

# The Importance of Preserving Birds and Their Habitats at Hanford Site and Oak Ridge Reservation: Information and Communication Tools for Governments, Local and Diverse Communities and Others

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## ABSTRACT

The Department of Energy (DOE) has one of the largest environmental remediation tasks in the world, cleaning up the radiologic and toxic contamination legacy of nuclear weapons production. DOE has committed itself to accomplish remediation “while protecting human health and the environment”. Many DOE sites are huge, encompassing habitats that are ecologically valuable because they have been protected from human disturbance for 70 years or more. Yet information on the importance of DOE lands for protecting specific ecological resources is often buried in volumes of data. In this paper, we examine the importance of DOE lands as habitats for birds using two sites as examples: the Hanford Site and Oak Ridge Reservation. Our overall goal was to provide a model for communication of key information useful for the public and decision-makers. Birds are conspicuous and familiar features of the landscape, and bird populations are important indicators of habitat quality. As future land use plans evolve, birds can convey important messages about habitat uniqueness and conservation importance and recreational values of designating DOE land for conservation, but only if they are in accessible formats. At the semi-arid Hanford site, shrub-steppe is an important habitat outside the Columbia River corridor. At the wet Oak Ridge Reservation eastern deciduous forest, interior forest is a particularly important habitat. There are different groups of bird species dependent on each habitat. We use two methods for each habitat: 1) a comparison of historical written records and 2) a comparison of land use/land

cover data. Habitat loss through development, fragmentation, and degradation is one of the most important causes of avian decline. Importantly, we present the data in a manner suitable for discussion among diverse audiences regarding future use of sites now undergoing remediation. The Hanford Site has recorded 205 bird species, including shrub-steppe species of regional importance. The Oak Ridge Reservation has recorded 213 species of birds, including Neotropical migrants of international concern. In both cases, their respective habitat is key to protection of the unique avian assemblages, and there is a higher percentage of these habitats on the DOE lands than in the surrounding habitats. Our analysis also concludes that these habitats that are of high importance to the rare and declining avian assemblages are mostly increasing on the DOE sites as the once agrarian landscape has reverted to more natural habitat. Since acquisition, DOE has developed about 10% of the land for nuclear and industrial activities, leaving the rest of it as a security buffer for the nuclear production mission. The tables provided in this manuscript can serve as valuable tools in communicating the importance of these lands and protecting these lands for surrounding communities. We commend the DOE for its protection of ecological resources for the regions and the Nation, applaud their mechanisms for ecological protection, and recommend that more of each site's respective unique and important habitats be designated as preserved in perpetuity as valued ecological resources. This designation entails communicating *with* Tribes, communities, government agencies and organizations, and the public about the ecological value of their protected lands.

## 1. INTRODUCTION

One environmental issue of great significance facing the world is cleaning up chemical and radiological wastes that remain from World War II, the Cold War nuclear productions, and past industrial activities. Protecting human health and the environment is important to Tribal, Federal, and State governments; non-governmental agencies; and the public [1-3]. In the United States, and elsewhere in the world, the agencies tasked with the cleanup tasks are each country's departments of defense, energy, and environment. In the U.S., it is the Department of Energy [4, 5] and the Department of Defense [6, 7] that face the greatest environmental cleanup, largely because of the presence of both nuclear and chemical wastes; the long period of research, development and manufacturing; and the extensive size of the industrial and nuclear facilities. The Department of Energy (DOE) was engaged in development, production, and testing of nuclear weapons until the end of the Cold War in 1989. Only about 10% of lands on the large DOE sites were industrialized; the rest was left as a buffer for security reasons, especially during the Cold War [8]. Now, however, the largely uncontaminated 90% of the land as well has become of interest to site neighbors, the local Tribes and the public, as well as U.S. governmental agencies and other groups.

Because much of the DOE lands were left undisturbed for 70 years or more, the lands have undergone succession and reverted to native ecosystems [9]. Some of the Department of Energy sites have some of the most valuable habitats in their regions [10-13]. This importance was recognized early on when the U.S. Congress declared some of the land on major DOE sites as National Environmental Research Parks (NERP) [14]. The land was to be used for research generally (e.g., long-term population trends, unique or rare plant communities); to determine the effect of their weapons' production activities (and contaminant levels and physical effects); and for protection of ecological resources (e.g., species declines, effects of humans).

The value of most ecological resources depends on the plant communities, which in themselves are dependent upon the geology, geography, and climate [15]. Within these constraints, the ecosystem that is

present is largely a result of natural and anthropogenic activities, and of the historical and current conditions. That is, each area has a usual climax community of specific plants (e.g., deciduous forest, coniferous forest, shrub-steppe, grassland, desert). Natural events (e.g., floods, hurricanes, tornados); anthropogenic events (e.g., clear-cutting, development, soil removal); or a combination (fires, disease, invasive species) can set back succession to earlier stages [15-17]. All successional stages, however, are valuable ecologically. Although most of the large DOE sites had significant areas that were designated as NERPs in the mid-1990s, the public was less aware of the research being conducted, or the ecological value of the NERP lands.

In this paper, we examine the importance of DOE lands as habitat for birds using two sites: the Hanford Site and Oak Ridge Reservation. Birds are familiar and conspicuous wildlife that can help DOE convey messages about their protected habitats. Our goal was to present data that can serve as a model for communication within and among DOE, other agencies and organizations, Tribes, and diverse communities surrounding these sites. These sites were chosen because they have very different ecological conditions: the Hanford Site is semi-arid shrub-steppe and the Oak Ridge Reservation is wet, eastern deciduous/coniferous forest. Further, Oak Ridge Reservation has on-going research, development and national security missions, while Hanford's primary mission is to clean up contamination from past activities. We use two methods for each: 1) a comparison of historical written records and 2) a comparison of current land use/land cover data. Habitat loss, fragmentation, and degradation are among the most important causes of avian decline [15, 18]. The world, in general, is seeing an age of mass extinctions, and birds are no exception [19-21]. Local extinctions occur as well, for example, fires on the Hanford Site shrub-steppe caused or contributed to the disappearance of the Sage Grouse from the Hanford Site [22]. Stopping avian declines and protecting species will depend in part upon public support. We present the data in a manner suitable for discussion and decision-making by locally diverse communities (as well as Federal and Tribal governmental agencies).

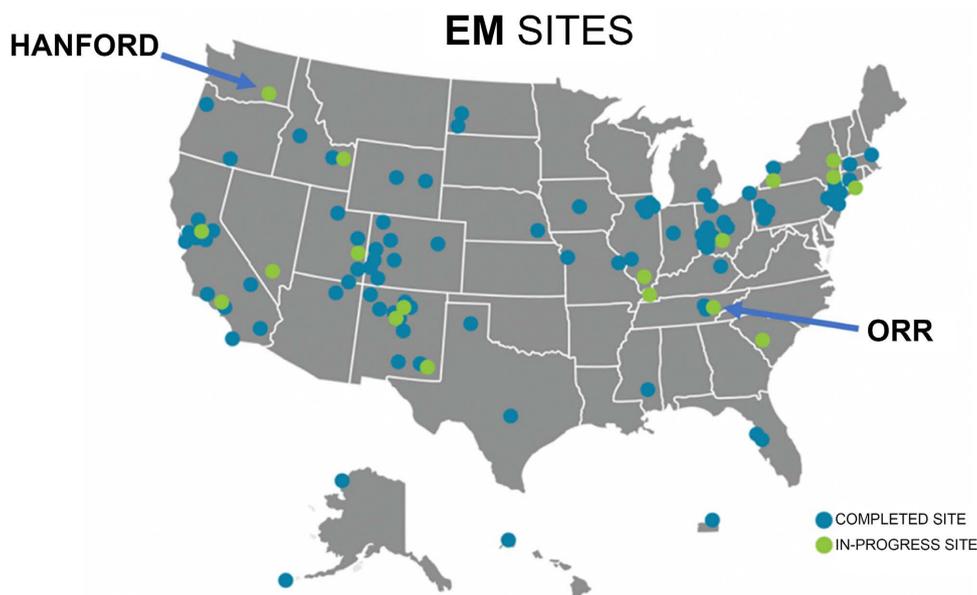
Developing information to protect ecological resources, in this case birds, that can be used to make science-based decisions is critical to developing and implementing cleanup and restoration [16, 17]. Partly these decisions have been made to harmonize remedies with future land use uses and institutional controls [23-24]. It quickly became quite clear that making science- and risk-based decisions required input from stakeholders at all levels, including other governmental agencies, Tribal Nations, and many others [25-27]. For radionuclides and chemicals that pose a threat to human health, neighboring communities are somewhat aware of potential human health risks, which often are limited to specific on-site exposure pathways that are used for regulatory risk assessment. Once exposure pathways are identified, mitigation measures are put in place to prevent exposure. For individuals, historic potential exposure is a matter of the cumulative risks, and generally, of health disparities faced by racial and ethnic communities have been identified [27, 28]. Native Americans and minority communities living right next to chemical plants are often aware of their risks from site activities but may be less aware of the risks faced by eco-receptors, such as fragmentation of habitat [29, 30]. Community members, however, may be unaware of the value of particular ecological resources on contaminated sites that warrant protection. Multi-directional discussions and dialogues are essential to foster protection for these resources. Protection of ecological resources on contaminated sites requires the recognition of community experiences, knowledge, norms, beliefs, and values [29-33].

This paper aims to both provide information about the ecological value of habitats on DOE lands for birds, and to provide graphics that can foster discussions and exchange of information among and within diverse individuals and communities whose inclusion would improve the decision-making process regarding future land use and lead to better, more cost-effective remediation decisions [16, 34]. We use two DOE sites as case studies. The tables and graphics provide an information matrix that can be used with a variety of ecological issues to quickly provide governmental agencies and the public with information to make sound science-based decisions, as well as suggesting areas for further exploration. Local and diverse communities can then provide information and discussion about environmental restoration and cleanup, increasing multi-dimensional communication.

## 2. APPROACHES AND METHODS

Our overall approach involved an in-depth evaluation of ecological resources on the Oak Ridge Reservation and the Hanford Site from our own work and published documents [35-39]. DOE is conducting environmental management on both sites, remediating radiologic and chemical contamination left from the production of nuclear weapons (1940s through 1980s). **Figure 1** shows the distribution of the sites involved in DOE's Environmental Management or "cleanup" and the location of Oak Ridge and Hanford. Data in this paper were obtained as part of site-wide risk evaluations by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) of both sites for areas and facilities still requiring remediation. Details on data and analyses are available elsewhere [35-38]. However, herein we describe the main avian species of conservation concern at the Hanford Site and Oak Ridge Reservation from our research as part of the site-wide risk evaluations. We describe briefly the critical habitat for avian groups at risk and present data on land use and land change at both sites to illustrate the importance of each of these habitats to the protection of rare and vulnerable birds. Remediation activities at both sites are ongoing and could enhance or degrade habitats. Avian species lists were obtained from the relevant site Environmental Reports [39, 40] and other tables [41, 42].

Our assessment of critical habitat for birds included using: 1) historical records and literature to determine land cover changes and 2) National Land Cover Database (NLCD) [43]. The NLCD [43] was used to compare the amount (and percent) of several types of land use types with a buffer area of 10 km around the current ORR site boundaries and with an area 30 km around the current ORR boundaries. There are fifteen or more land cover types that are depicted in the NLCD [43] databases for different regions of the U.S. We combined some categories to form a clearer picture of habitats. Thus, we combined all the anthropogenically developed land cover types into one developed category; all the forest types (deciduous, coniferous) into one forest type; and the herbaceous wetlands and barren lands together because they are relatively uncommon on both sites. We compared the habitat types on the sites with the habitats in immediate vicinity (within 10 km) and in the 30 km area around each site.



**Figure 1.** Map of the department of energy's environmental management (EM) sites, showing the locations of the lands acquired during and after World War II. Most lands were undisturbed for 60 - 75 years. Remediation has been completed at most of the former sites and is ongoing at about 16 sites. (Map from DOE. <https://www.energy.gov/em/about-us>).

In short, we use data we obtained from our on-site evaluations and federal documents to compile the data, and to put it in a form that can be easily communicated to a wide range of audiences, with different levels of expertise. For more effective and inclusive decision-making, governmental agencies, regulators, resource trustees, and the public need to have the same information that encompasses the key points needed for protection of natural resources. Our tables and graphics provide a template for communicating complex information quickly and effectively.

### 3. RESULTS

The Hanford Site and Oak Ridge Reservation will be described separately to provide a perspective on the relationship between birds and habitats on site compared with the surrounding region.

#### 3.1. Hanford Site

The Hanford Site bird list has about 205 bird species [39, 41]. However, the species of concern are those that primarily use the shrub-steppe habitat and are “found nowhere else in the state” [44]. Since there are no trees, but only low shrubs, grasses, and other low vegetation, species of concern are open country birds. The bird species of concern are listed in Table 1. They include species that may be on a Federal or State Endangered and Threatened species list. Washington also lists “candidate” as “Candidates for listing in Washington State as Endangered, Threatened or Sensitive” [44].

Historically, the critical native habitat for the region is the shrub-steppe [45, 46]. The historical records indicate stability or increase in the vegetation species that are indicators of shrub-steppe habitat, compared to declines in the region (Table 2). As is clear, the Hanford Site has gained considerable habitat for the Bunchgrass steppe, the native climax habitat. This increase is largely because offsite the entire Columbia River ecoregion has been developed for agriculture, industry, residences, while most of the Hanford Site was allowed to revert to its native habitat once the DOE acquired the site. Onsite most of the land was undisturbed by industrialization, natural succession could occur, except for periodic devastating fires. In the 1980s wildfires damaged much of the Big Sagebrush habitat, contributing to the extirpation of the Greater Sage Grouse [22]. Proliferation of electric transmission towers likely impacted the grouse as well. A remnant population in Yakima County could repopulate Hanford Site. On the other hand, Sandhill Crane populations have benefitted from protection [47].

In addition to the “Endangered” and “Threatened” categories, Washington Department of Fish and

**Table 1.** Avian species of primary conservation concern at Hanford (after [39, 41]).

	Federal & State Status	Hanford Status
Sandhill Crane <i>Grus canadensis</i>	State Endangered	Migrant (breeds in Yakima County)
Greater Sage Grouse <i>Centrocercus urophasianus</i>	Fed Near-threatened State Endangered	Rare resident [41] 1999: Extirpated from ALE [22] 2022 Breeds in Yakima Co
Sagebrush Sparrow <i>Artemisiospiza nevadensis</i>	State Candidate	Uncommon summer
Sage Thrasher <i>Oreoscoptes montanus</i>	State Candidate	Rare summer
Loggerhead Shrike <i>Lanius lucovicianus</i>	State Candidate	Uncommon summer
Swainson’s Hawk <i>Buteo swainsoni</i>	State Monitored	Uncommon summer
Ferruginous Hawk <i>Buteo regalis</i>	State Threatened	Rare summer
Burrowing Owl <i>Speotyto cunicularia</i>	State Candidate	Uncommon summer

**Table 2.** Historical changes in vegetation type on the Hanford Site compared with the Columbia River Ecoregion [45, 46].

Cover type	Percent change on Hanford Site	Percent change in Ecoregion
Bunchgrass steppe	162% increase	58% decrease
Idaho fescue steppe	No change	72% decrease
Bitterbrush steppe	1% decrease	34% decrease
Big sagebrush steppe	7% decrease	59% decrease
Juniper/sagebrush steppe	No change	Minus 1% decrease
Water	No change	No change

Wildlife (WDFW) has a designation “Candidate” category denoting “a candidate for listing as State Endangered, Threatened or Sensitive” [44]. Some species have been on the list as candidates for more than a decade.

The second method of analyzing vegetation changes on the Hanford Site involved comparing current vegetation on the Hanford Site to the surrounding region using the National Land Cover Database [43]. Figure 2 shows the relevant map, and Figure 3 indicates the percentage of each habitat type on the Hanford Site and the surrounding 10 km area and 30 km area. Obviously, there is significantly more shrub-steppe habitat on the Hanford Site than the surrounding areas. In the NLCD data base, the shrub-steppe is denoted as shrub/scrub and grassland.

### 3.2. Oak Ridge Reservation

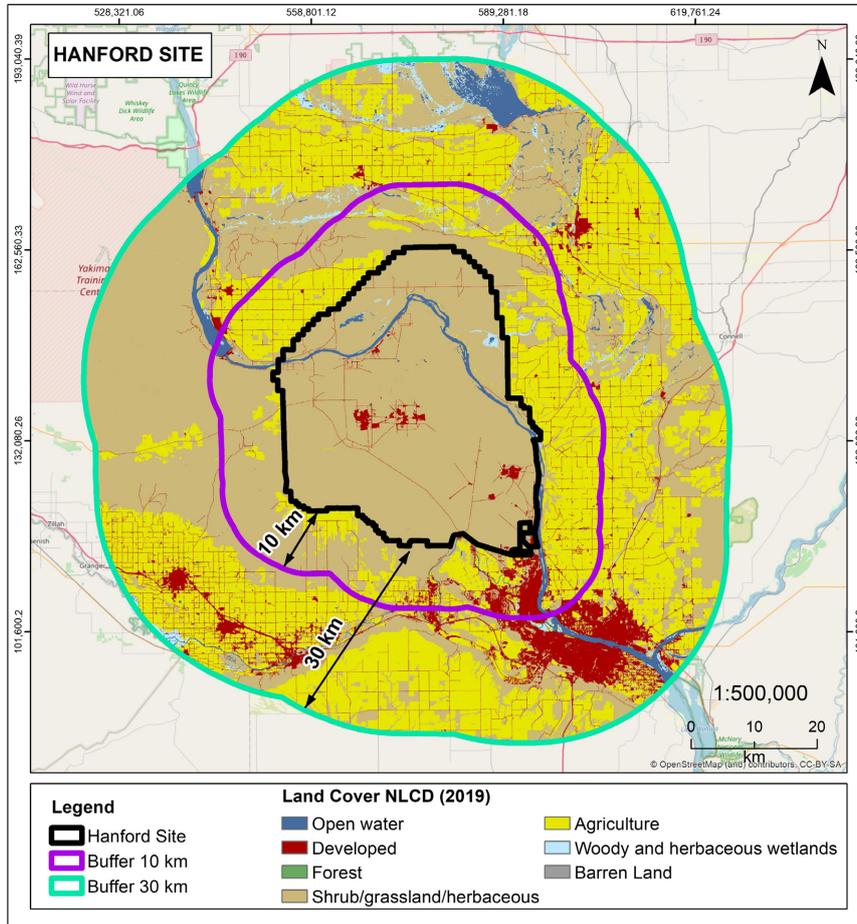
The Oak Ridge Reservation (ORR) also has over 200 species of birds listed for the site [40, 42]. Avian species of conservation concern are listed in Table 3. The Wood Stork is Federally Threatened. The other species are part of a group designated Neotropical migrants that suffer habitat loss and fragmentation on their neotropical wintering areas, as well as on their temperate breeding grounds, including the region around ORR.

Historical records for changes in vegetation on Oak Ridge Reservation are sparser than for the Hanford Site, but there are some estimates of changes in the percent that is forested from the 1940s to 2016 (Table 4). The major change appears to have happened from 1940 to 1980, beginning after DOE occupied and displaced about 3000 people into the surrounding area. The huge construction projects at Y-12 and K-25 attracted many workers so that the city of Oak Ridge reached 75,000 people. Most of the former farmland on ORR was allowed to undergo succession to forest, except for the three factory sites (see discussion), while around ORR the largely agricultural areas remain agricultural.

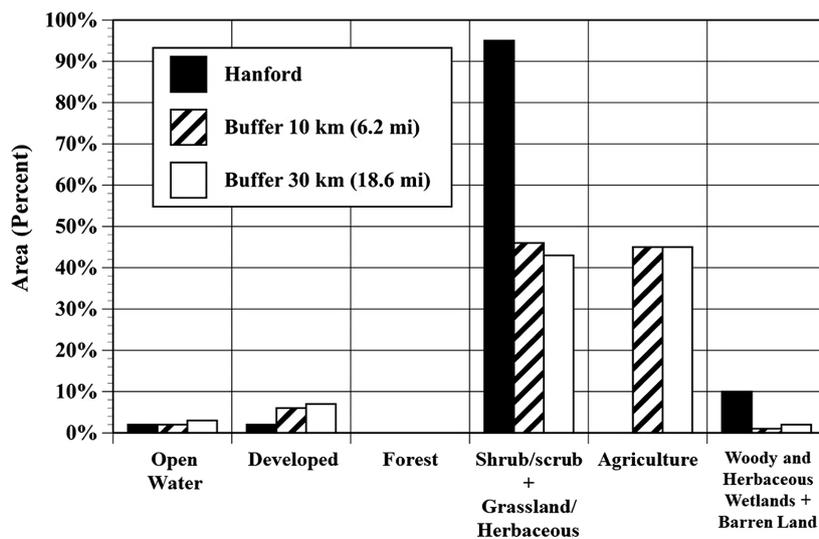
The second method of analyzing vegetation changes on the Oak Ridge Reservation involved comparing current vegetation on the Hanford Site to the surrounding region using the National Land Cover Database [43]. Figure 4 shows the land use/land cover map, and Figure 5 shows the percentage of each habitat type on ORR and the surrounding 10 km area and 30 km area. There is significantly more forest habitat on Oak Ridge Reservation than the immediate surrounding areas.

## 4. DISCUSSION

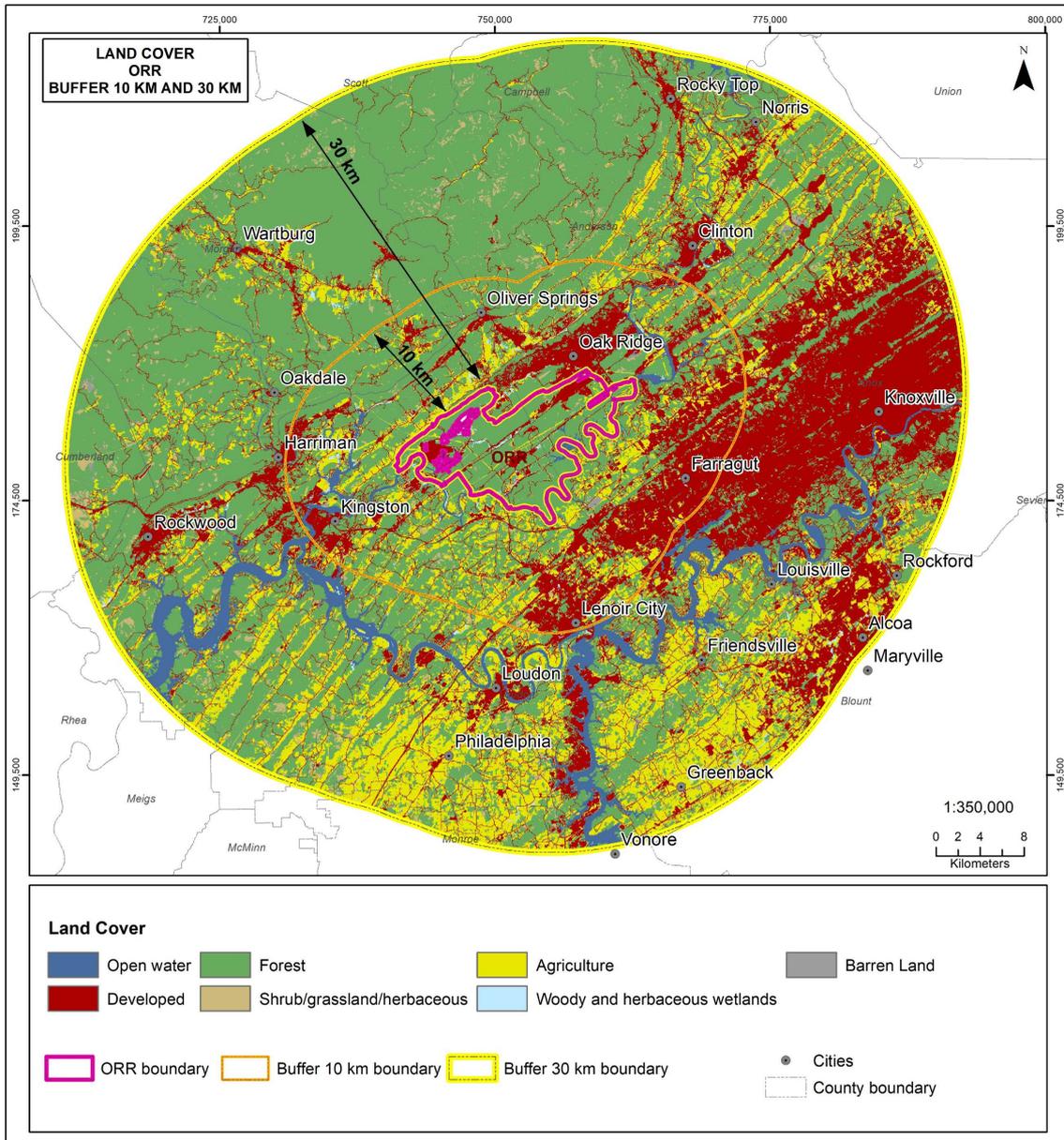
The Hanford Site [48] and Oak Ridge Reservation [49] have land use plans that take into account cleanup and residual contamination that may allow commercial/industrial, residential, recreational, and conservation designations for different parts of the sites. Land use plans may change over time, and discussion with Tribes and the public may influence the designation of more conservation areas on the locally unique landscapes. Protecting the environment includes the ecosystems and wildlife of conservation importance and recreational value, and birds as the most conspicuous wildlife can illustrate the importance



**Figure 2.** Map of habitat types for the Hanford Site (data from USGS land use/land cover [43]). The Hanford Site is clearly surrounded by agricultural areas.



**Figure 3.** Percentage of different land use/land cover types on the Hanford Site (derived from NLCD data [43]).



**Figure 4.** Major land cover types on ORR, the 10 km buffer, and the 30 km buffer. Data from USGS land use/land cover data base [43].

**Table 3.** Avian species of primary conservation concern at Oak Ridge Reservation (after [40, 42]).

SPECIES	Federal & State Status	Status Oak Ridge/Region
Wood Stork <i>Mycteria americana</i> <sup>a</sup>	Federally threatened	
Golden-winged Warbler <i>Vermivora chrysoptera</i>	Need of management <sup>b</sup>	Not a breeder on ORR
Henslow's Sparrow <i>Ammodramus henslowii</i>	Need of MSanagement	Not a breeder on ORR
Wood Thrush <i>Hylocichla mustelina</i>	Regional concern <sup>c</sup>	Declining/declining
Cerulean Warbler <i>Setophaga cerulea</i>	Need of Management	Stable/declining
Prairie Warbler <i>Setophaga discolor</i>	Regional concern	Declining/declining

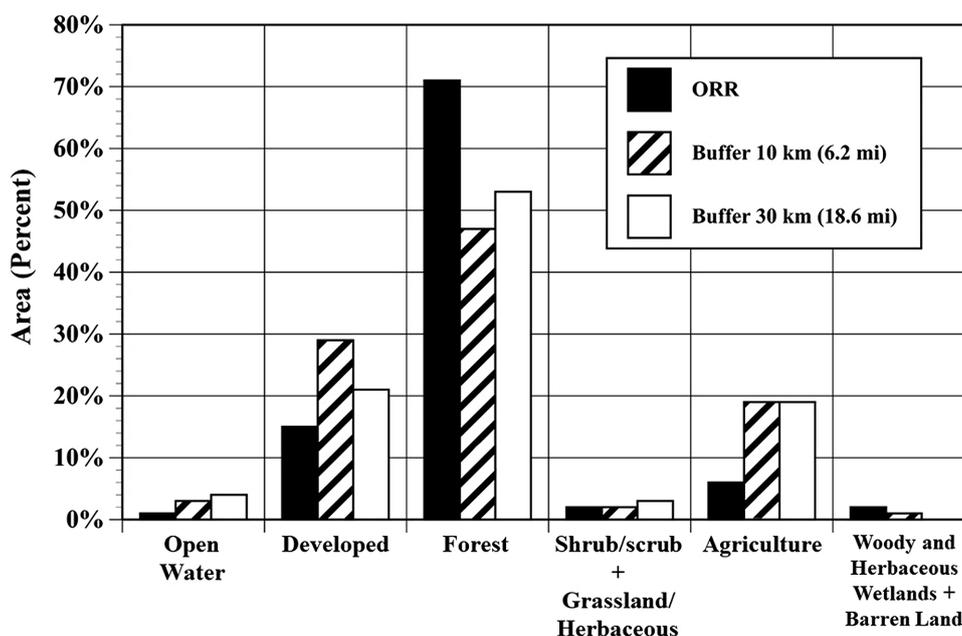
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Black and White Warbler <i>Mniotilta varia</i>	Regional concern	Not available/declining
Prothonotary Warbler <i>Protonotaria citrea</i>	Regional concern	Stable/Stable
Kentucky Warbler <i>Geothlypis Formosa</i>	Regional concern	Increasing/declining
Canada Warbler <i>Cardellina canadensis</i>	Regional concern	Not available/declining
Yellow-breasted Chat <i>Icteria virens</i>	Regional concern	Stable/declining

<sup>a</sup>All the ORR species are Neotropical Migrants except the Wood Stork; <sup>b</sup>Tennessee designation is “Need of Management”; <sup>c</sup>Partners in Flight designation of “Regional Importance”.

**Table 4.** Temporal changes in forest cover on Oak Ridge and the surrounding areas, from historical records and N. Giffen (pers. comm, August 2022).

Year	Oak Ridge Reservation	10 km buffer	30 km buffer
1940	50%	50%	about 50%
1980	80%	50%	53%
2001	70%	49%	54%
2016	71%	46%	53%



**Figure 5.** Percentage of different land use/land cover types on the Oak Ridge Reservation (after NLCD data [43]). Forest includes both deciduous and coniferous forest. The 10-km circle includes the city of Oak Ridge (2020 population 31,000). The 30-km circle includes Knoxville (2020 population 186,000).

of protecting unique natural ecosystems. For example, the land use designation for East Tennessee Technology Park (for industrial use) within Oak Ridge Reservation changed in 2021 to include a large tract designated for conservation [50].

Both the Hanford Site and Oak Ridge Reservation have important avian assemblages, largely because they have large, unbroken tracts of native vegetation with relatively few invasive species. The onsite habitats are relatively protected from further development (except where needed to complete remediation) and fragmentation. Invasive species have multiple effects, inhibiting native plant growth and promoting fires. Cheat Grass (*Bromus tectorum*) is a notorious annual that dries up, ignites easily, and burns rapidly. Fire, both natural and anthropogenic, is probably the largest threat to Hanford's shrub-steppe, where several devastating fires have been documented in recent decades, requiring extensive re-seeding to re-establish the habitat [51]. It is important that both DOE sites maintain more of the native ecosystems than the surrounding regions, and native ecosystems on both sites support birds that are of conservation concern. Emphasizing bird populations on and offsite can be valuable to illustrate the importance of large patches of native vegetation in the multi-directional discussion and transfer of information among DOE and its stakeholders. The bird data can demonstrate the importance of the large tracts of important avian habitat with minimal fragmentation. Recognizing the importance of large, unbroken tracts as conservation measures for declining bird populations will lead to more areas being designated as conservation areas, as well as leading to improved management.

#### 4.1. Climax Vegetation and Avian Species of Concern

Often rare and unique habitats are considered the prime habitat for a range of endangered or threatened species, or species of special concern [52]. However, it is also true that some common habitats have high value when there are large patches, unbroken by roads or other development. Fragmentation is one of the key factors associated with declines in many species, including birds [18, 53]. Both of the vegetation types evaluated here: shrub-steppe on the Hanford Site and forest on Oak Ridge are climax vegetation for the region [39, 40, 45]. Historically, before about 1800 at Oak Ridge and before about 1900 at Hanford, both vegetation types were widespread, occurring in large unbroken tracts. However, settlement and agricultural development drastically altered the landscape, usurping much and fragmenting much, leaving smaller patches, if any, of native, habitats, providing fewer and fewer places for birds to breed, particularly secretive species [54] or those with large home ranges. Smaller patches offer a greater ratio of edge habitat to central area [29]. Although some widespread species favor edge habitats, many species avoid nesting in edge areas where they are more vulnerable to predators and to nest parasitism by brown-headed cowbirds (*Molothrus ater*) and to invasive species [55]. Cowbird parasitism is a serious threat implicated in declines and extinctions of several threatened species [55, 56].

Both the Hanford Site and Oak Ridge Reservation, as NERPs, have had significant surveys of habitat, birds, and other ecological resources and have developed monitoring and management plans. Both produce environmental reports each year that allow for tracking of species [39, 40, 45, 54, 57-59]. For example, the Oak Ridge Reservation has a management plan for interior forests, the forest type that the bird species of concern, the Neotropical Migrants, require [59, 60]. Similarly, the Hanford Site has management plans for species of concern [54, 57]. It is challenging to implement general management plans if there is a disconnect between those planning and implementing remediation. Whereas development and habitat fragmentation are threats offsite, remediation can pose ecologic threats onsite if ecologic resources, such as birds, are not included in planning. Closer collaboration between ecological assessments and remediation planning would partly alleviate this problem. While our data relate to habitat, in connection to birds of conservation concern, the habitats at both sites represent functioning ecosystems that are also important for many other unique and rare plants and other animals [39, 40, 46].

#### 4.2. Communication Challenges

One of the difficulties with providing information to a wide range of Tribes and stakeholders (including governmental agencies) is that for large, contaminated sites (such as DOE lands), the information is often provided in different annual reports and project reports that are lengthy, with dozens of tables and appendices. One objective of communication, however, is to both make the full data available to stake-

holders, but also to provide data that address specific questions in a manner that are easily understandable while containing all the key information in tables and figures. For example, complex land use categories can be easily grasped when colors are used to denote key habitats, and when bar graphs showing the important habitats (e.g. for birds) are presented. Key species of conservation or management concern can be listed, with photos of each species. The amount of critical habitat can be easily summarized to provide an instant understanding of how much habitat has been gained or lost.

In addition to having graphs that are easy to follow, making sure that the key information is provided is essential. That is, to protect birds you need to know the types of birds that are at risk (e.g. neotropical migrants at Oak Ridge Reservation; shrub-steppe species at Hanford Site), the individual species at risk, and the habitats that they require. With this information, people examine the protection and conservation issues involved in management, including remediation decisions.

### 4.3. DOE's Role in Ecological Protection and Communication

The data on historical records of land use, and the USGS land use/land cover analysis presented here show that both sites have maintained more high-quality habitat than their surrounding regions. For the period of 1940s through 1980s of rapid industrial growth on the sites, habitats were left alone if they were not needed for the nuclear mission. In 1989 with the start of Environmental Management that maintains the “protect human health and environment mission”, protection of the environment is integral to plans and operations. Shrub-steppe and interior forests are valuable and valued to support the shrub-steppe bird species of concern at the Hanford Site and the Neotropical migrants at ORR. Both species require large tracts of undisturbed land, which the DOE has provided. When DOE took over these lands in the 1940s, communities and farms were displaced [60, 61]. Most of the land area at both Hanford Site and Oak Ridge Reservation was not used for industrial purposes, and there remained the large relatively uncontaminated, unfragmented areas of the key habitats we see today. When the landscape was left fallow and allowed to revert to more natural habitat, this allowed birds and other animals to move in and increase. Bird populations have thrived in these protected ecosystems compared to the surrounding region (Table 1 and Table 3).

This paper demonstrates DOE's commitment to protection of the environment as well as human health, while pursuing its environmental management mission [61, 62]. It happens that protecting the environment and the unique habitats at the Hanford Site (e.g., shrub-steppe birds) and the forests at the Oak Ridge Reservation (e.g., Neotropical migrants), for example, will protect many groups of plants and animals adapted to these habitats. However, with on-going environmental remediation to complete the cleanup mission and pressures for private development from outside forces, it is important for DOE and other federal and state agencies, as well as other interested and affected parties to recognize and emphasize the valuable ecological resources on these sites. The data in this paper illustrates the regional declines in critical habitats for birds as well as the declines reported for several bird species offsite. That is, both sites have valuable habitat that contributes to the health of bird populations (as well as other ecological resources). Both sites are clearly aware of the importance of their ecological resources incorporated in their general management plans. This is a positive benefit of DOE presence, but also places an additional responsibility on DOE to continue protecting these resources. We suggest that values illustrated by birds and their habitats be incorporated into discussions and decisions regarding future land use, where conservation and recreation values are emphasized. The information, figures, and tables presented here can provide DOE, Tribes, and other stakeholders with an information base for multi-direction, multi-stakeholder involvement regarding how (and where) to protect their avian habitat resources [63]. Site neighbors may well be interested in aiding in the preservation of ecological resources and helping to make informed decisions about how these resources are protected and used. This is an opportunity to engage diverse communities to participate in both resource protection and resource use.

### 4.4. Conclusion

The data presented in this paper show that at the Department of Energy's Hanford Site and Oak

Ridge Reservation there are habitat-specialist avian assemblages that are declining generally but are stable or increasing on these sites. These species are in need of habitat protection. The land use/land cover data show that DOE has protected more of the critical habitat at the Hanford Site (shrub-steppe) and at the Oak Ridge Reservation (interior forests) that also protects the key avian assemblages than occur in the surrounding regions. The tables provided in this manuscript can serve as valuable tools in communicating *with* surrounding communities about the importance of protecting these lands and special habitats and allowing these communities to participate in science-based decision-making that make wise use of resources while accomplishing an environmental management mission.

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## CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding publication of this paper.

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