now, jack pines cover only 37% of the land, and fires happen every 775 years and burn only 6,296 ha of land ("Removing the Kirtland's Warbler," 2018).

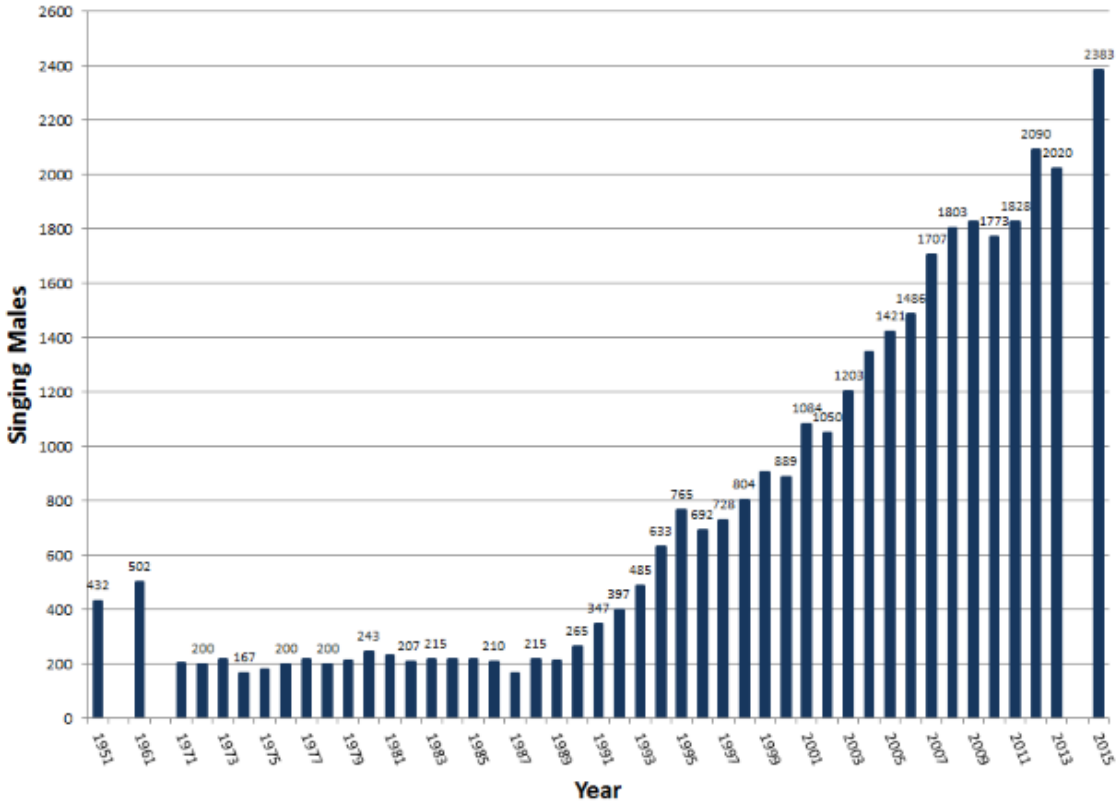
In order to resolve this issue, a group called the Kirtland's Warbler Recovery Team, which was made up of individuals from the USFWS, the United States Forest Service, and the Michigan Department of Natural Resources, gathered after the recovery plan for the bird was passed by the ESA. Basing their habitat management efforts on the recovery plan, they began clear-cutting some sections of forest and replacing those trees with jack pine as well as doing prescribed burns (Fitzmaurice and Case, 1995). However, these management techniques spurred public opposition to the warbler project. Local citizens questioned how effective clear-cutting would be, how these techniques would affect the other local wildlife, and whether they would have effects on the fire safety of

the region. In order to address this issue, the team hired a communications specialist to assess the situation and propose a resolution. They proposed a way to get locals involved in and on board with the recovery process and a way to show the ecological and economical value of the bird. The team invited key members of the community including legislators, the media, and school groups to go on tours to see the birds. They also developed a self-guided auto tour targeted at local residents as well as visitors to the area. The tour explained the goal of conserving the Kirtland's warbler and how it could be beneficial economically and as a tourism asset (Fitzmaurice and Case, 1995).

Bird watchers and environmentalists were happy to see the bird thriving, and locals were positively affected by the influx of visitors and tourism. Giving some management and conservation control to smaller programs could help solve funding issues and hostility toward the federal government control. The recovery of the Kirtland's warbler shows how conservation programs can benefit both the listed species and the community near it economically and through educational means. It also shows that some of the negative views of the ESA could be changed by educating the public, involving them in the recovery process, and finding solutions that benefit the communities affected by the ESA. By creating meaningful ways of conveying information about the bird, the team was able to increase the effectiveness and the positive attitude toward their management efforts.

In 2018, the Kirtland's warbler population had grown so much that officials proposed to delist the bird, showing that the ESA was having a positive effect on the species. The species would be considered for recovery when they had a self-sustaining population of at least 1,000 pairs. Figure 11 shows that in 2015, 2,383 singing males were

Fig. 11. The number of singing male Kirtland's warblers has risen from around 200 in the 1970s to over 2,300 in 2015 ("Removing the Kirtland's Warbler," 2018).



censused, suggesting that the number of pairs was well above the minimum mark ("Removing the Kirtland's Warbler," 2018). The USFWS determined that the two main threats to the birds' population—brown-headed cowbirds and habitat loss—had been addressed and that the bird could live without support ("Removing the Kirtland's Warbler," 2018). Following this announcement, they let the public comment on their proposal and they published the proposal along with a lot of research that had been done

on the birds in the last 50 years. However, some researchers like Scott et al. (2005) suggest that the Kirtland's warbler may never be able to fully recover since they require prescribed burns in lieu of the naturally occurring forest fires that humans are suppressing, as well as constant removal of cowbirds in the area. If this is the case, does that mean that the Kirtland's warbler is a lost cause? Does it mean that conservation efforts should stop since they will never fully recover? Or does this mean that researchers and the government should change their view of the meaning of "recovered"?

As of January of 2019, the Kirtland's warbler is still on the Endangered Species List, causing some to wonder if the ESA is effective. How can it be effective if species with a seemingly healthy population can't be taken off of it? Scott et al. (2005) address this issue by proposing that researchers and the public view recovery as a continuum rather than recovered vs. not recovered. Their article points out that as climate change, human impacts, and threats from invasive species rise, the number of threatened and endangered species as well as conservation-reliant species is likely to increase. It is difficult to manage all aspects of conservation for one species, let alone the thousands that are listed. By viewing recovery as a spectrum, conservationists may be better able to allocate funds and efforts to certain species.

Chapter Six: Is the Endangered Species Act Still Effective?

My conclusion should be prefaced with a few statements. The results and conclusions I drew from my study was not what I had expected when I began structuring and writing this thesis. Over the course of the paper, my opinions were challenged, and some changed. I hypothesized that the ESA had large, direct impacts on birds in the United States. After reading the case studies, I still believe that the ESA affected threatened and endangered birds, but in a different way than I originally thought. It affects birds indirectly and on a broader scale. Instead of specifically managing each species, it gives outlines of actions that can be taken, and it is often up to other agencies and organizations, such as the USFWS, state programs, or other conservation plans and management programs to directly work with the species. It is more overarching and acts more of a guideline than a precise and detailed plan.

Even though the Endangered Species Act has been in effect since the 1970s, very few of the bird species that have been listed have recovered. The bald eagle was delisted, and the Kirtland's warbler was proposed to be delisted, indicating that their populations have recovered significantly since they were first listed. Least terns, piping plovers, and northern spotted owls, however, have not recovered as much. In fact, the northern spotted owl fecundity and survival may even be declining in some areas (Davis et al. 2011). What does this say about how the Endangered Species Act is affecting birds in North America?

One issue is that after the ESA was passed, it lost bipartisan support. Conflicting interests caused the two parties to split on environmental issues. Money and the economy are two main dividers. Compromises include cutting funding to the ESA or determining

ways that the money can be spent. However, these compromises force the USFWS to prioritize spending on certain species since there isn't enough funding to focus adequate funding toward all species. Of the avian species listed, a few that were facing only moderate threats received over 50% of the funding; these species were usually distributed widely, had the most recovery potential, and some had captive breeding programs (Restani and Marzluff, 2001). Funding was not based on which species were facing the most threats to their survival. This is one reason that some bird species may be recovering faster than others.

Another factor affecting which species recover and which don't is the type of threat that is causing the species to decline. The bald eagle population was suffering primarily because of DDT pollution, and the Kirtland's warbler population was suffering because of lack of habitat and competition from brown-headed cowbirds. These threats were relatively easy to combat because DDT could be banned and there were other options available for farmers, the Kirtland's warbler range is very small and it was easy to concentrate efforts to create new habitat and remove cowbirds from that area. Least terns, piping plovers, and northern spotted owls are threatened by large-scale issues like habitat reduction. There is also a conflict of interest between human wants/needs and the needs of the birds. Dams along the Missouri River create lakes for recreation and regulate the flow of water. Unfortunately, that means that there are many years when there is a lot of snowpack upriver that causes high water levels downstream, flooding the nests of least terns and piping plovers. In order to keep houses along the river from flooding, moderately high levels of water are released over the summer, reducing nesting habitat for the entire nesting season. In the case of northern spotted owls, conservationists must

compromise with timber companies in the Pacific Northwest to determine who gets the prime nesting habitat for the owls. Because their range is larger, it is harder to trap barred owls who are competing with the northern spotted owls for food and habitat. Some species that haven't recovered yet are facing threats that are harder to combat than the threats of recovering species.

The ultimate goal of the ESA is "the recovery of endangered and threatened species and their ecosystems, so they no longer need the conservation measures afforded them under the act", but another goal is to simply prevent extinction (Abbitt and Scott, 2001). In this capacity, the act has excelled. Recovery outnumbers extinction 2 to 1, and of the 107 taxa that were reported to go extinct between 1973 and 1994, 79%, or 85 species, were never given the protection of the Endangered Species Act (Schwartz, 2008). Comparatively, only 23 species out of over 1,500 that have been listed had their last known occurrence while listed, suggesting that the act positively affects species and prevents or slows down extinction. Schwartz states in his article that some estimates say that during the first thirty years of its existence, the ESA may have saved as many as 227 species from extinction. Three times as many species have moved toward recovery compared to those that moved toward extinction while listed (Schwartz, 2008). Many species have also stayed at the same listing status, potentially because listing helped the population to stabilize instead of decrease. Perhaps instead of proving that the ESA is a failure, the fact that many species are listed and need to stay listed shows the importance of this law. It is a barrier against extinction (Doremus and Pagel, 2001). Instead of using just delisting as a form of evaluation, species saved from extinction could also be used, as well as how many species have changed listing status toward recovery.

Some species have not been delisted because researchers and conservationists fear that a lack of protection could cause the species' population to decline again. If a mistake is made and a species declines too rapidly after delisting, that species could go extinct. It is also costly to relist a species; some estimates claim average costs of $60,000 to list a species (Doremus and Pagel, 2001). While it is costly to list a species, keeping a species on the list shouldn't impede economic progress since the ESA only prohibits projects that might cause extinction. Section 7 states that federal agencies must consider the effects of their actions on listed species, but it forbids only actions that may jeopardize the species' continued existence. Between 1987 and 1994 only 54 projects out of nearly 100,000 consultations were blocked by the ESA. (Doremus and Pagel, 2001). Some critics still use the low number of recovered species to show the ineffectiveness of the ESA and, feeling pressured to boost public opinion of the ESA, conservationists push to delist more species. However, delisting could harm species if they're not recovered enough and delisting a species won't save money. If a species is delisted, they often have to be monitored for another five years in order to evaluate the effects of delisting (Doremus and Pagel, 2001). While delisting may be a goal of the ESA, it is possible that it should not be the only goal.

How can attitudes toward the ESA be changed? Should the ESA itself be changed since our attitudes toward species conservation are shifting? How could it be changed or interpreted to promote bipartisan agreement? Contention surrounding the ESA could be in part due to the tendency of humans to seek self-preservation. The ESA puts the existence of a species above the economic interests of humans, which in some ways is necessary but in other ways creates a moral struggle. Heinen suggests that if a social

community being affected by the ESA is small, if the plight of the species is perceived as urgent, and if the people of the community aren't affected economically by a proposed solution, conservation efforts are usually much more effective (1995). Using this information when developing management plans could help increase effectiveness. There may also be more than one way to solve an environmental issue. For instance, solutions that involve social incentives are effective in managing some species, but in other situations, economic incentives were more effective (Heinen, 1995). This was demonstrated in the Kirtland's warbler case study by the Kirtland's Warbler Recovery Team and their solution to local discontent over the management program. Programs need to be dynamic and adjust to the social climate and the area the program is taking place in.

Other issues with the ESA are: currently, the act is best used for protecting large vertebrates; habitat is not protected adequately to allow for species recovery; and there aren't clearly defined criteria that designate what is endangered, threatened, or recovered (Heinen, 1995). Large vertebrates are typically high-profile animals; the public recognizes them, and they are well-known. Funds have been divided unequally with most of the money going to single-species conservation instead of a broader, overarching ecosystem approach (Rohlf, 1991). These may be reasons that the ESA is not performing as well as conservationists had hoped.

Some of these issues will not be easy to fix. Defining "endangered" and "threatened" may take a lot of debates, since there are different ideas on what these terms mean. Protecting habitat may not be as simple as designating protected areas. Some areas, such as the sandbars that plovers and terns nest on and the old-growth forests of the

Pacific Northwest leave little room for compromise. Either the sandbars flood or they don't; either the old-growth trees are cut down or they aren't. However, completely protecting these habitats creates issues for humans. If no old-growth forests can be harvested, timber companies may lose a large portion of potential income. If no spillways or flood gates along the Missouri River are opened, all the reservoirs will overflow, putting homes and landowners at risk.

There are a few habitat protection strategies that could be used more often. One example of this is monitored grazing. This means letting cattle graze but monitoring the cattle throughout the whole grazing season, leading them away from sensitive habitat like wetlands and into better grazing areas (Sidle, 2005). This benefits both the ranchers and the environment. The cattle are led to more robust grazing areas, leading to healthier animals and better-tasting beef. Wetlands and sage grouse habitat could be protected from trampling, as well as piping plover and least tern habitat along the Missouri River, and the human presence would deter wolf predation in the west, protecting the wolves from being shot and the cattle from being eaten. This is an example of moving away from federal programs and making it a more personal conservation effort. Since it benefits the ranchers personally and the money used to pay for extra help is theoretically offset by the money gained from less cattle loss and higher quality beef, they are more likely to participate in conserving a species. If more programs like this could be implemented, both people and the environment would benefit. However, currently the ESA doesn't outline or suggest any programs like this.

The ESA might be viewed more positively if it could be tailored to each community's needs and each species' needs. The United States tends to value the rights

of an individual over the common good. This can be seen in the bald eagle and northern spotted owl case studies; private property owners can affect how the ESA is implemented. One way to address this is to give state and local governments more say in how federal funding gets used when it comes to implementing recovery plans and conservation efforts. According to Heinen, many state programs work with federal agencies but have more freedom and the ability to tailor programs to specific needs on a smaller scale (1995). If given the opportunity, states could provide wider protection for more species since many already have endangered species programs in place and some may have more freedom in finding funding for these programs (Heinen, 1995). These sort of conservation efforts would be effective for species like the bald eagle which have a wide range, so the recovery plan might have to look different in different states. It would also be effective for species like the Kirtland's warbler whose population is confined to a couple counties in one state.

Giving that state more say in how they were going to manage that species would potentially ease conflicts by letting states tailor the recovery plans to the needs of the species in that area as well as the needs of local people. There are many non-governmental programs and organizations that could work alongside individual states to protect species, and because they would be working at a much smaller scale than the federal government, they could respond to changing needs faster and more effectively. By dividing funds and effort between state and local governments and the federal government, the workload could be shared, and the states could more effectively deal with local changes. This is, of course, assuming that the state and local governments actually do something about the listed species in their area. Requiring state and local

management programs but letting the states decide how to implement them may be another option.

Even though there are suggestions to improve the way the ESA operates, delisting is the only goal and the only measure of effectiveness, then the ESA will always be seen by critics as a failure. Humans have impacted the environment with such magnitude and at such a high pace that substantial progress in the recovery and delisting of species is very unlikely (Scott et al. 2005). Recovery should be viewed as a spectrum or continuum instead of a recovered vs. not recovered dichotomy. The improvement of a species' population or the prevention of a species' extinction should be celebrated just as much as its full recovery and should be used to show the effectiveness of the ESA. It may also be necessary to add active management to the definition of "recovery" since some species like the Kirtland's warbler may be conservation-reliant species (Scott et al. 2005).

Other mindsets that may need to change is the notion that individual rights trump the common good, and that the only good solution is one that is short-term with immediate and obvious benefits. It may not be possible to completely reconcile with individuals who disagree with the ESA. The economy or the American people may have to make some sacrifices in order to save certain species, and we will have to accept some limits, or we will continue to push species to extinction. This doesn't mean that the economy will crumble or that individuals will no longer be able to develop their properties. There are solutions that can minimize the impact on the economy or private property owners. However, in order for the ESA in order to work, it must be allowed to do what it was designed to do: protect plant and animal species so that the ecosystem isn't damaged and so the American people can continue to enjoy those species.

The Endangered Species Act has done a lot to prevent the extinction of species and to bring some species to recovery in the 40 years that it has been in effect. Although it is a controversial law, it is undisputedly one of the strongest pieces of environmental legislation in the United States. It has positively affected bird species in the United States by providing funding to recovery and conservation programs, protecting them from harm and harassment, opening the door for research, management, and conservation, designating critical and protected habitat, and by raising awareness of the plight of endangered species. Without it, birds like the bald eagle or the Kirtland's warbler may not have made such a huge comeback or they may not have recovered at all since animals that aren't listed are not as likely to receive aid or protection. Other species such as the northern spotted owl, piping plover, and least tern may have had a steeper decline in population. Preserving these bird species protects biodiversity and important environmental indicators. DDT may not have been found to be harmful if a well-known species like the bald eagle hadn't been negatively impacted by it, and other species could have been harmed or gone extinct. While the ESA isn't perfect, it provides a barrier of protection for sensitive species in the United States, and with proper conservation plans and management efforts, it could be used to save birds and other species while minimizing the negative impacts on the economy or the American people.

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