Species Status Assessment Report for the Columbia River Distinct Population Segment of Columbian white-tailed deer *(Odocoileus virginianus leucurus)*

Version 1.0

Photo courtesy of Jon Heale

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Executive Summary

This species status assessment reports the results of the comprehensive status review for the Columbian white-tailed deer (*Odocoileus virginianus leucurus*) and provides a thorough account of the species' overall viability and extinction risk. The U.S. Fish and Wildlife Service (Service) listed the Columbian white-tailed deer as endangered under the Endangered Species Act on October 13, 1970 (35 FR 16047). The Columbian white-tailed deer is a subspecies of white-tailed deer found in two distinct population segments (DPS) known as the Douglas County and Columbia River populations. On July 24, 2003, the Service removed the Douglas County DPS of Columbian white-tailed deer from the List of Endangered and Threatened Wildlife due to recovery. Therefore, only the Columbia River DPS will be discussed in this report. The Columbia River DPS is found in limited areas of Clatsop, Columbia, and Multnomah Counties in Oregon, and Clark, Cowlitz, Pacific, Skamania, and Wahkiakum Counties in Washington. A recovery plan published in 1982, revised in 1983, established population viability and habitat security targets. On October 17, 2016, the Service reclassified the Columbia River DPS of Columbian white-tailed deer as threatened and published a special rule under section 4(d) of the Endangered Species Act (81 FR 71386).

To assess the viability of the Columbia River DPS, we used the three conservation biology principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 306-310). Briefly, resiliency supports the ability of the species to withstand environmental and demographic stochasticity (for example, wet or dry, warm or cold years); redundancy supports the ability of the species to withstand catastrophic events (for example, droughts, large pollution events), and representation supports the ability of the species to adapt over time to long-term changes in the environment (for example, climate changes). In general, the more resilient and redundant a species is and the more representation it has, the more likely it is to sustain populations over time, even under changing environmental conditions. Using these principles, we identified the species' ecological requirements for survival and reproduction, and described the beneficial and risk factors influencing the species' viability.

Using geographic location and natural barriers to movement, we divided the Columbia River DPS into ten subpopulations. Based on the biology of the species and the information presented in the recovery plan, we determined that to be resilient, Columbian white-tailed deer subpopulations within the DPS need a minimum of 50 deer and an abundance of cover and forage distributed in a mosaic pattern and minimal amounts of invasive plants. We did not have data to evaluate each of these measures for every subpopulation. However, we did quantify abundance; reproductive success (using fawn to doe ratios); dispersal and connectivity; habitat quantity; and the amount of protected and secure habitat. Ideally, at the species level, resilient

subpopulations would be distributed across the range of the DPS and have connectivity across the landscape (to provide both redundancy and representation).

Fifty-five years have passed since the Columbian white-tailed deer was federally listed as endangered, and the species is now more abundant and better distributed throughout the lower Columbia River Valley (Table ES-1). At the time of listing, only 300 to 400 Columbian white-tailed deer were thought to reside in the Columbia River DPS based on ground count estimates. We estimate the current DPS to contain 1,354 deer across 10 subpopulations based on aerial and ground count estimates in just under 23,000 hectares (56,834 acres) of habitat. The improvement is due to the maintenance and augmentation of existing subpopulations, and the establishment of new subpopulations via successful translocations within the DPS. The presence of Columbian white-tailed deer in new areas increased both the geographic range of the DPS and connectivity throughout the landscape. An increased number of subpopulations, composed of a greater number of individuals and with expanded distribution and connectivity across the species range, means the Columbian white-tailed deer has a greater chance of withstanding stochastic events (resiliency), surviving potentially catastrophic events (redundancy), and adapting to changing environmental conditions (representation) over time.

Table ES-1. Comparison in status of Columbian white-tailed deer subpopulations and distribution between the time of listing to survey results from 2025.

	Listed as endangered (1970)	**As of 2025**
Number of deer	300-400	1,354
Number of subpopulations	5	10
Number of viable (≥50 deer) subpopulations	3	8
Number of secure subpopulations	1	3
Number of viable and secure subpopulations	1 (JBH Mainland)	3 (Tenasillahe Island, Puget Island, Ridgefield)
Area of habitat known to be occupied (hectares)	8,789	22,589
Amount of secure habitat (hectares)	1,388 (16 percent)	9,417 (42 percent)

The recovery plan (U.S. Fish and Wildlife Service 1983, pp. 31-33) established two criteria for delisting: (1) maintain a minimum of at least 400 Columbian white-tailed deer across the Columbia River DPS; and (2) maintain three viable subpopulations (at least 50 deer), all located on secure habitat. The total population of the Columbia River DPS has been maintained at over 400 deer annually since regular surveys began in 1984, with a 2025 population estimate of 1,354 deer (U.S. Fish and Wildlife Service 2025, unpublished data). Of those deer, 959 (71 percent) reside on secure habitat, even though secure habitat only comprises 42 percent of available habitat. Overall, the majority of subpopulations – 7 out of 10 – are ranked with high or moderate resilience and per the thresholds in the recovery plan, there are currently three subpopulations considered both viable and secure: Puget Island, Tenasillahe Island, and Ridgefield.

Redundancy and representation have increased relative to the time of listing, with new subpopulations in and around Ridgefield National Wildlife Refuge (representing the easternmost extent of the species' range) and Columbia Stock Ranch (CSR) near Deer Island, Oregon. No known ecological settings for the species have been lost, although the deer would benefit from moving to more upland areas. Much of the former range of the Columbian white-tailed deer still shows high-quality habitat remnants theoretically capable of supporting deer populations (Butler et al. 2014, p. 22). Although connectivity is limited, every subpopulation has some level of connection between at least two other subpopulations and several connect to three other subpopulations. The most difficult area for deer dispersal appears to be near Longview, Washington, where there is a great deal of industrial activity. The lack of high dispersal probability likely reflects the fragmented nature of suitable habitat throughout the range of the deer. The presence of multiple highly and moderately resilient subpopulations distributed across the geographic range of the Columbian white-tailed deer increases the likelihood that the species will be able to adapt to environmental changes as well as to withstand catastrophic events.

We also considered the viability of Columbian white-tailed deer 50 years into the future. Based on population modeling and climate change models, we anticipate that resiliency, redundancy, and representation will remain intact, albeit at possibly lower levels for some subpopulations, in the future. A Population Viability Assessment determined that there is a 97 percent probability that the Columbia River DPS would remain over 400 individuals in the next 50 years even when taking into account the possibility of severe flooding and additional habitat loss (Miller et al 2020, pp. 26-33). For westernmost and easternmost subpopulations, projected severe flooding and habitat loss resulted in fewer deer than in the status quo scenario due to depressed growth rates, yet extinction risk remained low (Miller et al. 2020, pp. 23, 25). The subpopulations in the middle of the DPS were at greater risk due to less habitat currently and into the future and fewer deer, though modeling indicated that at least some connectivity decreased extinction risk and that habitat enhancement and management could decrease the risk of extinction. Potential impacts from sea level rise would be greater in the westernmost portion of the DPS because tidal influence decreases with distance upriver. However, these subpopulations have also shown the repeated ability to rebound from stochastic and catastrophic events over the past 50 years. Given that these western subpopulations are all in moderate or high condition currently and sea level rise is a gradual change on the landscape, it is unlikely that these subpopulations would all decrease to low condition or extinction even with environmental changes on the landscape. However, this will be dependent upon maintaining, or potentially raising, the existing levees.

Gradual changes in sea level rise over time will slowly alter the habitat. These changes are likely to decrease suitable habitat in portions of the species' range and possibly create opportunities for deer to shift their movements to other areas as long as some connectivity remains. For instance, there are large swaths of County lands along the east fork of the Lewis River in Washington that do not contain Columbian white-tailed deer, yet the County lands do contain habitat and security. Future habitat availability will be dependent upon keeping these areas intact rather than altering the area to create fish habitat. There are also areas within, and adjacent to, the CSR, Ridgefield, and Sauvie/Scapoose subpopulations that currently contain portions of unoccupied suitable habitat that we predict will continue to provide habitat options in the future. Protected lands will also continue to manage habitat and maintain levees to reduce or prevent impacts from sea level rise. Thus, habitat loss because of climate change is likely, though we do not know the extent of possible habitat impacts and the resulting effects to Columbian white-tailed deer.

List of Acronyms

Act	Endangered Species Act
AHD	Adenovirus hemorrhagic disease
BPA	Bonneville Power Administration
BTV	Bluetongue virus
CWD	Chronic wasting disease
DCP	Disease Contingency Plan
DPS	Distinct Population Segment
EHDV	Epizootic hemorrhagic disease virus
FLIR	Forward-Looking Infrared
IPCC	Intergovernmental Panel on Climate Change
JBH	Julia Butler Hansen Refuge for Columbian White-tailed Deer
MHHW	Mean higher, high water
MOU	Memorandum of Understanding
MVP	Minimum viable population
NOAA	National Oceanic and Atmospheric Administration
NWR	National Wildlife Refuge
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
PHVA	Population and habitat viability analysis
PVA	Population viability analysis
Service	U.S. Fish and Wildlife Service
SLR	Sea level rise
SSA	Species Status Assessment
WDFW	Washington Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation

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Chapter 1. Introduction and Overview of the Species Status Assessment Framework

1.1 Background

The Columbian white-tailed deer *(Odocoileus virginianus leucurus)* is the westernmost representative of 38 subspecies of white-tailed deer in North and Central America. On October 13, 1970, the Director of the Bureau of Sport Fisheries and Wildlife listed the Columbian white-tailed deer as an endangered subspecies (35 FR 16047) under the authority of the Endangered Species Conservation Act of 1969. Species listed as endangered under the Endangered Species Conservation Act of 1969 were automatically included in the List of Endangered and Threatened Wildlife when the Endangered Species Act (Act) was enacted in 1973. Critical habitat was not designated for this species.

In December 1971, the U.S. Fish and Wildlife Service (Service) established the Julia Butler Hansen Refuge for the Columbian White-tailed Deer (JBH), in Cathlamet, Washington. The JBH Refuge contains over 2,265 hectares (ha) (5,600 acres) of pastures, forested tidal swamps, brushy woodlands, marshes, and sloughs along the Columbia River in both Washington and Oregon. The Mainland unit, Hunting Islands, and Price Island are in Washington. Tenasillahe and Wallace Islands, and several small parcels around Westport are in Oregon.

On October 21, 1976, the Service released the Columbian White-tailed Deer Recovery Plan. On June 14, 1983, the Service released the Revised Recovery Plan for Columbian white-tailed deer (hereafter "recovery plan"). The plan addressed the two main populations of Columbian white-tailed deer, Columbia River and Douglas County, separately. On July 24, 2003, the Service published a rule (68 FR 43647) that: (1) recognized the Douglas County and Columbia River populations as distinct population segments (DPSs) under the Service's 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Act (see 61 FR 4722; February 7, 1996), and (2) removed the Douglas County population of Columbian white-tailed deer from the List of Endangered and Threatened Wildlife. It was determined that recovery criteria for the Douglas County population had been met, as it achieved benchmarks in both population size and amount of secure habitat. On October 17, 2016, the Service reclassified the Columbia River DPS of Columbian white-tailed deer as threatened and published a special rule under section 4(d) of the Act (81 FR 71386). This Species Status Assessment (SSA) report discusses only the Columbia River DPS of Columbian white-tailed deer.

1.2 Analytical Framework

The SSA framework (U.S. Fish and Wildlife Service 2016a, entire) is intended to support an in-depth review of the species' biology, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. The intent is for the SSA report to be easily updated as new information becomes available, and to support all functions of the Endangered Species Program.

This SSA provides biological information in support of the 5-year review and evaluation of listing status for the Columbian white-tailed deer under the Act. Importantly, the SSA does not result in a decision by the Service on whether the status of the species should be changed under the Act. Instead, this SSA provides a review of the available information strictly related to the biological status of the Columbian white-tailed deer. Any recommendation for a possible change in status will be made by the Service after reviewing this document and all relevant laws, regulations, and policies, and the results of a proposed change in status, if any, will be announced in the *Federal Register*, with appropriate opportunities for public input.

Using the SSA analytical framework (Figure 1), we consider what a species needs to maintain viability by characterizing the biological status of the species in terms of its resiliency, redundancy, and representation (together, the 3Rs) (Smith et al. 2018, entire). For the purpose of this assessment, we define viability as the ability of the Columbian white-tailed deer to sustain subpopulations within the DPS ecosystem over time. In general, there is a positive association between measures of the 3Rs and the relative viability of a species: as resiliency, redundancy, and representation increase, the viability of the species over time increases (conversely, risk to the persistence of the species decreases). We apply the SSA analytical framework to evaluate the needs of the species, the current condition of the species in terms of the 3Rs, and the relative viability of the species under likely future conditions (Smith et al. 2018, entire). Evaluating the predicted future condition of the Columbian white-tailed deer under alternative plausible future scenarios enables us to create a “risk profile” for the species, which captures the range of most likely status outcomes for the species within the foreseeable future, while simultaneously acknowledging the degree of uncertainty inherent in such future projections. These scenarios do not include all possible futures, but rather include specific plausible scenarios that represent examples from the continuous spectrum of possible futures.

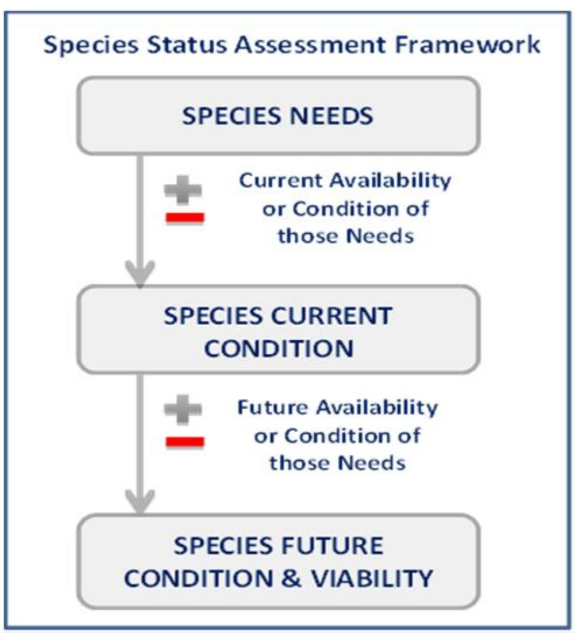

Figure 2. Species Status Assessment Framework (U.S. Fish and Wildlife Service 2016a).

We define resiliency, redundancy, and representation as follows:

- Resiliency is the ability of a species to withstand environmental stochasticity (normal, year-to-year variations in environmental conditions such as temperature, rainfall), periodic disturbances within the normal range of variation (fire, floods, storms), and demographic stochasticity (normal variation in demographic rates such as mortality and fecundity) (Redford et al. 2011, p. 40). Simply stated, resiliency is the ability to sustain populations through the natural range of favorable and unfavorable conditions.

  We can best gauge resiliency by evaluating population level characteristics such as: demography (abundance and the components of population growth rate - survival, reproduction, and migration), genetic health (effective population size and heterozygosity), connectivity (gene flow and population rescue), and habitat quantity, quality, configuration, and heterogeneity. Also, for species prone to spatial synchrony (regionally correlated fluctuations among populations), distance between populations and degree of spatial heterogeneity (diversity of habitat types or microclimates) are also important considerations.

- Redundancy is the ability of a species to withstand catastrophes. Catastrophes are stochastic events that are expected to lead to population collapse regardless of population health and for which adaptation is unlikely (Mangal and Tier 1993, p. 1083).

  We can best gauge redundancy by analyzing the number and distribution of populations relative to the scale of anticipated species-relevant catastrophic events. The analysis entails assessing the cumulative risk of catastrophes occurring over time. Redundancy can be analyzed at a population or regional scale, or for narrow-ranged species, at the species level.

- Representation is the ability of a species to adapt to both near-term and long-term changes in its physical (climate conditions, habitat conditions, habitat structure, etc.) and biological (pathogens, competitors, predators, etc.) environments. This ability to adapt to new environments - referred to as adaptive capacity - is essential for viability, as species need to continually adapt to their continuously changing environments (Nicotra et al. 2015, p. 1269). Species adapt to novel changes in their environment by either [1] moving to new, suitable environments or [2] by altering their physical or behavioral traits (phenotypes) to match the new environmental conditions through either plasticity or genetic change (Beever et al. 2016, p. 132; Nicotra et al. 2015, p. 1270). The latter (evolution) occurs via the evolutionary processes of natural selection, gene flow, mutations, and genetic drift (Crandall et al. 2000, p. 290-291; Sgro et al. 2011, p. 327; Zackay 2007, p. 1).

  We can best gauge representation by examining the breadth of genetic, phenotypic, and ecological diversity found within a species and its ability to disperse and colonize new areas. In assessing the breadth of variation, it is important to consider both larger-scale variation (such as morphological, behavioral, or life history differences which might exist across the range and environmental or ecological variation across the range), and smaller-scale variation (which might include measures of interpopulation genetic diversity). In assessing the dispersal ability, it is important to evaluate the ability and likelihood of the species to track suitable habitat and climate over time. Lastly, to evaluate the evolutionary processes that contribute to and maintain adaptive capacity, it is important to assess [1] natural levels and patterns of gene flow, [2] degree of ecological diversity occupied, and [3] effective population size. In our species status assessments, we assess all three facets to the best of our ability based on available data.

Chapter 2. Species Information

A comprehensive overview of the species can be found in the recovery plan (U.S. Fish and Wildlife Service 1983, entire), the most recent five-year review (U.S. Fish and Wildlife Service 2013a, entire), and the October 17, 2016, reclassification rule (81 FR 71386). A summary of the most relevant information, as it relates to this assessment, is presented below.

2.1 Taxonomy

The genus *Odocoileus* is classified into two distinct species, white-tailed deer (*O. virginianus*) and mule deer (*O. hemionus*), with each species further sub-divided into multiple subspecies. The Columbian white-tailed deer is one of 38 recognized subspecies of white-tailed deer, a species with a continuous geographic distribution that extends from southern Canada to South America, including most of the continental United States (Halls 1981, pp. 44-45). The taxonomic description of this subspecies by David Douglas was based on two specimens he collected in Oregon, from the prairies of the Cowalidske and Multnomah Rivers within 161 kilometers (km) (100 miles) of the Pacific Ocean (Smith 1991, p. 3). The Columbian white-tailed deer range overlaps with the Columbian black-tailed deer (*O. h. columbianus*), which is a recognized subspecies of mule deer only found west of the Cascade Crest.

In addition to the Columbian white-tailed deer, another subspecies of white-tailed deer resides in Oregon – the Northwest white-tailed deer (*O. v. ochrourus*). Several studies have suggested that Columbian white-tailed deer may not be specifically distinct from Northwest white-tailed deer based on allozyme, mtDNA phylogeny, and haplotype network analyses (Gavin and May 1988, p. 7; Piaggio and Hopken 2009, p. 15, Hopken et al. 2015, p. 645). These studies suggest that while more data is needed to elucidate the genetic relationships between the subspecies, they do have a very recent shared evolutionary history (Gavin and May 1988, p. 9; Piaggio and Hopken 2009, p. 16), and may have limited gene flow (Piaggio and Hopken 2009, pp. 16-17). The studies also detected hybridization of white-tailed deer with black-tailed deer using nuclear protein allozymes, mtDNA, and microsatellites in the Columbia River DPS and in northeastern Oregon (Gavin and May 1988, p. 6; Piaggio and Hopken 2009, p. 18; Piaggio and Hopken 2010, p. 15; Hopken et al. 2015, p. 644). The most recent study did not reveal any first or second generation Columbian white-tailed deer with black-tailed deer hybrids, suggesting that hybridization was an historical occurrence between an *O. virginianus* male breeding with an *O. hemionus* female rather than a recent event (Hopken et al. 2015, p. 644).

The current accepted taxonomy for Columbian white-tailed deer (ITIS 2021) is:

Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Class Mammalia
Family Cervidae
Genus Odocoileus
Species *Odocoileus virginianus*
Subspecies *Odocoileus virginianus leucurus* (Douglas 1829)

2.2 Species Description

The Columbian white-tailed deer resembles other white-tailed deer subspecies with a reddish-brown summer coat and a grayish-brown winter coat. It ranges in size from 39 to 45 kilograms (kg) (85 to 100 pounds) for females/does and 52 to 68 kg (115 to 150 pounds) for males/bucks (Oregon Department of Fish and Wildlife 1995, p. 2). White-tailed deer are generally distinguished from black-tailed deer by their longer and thicker tail that is brown rather than black on the dorsal surface; a smaller metatarsal gland; white eye rings; smaller ears; and, in adult males, antlers with prongs arising from a single main beam (Baker 1984, p. 8; Geist 1998, p. 258)(Figure 2).

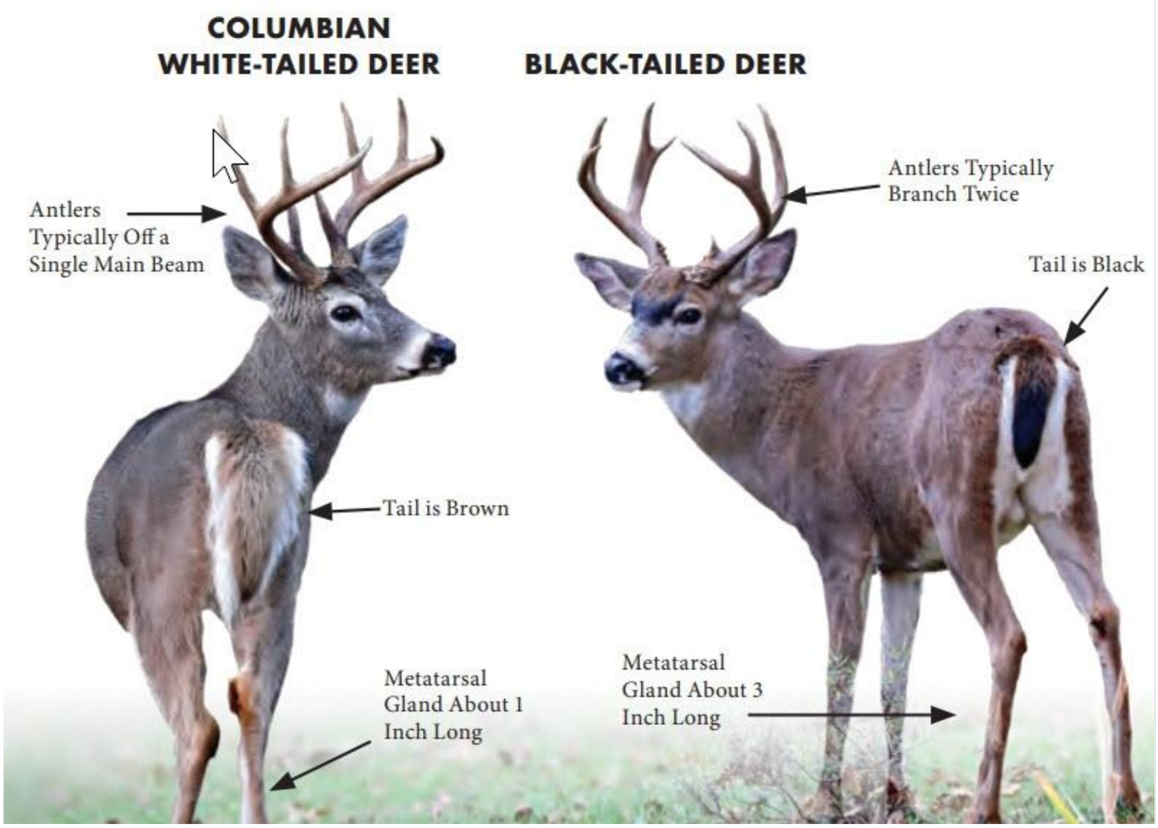

Figure 2. Differences between Columbian white-tailed deer and Columbian black-tailed deer. Photo available at: https://myodfw.com/articles/identifying-columbian-white-tailed-and-black-tailed-deer

2.3 Life History

Life stages of Columbian white-tailed deer fall into three categories: fawn (birth to 12 months), yearling (12 months to 18 months), and adult (over 18 months). Although Columbian white-tailed deer can live up to 20 years, their median lifespan ranges from 3 to 5 years for bucks and 5 to 9 years for does (Gavin 1984, p. 490; U.S. Fish and Wildlife Service, unpublished data). While adult survival is generally high and relatively stable among years within the DPS, fawn survival can fluctuate dramatically from year-to-year depending on predation and environmental conditions. Coyotes (*Canis latrans*), domestic dogs (*Canis lupus familiaris*), and bobcats (*Lynx rufus*) are predators of Columbian white-tailed deer in the DPS (Gavin et al. 1984, p. 32; P. Meyers 2022, pers. comm). However, white-tailed deer predators in North America also include wolves (*Canis lupus*), bears (*Ursus* sp.), large cats (*Felis* sp.), eagles (*Aquila* sp. and *Haliaeetus* sp.), and alligators (*Alligator* sp.)(Geist 1998, p. 280). When predators are near, does will stamp their front legs or snort to warn their fawns, who then crawl into cover (Geist 1998, p. 286). Fawn mortality most often occurs in June and July when they are most vulnerable, whereas adult and yearling male mortality is higher from November to January (Gavin et al. 1984, p. 27). Other causes of death include vehicle collisions, bacterial infections, bot fly (*Cephenomyia* sp.) infestation, drowning, accidents such as catching a foot in a fence, and nutritional stress (Crews 1939, p. 28; Gavin et al. 1984, pp. 30-32).

The Columbian white-tailed deer is a generalist herbivore that browses and grazes, allowing them to shift feeding behavior according to plant availability. Browsing refers to consuming high-growing plants such as leaves, tree bark, and shrubs whereas grazing refers to vegetation that grows near the ground such as grasses and forbs (collectively referred to as forage). The deer prefer to forage for food in plant communities with cover taller than 70 centimeters (cm) (28 inches) and prefer open canopy communities to closed canopy forest (Gavin et al. 1984, p. 14). Deer use pastures grazed by cattle in the fall and winter, however, they avoid pastures with cattle in the summer (Gavin et al. 1984, p. 14). A later study using GPS-collars suggested that deer generally avoid grazed pastures year-round, possibly because of insufficient cover (Heale 2018, p. 28). Cover provides protection from predators and thermal refugia in inclement weather. A diet and nutrition study conducted by JBH staff from 1996 to 1998 found that grasses made up only about a third of their overall diet, yet grasses were more than 50 percent of the Columbian white-tailed deer diet in winter, likely because forbs and browse are not readily available in winter (U.S. Fish and Wildlife Service 2010, p. 2-39). Fecal nitrogen and fecal diaminopimelic acid values for Columbian white-tailed deer showed seasonal variation, but indicated adequate dietary protein and energy for growth and reproduction (U.S. Fish and Wildlife Service 2010, p. 4-45).

Breeding occurs from mid-September through late December, with a peak in November. Does reach sexual maturity by 6 months of age or when their weight reaches approximately 36 kg (80 pounds); however, their maturation and fertility depends on the nutritional quality of available forage (Verme and Ullrey 1984, p. 96). Fawns are born in the early summer after an approximate 200-day gestation period. For this DPS, fawning usually peaks the first week in June. In the first few weeks after birth, fawns will conceal themselves in thick vegetation to protect themselves from predators while does are foraging. In their first pregnancy, does usually give birth to a single fawn, although twins are common in later years if adequate forage is abundant (Verme and

Ullrey 1984, p. 96). Does can produce offspring once per year throughout their adult life. We do not have data for this DPS on weaning time for fawns. Generally, white-tailed deer fawns are fully weaned from milk at 16 weeks of age when adult-like stomach proportions are attained (Short 1964, p. 457). Does associate with their fawns until late May to early June of the following year, establishing small social family groups (Gavin et al. 1984, p. 20).

Columbian white-tailed deer exhibit a skewed adult sex ratio with approximately three females to one male (Crews 1939, p. 26; Gavin 1984, p. 490; Gavin et al. 1984, p. 19), likely as a result of higher mortality in males. Prior to being listed in 1970, Columbian white-tailed deer were hunted, which can affect sex ratios. Additionally, counts were not corrected for detection probability in studies by Gavin, such that buck survival may be greater than is suggested by these sex ratios. Herd composition counts (males versus females) are conducted in November because this is when males can best be distinguished from females and best reflect the proportion of each sex in the population (Gavin et al 1984, p. 19). Fawn-to-doe ratios are also obtained in November to estimate age-specific reproductive success by approximating the number of yearlings to be recruited into the population. Fecundity rates are unknown. Early accounts in the 1970's showed a ratio of 29 to 42 males per 100 females and 35 to 60 fawns per 100 does (Gavin et al. 1984, pp. 19-20). The latest fawn-to-doe ratios for the JBH Mainland subpopulation were 32 fawns per 100 does, with a range of 12–34 over the last 5 years (U.S. Fish and Wildlife Service, unpublished data). Though data on fawn to doe ratios across all subpopulations in the range of the DPS is not complete, available data over the last 5 years shows an average of 32.6 fawns per 100 does for the DPS (U.S. Fish and Wildlife Service, unpublished data).

2.4 Habitat Requirements

Columbian white-tailed deer occupy habitat within the historical flood plain of the Columbia River. Habitat there is often classified as wetlands consisting of open pasture, shrubland, small mixed woodlots, commercial tree lots, and mixed coniferous/hardwood forests with a shrub understory. Pasture consists mainly of reed canary grass (*Phalaris arundinacea* L.). Woodlots consist of parallel rows of alder (*Alnus spp.*), willow (*Salix spp.*), and cottonwood (*Populus trichocarpa*). Forested areas consist of western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), alder, and willow, with a shrubby understory consisting largely of willow, dogwood (*Cornus spp.*), and both native and nonnative blackberry (*Rubus spp*.).

For example, habitat on JBH includes Sitka spruce (*Picea sitchensis*) intertidal swamp and scrub-shrub tidal wetland (Hunting and Price islands), cottonwood/willow swamp and scrub-shrub tidal wetlands (Wallace Island and portions of the Westport, Oregon mainland), and a mix of tidal marsh, reed canary grass pasture, old growth nonnative blackberry (*Rubus laciniatus*), cottonwood, and tidal wetland (Crims Island) (U.S. Fish and Wildlife Service 2013a, p. 23). On the JBH Mainland Unit, Service biologists often observe fawns in pastures of tall, dense reed canary grass and tall fescue (*Festuca arundinacea*), as well as mixed deciduous and Sitka spruce forest (U.S. Fish and Wildlife Service 1983, p. 10; Brookshier 2004, p. 2). Where lands are owned in fee title and intensively managed for deer, such as at JBH, population densities are managed for 35 to 40 deer per square mile, but have gone as high as 73 deer per square mile on Tenasillahe Island. On lands that are not actively managed, population densities of 20 to 25 deer per square mile can be expected.

The Carty Unit of Ridgefield National Wildlife Refuge (Ridgefield NWR) is comprised of mixed deciduous habitat with oak savannah. The area contains some areas of moderate to sparse reed canary grass, with upland meadows supporting a variety of grasses and forbs. This area also contains large areas of dry soils above the normal flood level. The Roth Unit represents more of a parkland mosaic, with dense deciduous tree stands and open meadows. The topography within this unit consists of fingers of high ground separated by swales. The three remaining units all contain large areas of low-lying meadow or seasonally-flooded wetlands with pockets of woody cover. Most of the open areas in the River S and Bachelor Island Units consist of low-lying meadows and wetlands.

Generally, white-tailed deer prefer edges and flat terrain (Geist 1998, p. 292). They are ecotone species, meaning they prefer areas of transition between two different biological communities. In the case of white-tailed deer, they use the edges between grasslands and forest (Geist 1998, p. 293) as well as marshlands between wet and dry ecosystems and estuaries between saltwater and freshwater. Columbian white-tailed deer select edges between habitats providing a mixture of woody cover and open areas, especially scrub-shrub, deciduous forest, and wetland herbaceous habitat types (Heale 2018, p. 28). Does preferred habitats that offered cover annually and seasonally, with cover sought out more strongly in winter than summer (Heale 2018, pp. 24, 28).

2.5 Dispersal and Distribution

Columbian white-tailed deer are nonmigratory and they exhibit variable sized home ranges from 59-520 ha (146-1,285 acres) in Douglas County (Smith 1991, p. 6) and from 19-317 ha (47-786 acres) in the Columbia River DPS (Gavin 1979, p. 106). Home range sizes vary depending on sex and age class with yearling and adult males having the largest home ranges on average (Table 1; Gavin 1979, p. 106). Home ranges are often linked to availability of cover, cognitive capacity (knowing one's surroundings), and density of obstacles. In other words, home ranges tend to be larger if there are few hiding places and home ranges tend to be smaller when there are many obstacles to facilitate escape from predators (Geist 1998, p. 284). Generally, white-tailed deer are not territorial (Smith 1991, p. 6), however, does will become more territorial near parturition, often reducing the size of the home range to stay closer to fawns once they are born (Geist 1998, p. 292). White-tailed deer are strong swimmers, taking readily to water (Geist 1998, p. 285). Columbian white-tailed deer have anecdotally been seen crossing the Columbia River, especially between the JBH Mainland Unit and Tenasillahe Island, which is separated by a 1.6 km (1 mile)-wide channel. However, we do not know the frequency of swimming events or if they are associated with particular times of year. We also do not know dispersal rates for Columbian white-tailed deer. While we do not know the extent of dispersal among the Columbian River DPS subpopulations, we can infer levels of dispersal based on other white-tailed deer data. These data indicate a relatively low survival risk of dispersal, with dispersal rates differing across landscapes (Haus et al 2019, p. 1185; Long et al 2021, p. 2735; Gilbertson et al 2022, p. 15). Evidence also suggests that roads and rivers are semi-permeable barriers to white-tailed deer dispersal that can influence dispersal behavior (Long et al 2010, p. 1247).

Table 1. Columbian white-tailed deer average home range sizes in hectares at JBH (Gavin 1979, p. 106).

	Males	Females
Fawn (n=12)	65	155
Yearling (n=15)	187	114
Adult (n=25)	209	104

Historical Distribution

Columbian white-tailed deer were formerly distributed throughout the bottomlands and prairie woodlands of the lower Columbia, Willamette, and Umpqua River basins in Oregon and southern Washington (Bailey 1936, p. 92; Verts and Carraway 1998, p. 479). The subspecies occupied a range of approximately 60,000 square kilometers (km^2) (23,170 square miles) west of the Cascades Mountains: from the Dalles, Oregon, in the east, to the Pacific Ocean in the west; and Lake Cushman in Mason County, Washington, in the north, to Grants Pass, Oregon, in the south (Crews 1939, p. 3)(Figure 3). Early accounts indicate that Columbian white-tailed deer were locally common, particularly in riparian areas along major rivers (Crews 1939, p. 5) until the arrival and settlement of pioneers in the fertile river valleys (Crews 1939, p. 2). Conversion of brushy riparian land to agriculture, urbanization, uncontrolled sport and commercial hunting, and perhaps other factors likely caused the extirpation of this deer over most of its range by the early 1900s (Crews 1939, pp. 2, 5). By 1940, a population of 500 to 700 animals along the lower Columbia River in Oregon and Washington, and a disjunct population of 200 to 300 in Douglas County, Oregon, survived (Crews 1939, p. 3; Gavin 1984, p. 487; Verts and Carraway 1998, p. 480). These two remnant populations remain geographically separated by about 320 km (200 miles), much of which is unsuitable or discontinuous habitat. At the time of listing, there were 300 to 400 deer estimated to reside in the Columbia River DPS.

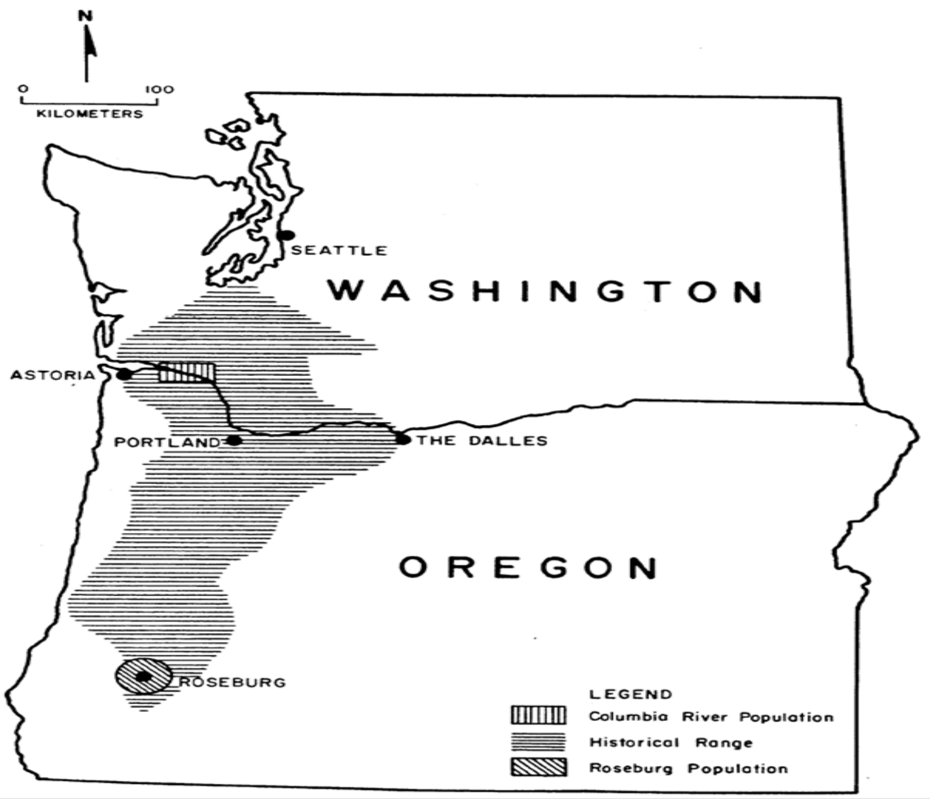

Figure 3. Historical range of the Columbian white-tailed deer (U.S. Fish and Wildlife Service 1983). The Roseburg population is now known as the Douglas County DPS.

Current Distribution
Columbian white-tailed deer currently occupy an area of approximately 25,000 ha (62,000 acres) in Clatsop, Multnomah, and Columbia Counties in Oregon, and Cowlitz, Wahkiakum, and Clark Counties in Washington (U.S. Fish and Wildlife Service, unpublished data)(Figure 4). While the deer do not currently reside in Pacific or Skamania Counties, they are listed as part of the Columbia River DPS there and suitable habitat is available for future range expansion.

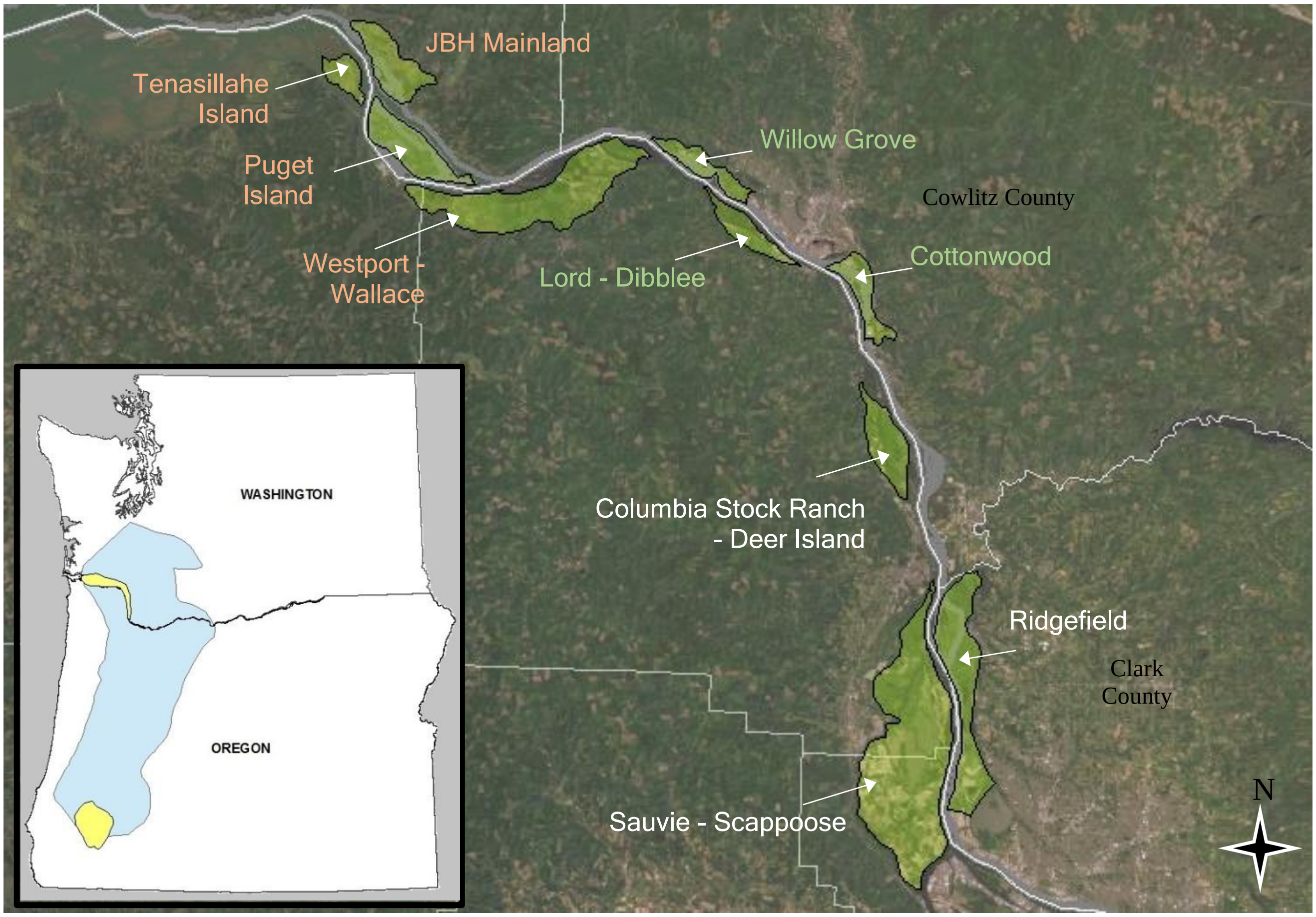

Figure 4. Current range of the Columbia River DPS of Columbian white-tailed deer (shown in green polygons), identifying the ten subpopulations. Inset map is the Columbia River Population (top yellow), the Douglas County DPS (bottom yellow), and the likely historical range (blue).

2.6 Ecological Needs

Habitat requirements for the successful development and survival of Columbian white-tailed deer individuals include cover, forage, and habitat edges. At this time, the known direct resource needs of Columbian white-tailed deer, by life stage, are summarized in Table 2.

Table 2. Resource needs of the Columbian white-tailed deer based on its life stages.

Life Stage	Timeline	Resource Needs
Fawn	Birth to 12 months	• Vegetative cover from predators • Thermal cover to reduce energy expenditure • Milk from mother until weaning, then foraging options
Yearling	12-18 months	• Vegetative cover from predators • Variety of graze and browse options • Habitat with edges between grasslands and forest • Protection from weather
Adult	Over 18 months	• Same as for a yearling, plus • Fawning areas with tall, dense cover

Based on the biology of the species and the information presented in the recovery plan, we determined that the resiliency of Columbian white-tailed deer subpopulations is dependent on an abundance of cover and forage distributed in a mosaic pattern with minimal amounts of invasive plants. Resilient subpopulations would also contain a minimum of 50 deer. Ideally, at the species level, resilient subpopulations would be distributed across the range of the species (redundancy and representation) and have connectivity across the landscape (redundancy and representation).

Chapter 3. Factors Influencing Viability

It is hypothesized that the extirpation of Columbian white-tailed deer over most of its range occurred by the early 1900s from conversion of brushy riparian land to agriculture, urbanization, and uncontrolled sport and commercial hunting (U.S. Fish and Wildlife Service 2003, p. 43647). Since listing, detailed threats assessments for Columbian white-tailed deer have been undertaken for the purposes of recovery planning (U.S. Fish and Wildlife Service 1983) and status assessment (U.S. Fish and Wildlife Service 2013a; 2016b). In 1983, the recovery plan identified the greatest anthropogenic threat to Columbian white-tailed deer as the continued degradation of riparian habitats through logging and brush removal followed by vehicle collisions, poaching, entanglement in barbed wire fences, and competition with livestock (U.S. Fish and Wildlife Service 1983, p. 18). Flooding was identified as the most significant natural threat followed by high tides, disease (foot rot), parasites (stomach worms), competition with elk (*Cervus canadensis*) and black-tailed deer, and hybridization with black-tailed deer (U.S. Fish and Wildlife Service 1983, p. 18). While some of the aforementioned threats such as vehicle collisions occur in limited instances, they do not rise to the level of subpopulation-level threats. Therefore, they will not be discussed in this SSA. Some previous assessments have discussed threats in terms of the five factors identified in the Act. However, the threats can also be understood in terms of their effect on the species' ability to maintain resiliency, redundancy and representation, that is, their effect on the species viability. Below we discuss habitat related stressors, disease, predation, hybridization, and climate change.

3.1 Habitat-related Stressors

Loss of habitat is suspected as a key factor in historical Columbian white-tailed deer declines, as over 12,140 ha (30,000 acres) of habitat along the lower Columbia River were converted for residential and agricultural use from 1870 to 1970 (Northwest Power Conservation Council 2004, p. III, 13-13). Columbian white-tailed deer evolved as a prairie edge/woodland-associated species that were not confined to river valleys. The Columbia River DPS population has been forced by anthropogenic factors into the wetter lowland areas it now inhabits such that urban, suburban, and agricultural areas now limit connectivity and population expansion. Though limited access to high-quality upland habitat in the Columbia River DPS remains the most prominent hindrance to Columbian white-tailed deer expansion today, the majority of habitat loss and fragmentation has already occurred. Significant future changes are not anticipated to currently available habitat for the Columbia River DPS from residential or agricultural use.

Historical habitat loss was mainly centered on development that fragmented the landscape. Habitat loss from human development still remains a factor today, though in many instances, the severity of impacts is less than previously thought and Columbian white-tailed deer response depends on the type of development and human population distribution. For instance, Multnomah County has the highest human population size and density in Oregon (Table 3). Development in this County will continue, especially around the city of Portland, and habitat in that area will be limited for Columbian white-tailed deer. If development pushes deer outward, Pacific and Skamania Counties, Washington on the eastern and western peripheries of the range, could potentially support the displaced deer as they contain suitable habitat yet do not currently contain any Columbian white-tailed deer subpopulations. Utilizing this unoccupied habitat may require translocating deer to these Counties. Puget Island in Wahkiakum County, Washington has supported stable and persistent Columbian white-tailed deer populations despite changes in land use from large agricultural farms into smaller hobby farms. This may be in part because Wahkiakum County has the lowest human population total and the second lowest population density in the deer's range (Table 3). Even though the County experienced an increase in population size between 2010 and 2020, this change has not inhibited the ability of Columbian white-tailed deer to maintain a stable population on the island. Development has occurred at a swift pace in some locations, particularly in Clark County. For instance, the town of Ridgefield, Washington's current human pop is now 2.5 times its population from 10 years ago (see https://www.census.gov/quickfacts/ridgefieldcitywashington). While Ridgefield NWR adjacent to the town will not be developed, lands surrounding the refuge may continue growing at this pace. The consequences of increased development include habitat loss, potentially further isolating adjacent deer populations. In addition, Columbian white-tailed deer populations have been established in semi-rural, privately owned lands near Willow Grove in Cowlitz County, Washington and Dibblee Point in Columbia County, Oregon. These areas are near the larger urban center of Longview, Washington and will likely see a continued change from an agricultural to a suburban landscape, thus limiting habitat for deer. However, these counties are experiencing the smallest amount of human population growth and the effect on Columbian white-tailed deer will likely depend on the density of development.

Table 3. Population data by county in the range of the Columbian white-tailed deer Columbia River DPS (from the 2020 U.S. Census).

	County	Columbian White-tailed Deer Total (2022)	Human Population Density*	Human Population Total	Percent Change (2010–2020)
Oregon	Clatsop	357	49.6	41,072	10.9
	Columbia	179	79.8	52,589	6.6
	Multnomah	35	1,891.2	815,428	10.9
Washington	Clark	262	800.8	503,311	18.3
	Cowlitz	125	97.0	110,730	8.1
	Pacific	0	25.0	23,365	11.7
	Skamania	0	7.3	12,036	8.8
	Wahkiakum	338	16.8	4,422	11.2
	Total	**1,296**		**1,562,953**	

*People per square mile

Habitat loss also arises from invasion of nonnative plants. The persistence of invasive species, especially reed canary grass, has reduced forage quality over much of the Columbian white-tailed deer range but we do not know to what degree it affects overall habitat quality and quantity since we do not have those data for the DPS. It also remains unclear as to how much this change in forage quality is affecting the overall species status. While Columbian white-tailed deer will eat reed canary grass, it is only palatable for about 2 months in spring, and it is not a preferred forage species. Columbian white-tailed deer will drop their fawns in reed canary grass, which provides cover and protection to vulnerable fawns. Cattle grazing has been used on JBH lands to control the growth of reed canary grass along with tilling and planting of pasture grasses and forbs. This management entails a large effort that will likely be required on a continual basis unless other control options are discovered. Reed canary grass is often suppressed in agricultural and suburban landscapes, but remote areas, such as the upriver islands, experience little control. Reed canary grass thrives in wet soil. Increased groundwater due to sea level rise or subsidence of diked lands may exacerbate this problem by extending the area impacted by reed canary grass. However, where groundwater levels rise high enough, reed canary grass will be drowned out and eradicated, though this rise in water level may also negatively affect Columbian white-tailed deer. The total area occupied by reed canary grass in the future may therefore decrease, remain the same, or increase, depending on topography and/or land management.

In recent years, the Bonneville Power Administration and some landowners have expressed interest in restoring the natural tidal regime of the Columbia River to some of the land inhabited by deer for fish habitat enhancement. Such a change would permanently eliminate suitable habitat for Columbian white-tailed deer. If this were to occur, the deer would need to move to alternative areas containing a sufficient amount of protected habitat either via natural movement or via translocations by land managers; yet there are limited areas of suitable size for new subpopulations of Columbian white-tailed deer within the Columbia River DPS. Eliminating existing suitable habitat would alter the abundance, dispersal probability, and demographics of Columbian white-tailed deer subpopulations.

3.2 Disease

Necrobacillosis is a bacterial disease that can cause necrotic stomatitis and foot rot (hoof disease) in addition to necrotic lesions in a variety of organs such as the liver and kidney. Several anaerobic bacteria have been identified in this disease, many of which are common commensal flora in the ruminant gastrointestinal tract. Coarse forage or coarse substrate are thought to cause breaks in the oral mucosa (necrotic stomatitis) or interdigital space (foot rot), which result in tissue invasion and infection under moist conditions. Additionally, there is evidence of a connection between digital necrobacillosis with high precipitation events and high air temperature (Handeland et al 2010, p. 37). Deer on the JBH Mainland Unit and Puget Island have occasionally displayed visible evidence of hoof disease like foot rot, likely contributing to low levels of illness and mortality. However, its prevalence is not known to be a limiting factor in population growth (U.S. Fish and Wildlife Service 2010, p. 4-53). Of the 49 deer captured from the JBH Mainland Unit and Puget Island in 2013, none displayed evidence of hoof disease (U.S. Fish and Wildlife Service, unpublished data). Likewise, none of the 37 deer captured on Tenasillahe Island and released on Columbia Stock Ranch between 2020 and 2022 showed evidence of hoof disease (U.S. Fish and Wildlife Service, unpublished data). At this time, hoof disease does not represent a subpopulation-level threat. However, with the increase of flooding events predicted by climate models and the possible increase in ground water levels due to sea-level rise, hoof disease may rise to a subpopulation-level threat in the future.

Hemorrhagic disease is a common term referring to illness in domestic and wild ruminants caused by either epizootic hemorrhagic disease virus (EHDV) or bluetongue virus (BTV). Spread by biting midges (family Ceratopogonidae), not through direct animal-to-animal contact, these viruses are related and are difficult to distinguish clinically. Mortality resulting from these diseases is often concentrated in late summer to early fall as declining water levels and heat provide suitable breeding habitat for the midge vector infecting deer that congregate in remaining late-summer water sources. Both EHDV and BTV are more common in dry conditions, especially when coupled with drought, and fade after the first hard frost kills the midge population. In Oregon, EHDV was confirmed present in 2014 and BTV was confirmed in 2019 (Oregon Department of Fish and Wildlife 2021, website). Antibodies to EHDV were detected in 1 out of 42 Columbian white-tailed deer captured for translocation from JBH in recent years, while BTV antibodies were detected in 1 out of 37 deer from Tenasillahe Island (U.S. Fish and Wildlife Service, unpublished data). These deer may have encountered a virus in previous years and still carried antibodies. In Washington, the most recent outbreak of EHD and BTV killed at least 39 deer in 2021 (Washington Department of Fish and Wildlife 2021, website), however, viral outbreaks have not been detected within the range of the Columbia River DPS.

Adenovirus hemorrhagic disease (AHD) is often confused with EHDV and BTV based on similar clinical signs and seasonal occurrence in late summer/fall; however, transmission is via direct or indirect contact rather than being transmitted via an insect vector. Oregon confirmed its first case of AHD in 2001 in southwest Oregon (Oregon Department of Fish and Wildlife 2021, website). Since then, AHD has been widespread throughout the state, affecting mule deer, black-tailed deer and white-tailed deer. Adenovirus hemorrhagic disease was confirmed as cause of death in a Columbian white-tailed deer in December 2019 near Clatskanie, Oregon, with periodic localized outbreaks occurring in nearby surrounding areas (K. Licence 2019, pers. comm). Washington confirmed its first case of AHD in 2017 in Klickitat County (Washington Department of Fish and Wildlife 2021, website). Antibodies indicating exposure to AHD were identified in 3 out of 37 Columbian white-tailed deer captured and tested from Tenasillahe Island in recent years (U.S. Fish and Wildlife Service, unpublished data). These deer may have encountered a virus in previous years and still carried antibodies; however, they did not show any signs of disease. Significant subpopulation-level impacts to this species have not been documented. Future changes in climate and hydrology may result in expansion of these viruses with increased risk for Columbian white-tailed deer.

Chronic wasting disease (CWD) is now considered to be the most important disease threatening North American cervids, including deer, elk, caribou and moose. As of August 2024, it is known to occur in 475 counties within 35 states and four Canadian provinces with continued spread each year (CDC data, 2024). In 2021, CWD was detected in Idaho for the first time, near the border with Washington. In response to this detection, the Washington State Legislature provided funding for WDFW to conduct a CWD Pre-Detection Surveillance Program to test harvested, road-killed, and opportunistically found dead deer in eastern Washington. In summer 2024, Washington's first confirmed case of CWD was detected in the Fairwood area of Spokane County in a Northwest white-tailed deer. There are now six confirmed detections in two counties, all within Northwest white-tailed deer, as of December 2024. The WDFW continues to coordinate with federal and other state agencies, tribes, hunting organizations, taxidermists, and meat processors to collect samples to test for CWD. While sampling of all animals is currently limited to the incident response area, WDFW continues to sample suspect cases statewide and tests all Columbian white-tailed deer samples that are collected (T. Ott 2024, pers. comm). To potentially slow the spread of CWD, changes have been made to state rules that impact hunters, game salvagers, and people who feed wildlife. On March 24, 2025, the WDFW director approved proposals to (1) ban feeding deer, elk, or moose statewide, including baiting while hunting; (2) limit transporting harvested deer, elk, and moose (cervids) in Washington, importing meat and other cervid parts into Washington, and using scent lures derived from cervid urine or glandular materials; and (3) make CWD testing mandatory of harvested and salvaged cervids in any WDFW region where CWD has been detected (https://wdfw.wa.gov/newsroom/news-release/wdfw-approves-new-rules-limit-spread-chronic-wasting-disease). Currently, CWD has only been detected in WDFW's Eastern Region. This disease has not been detected in Oregon. The ODFW began testing for CWD in 1996 with over 30,000 deer and elk sampled for the disease to date from hunter-harvest animals, roadkill, and animals found dead or sick in the field (https://myodfw.com/CWD). Since 2002, ODFW has focused on prevention and surveillance of CWD guided by a team of biologists and veterinarians following an internal CWD plan not available to the public. In January 2022, the new HB 3152 bill in Oregon began requiring hunter check station stops so that carcasses could be tested for CWD.

Chronic wasting disease is always-fatal transmissible neurologic disease caused by abnormally folded proteins called prions with no treatment or cure. The disease is classified as a transmissible spongiform encephalopathy and is similar to scrapie in sheep, mad cow disease in cattle, and Creutzfeldt-Jakob disease in humans. As the disease progresses, the animal begins to display abnormal behavior, loses weight, and loses control of normal bodily functions. Animals may show no visible signs of illness for a year or more after infection, such that deer may be infected and shedding the prion even if they look healthy. The disease is contagious, with infectious prions passed through direct animal-to-animal contact, as well as indirectly through prion-contaminated environments. Once infected, the animal sheds prions through saliva, urine and feces, and infected carcasses contribute to environmental contamination. Once in soil, CWD prions remain infectious for decades because prions are difficult to remove from the environment. We do not know exactly how long prions can remain in soil. Detecting the disease is also challenging because tests on live animals are still being developed. Current testing methods look for the infectious prions in lymph nodes and brain stem samples from dead animals; however, these prions may not be detected in animals in the early stages of the disease. Recent testing did not detect CWD in five samples of live deer and three samples of dead deer from Tenasillahe Island in 2020, and CWD was not detected in three samples collected from dead deer in 2023 (U.S. Fish and Wildlife Service, unpublished data). White-tailed deer dispersal movements are generally brief and direct, which may reduce the likelihood of disease transmission occurring during dispersal events (Long et al 2010, p. 1246). In the future, CWD may rise to a subpopulation-level threat if it is detected in the DPS.

3.3 Predation

Coyote predation is thought to have the most significant impact on Columbian white-tailed deer fawn recruitment throughout the DPS. On the JBH Mainland Unit, 116 fawns were fitted with radio collars and tracked for the first 150 days of age from 1978 to 1982 and 1996 to 2000. Results demonstrated a 23 percent survival rate (27 of 116) with disease and starvation accounting for 16 percent of known fawn mortalities and coyote predation accounting for 69 percent of documented mortalities (Clark et al. 2010, pp. 8-9). This number is consistent with studies of white-tailed deer in Texas, where coyotes caused 53 to 80 percent and 10 to 60 percent of fawn mortality, as well as studies of other ungulates (summarized by Connelly 1981, pp. 384-386). A more recent analysis of fawn survival used 29 populations across 16 states east of the Rocky Mountains along with two study sites in Pennsylvania to investigate patterns across landscapes and densities (Gingery et al 2018, pp. 1005-1006). This metanalysis determined that predation was the most common cause of death, with canids being the primary culprit and that agricultural land cover increased fawn survival even though natural sources of mortality did not differ across landscape types (Gingery et al 2018, pp. 1010-1011). To evaluate the effect of coyote removal on fawn survival and recruitment, a research study removed 474 coyotes over 3 years in South Carolina (corresponding to a removal rate of 1.63 coyotes/km^2) and captured neonate data from 135 adult does (Kilgo et al 2014, p. 1265). While an increase in fawn survival occurred initially from coyote removal, the result was modest because the magnitude of the increase and consistency across years were inconsistent and coyotes continued to account for more than 70 percent of mortality (Kilgo et al 2014, pp. 1267-1258). The studies did not find a relationship between fawn survival and deer density in any habitat type (Gingery et al 2018, p. 1011) or between fawn survival and the amount of vegetative cover available (Kilgo et al 2014, p. 1267). The latter result also did not differ before or during coyote removal periods (Kilgo et al 2014, p. 1267). The mean age of Columbian white-tailed deer fawns killed by coyotes was 40 days, primarily in June, July, and August, and the survival rate was higher in years when coyote removal occurred (Clark et al. 2010, p. 9). However, coyote predation is unlikely to rise to a DPS-level threat. Recent fawn:doe ratios in this DPS suggest that 22 to 44 percent of fawns born are recruited into the population. A modeling study found adult female survival was the most important factor influencing white-tailed deer growth rates and even 25 percent fawn survival rates were unlikely to result in a population decline in an unhunted population (Robinson et al. 2014, p. 78).

Coyote control occurs in the Columbia River DPS to potentially improve fawn survival. The JBH Refuge removes coyotes as necessary per their Comprehensive Conservation Plan (CCP) to maximize survival rates of adults and juveniles and promote healthy deer herds on refuge management units (U.S. Fish and Wildlife Service 2010, p. 2-52). On the JBH Mainland Unit, 12 coyotes were removed in 1997, one in 1998, four in 2005, 11 in 2006, and eight in 2007 (U.S. Fish and Wildlife Service 2010, p. 4-33). At Tenasillahe Island, the number removed was 12 in 2004, six in 2005, four in 2006, and five in 2007 (U.S. Fish and Wildlife Service 2010, p. 4-33). The lethal coyote control used on the refuge did not seem to affect the local coyote population. Therefore, JBH shifted the timing of coyote removal in 2008 from winter/early spring to the critical fawning period of June-September. Since then, an average of 37 fawns to 100 does has been maintained. Coyote removal continues on JBH as funding allows per the criteria established in the CCP. In FY2024 and 2025, the Refuge will not have enough funds to implement coyote control. The impact of halting coyote control is unclear as the effect on the overall coyote population or on fawn survival is uncertain (P. Meyers 2021, pers. comm). Ridgefield NWR implemented a coyote control program in May 2013, to support the newly translocated Columbian white-tailed deer. The decision to conduct predator control is made on a yearly basis depending on the previous fall's fawn:doe ratios and the estimated deer population. No coyote control occurs when deer numbers are greater than 25 percent above the population objective (i.e., 100 animals). Coyote control would be triggered by 1) very low fawn:doe ratios, 2) very low deer numbers, or 3) a moderate combination of both (U. S. Fish and Wildlife Service 2013c, p. 9). Coyote control ended following translocations because the subpopulation has been steadily growing and the threshold for initiating control in their CCP has not been reached (A. Chmielewski 2021, pers. comm). The relatively recent published studies on the effects of coyote predation on fawn survival has found weak evidence that coyote control can increase fawn survival when implementing a much greater coyote control effort than has been implemented for Columbian white-tailed deer.

Coyote population estimates do not exist for the Columbia River DPS area. Generally, coyotes are ubiquitous and predator control does not occur in all Columbian white-tailed deer habitat. For instance, coyote densities and home ranges on JBH are unknown, but coyotes are observably common throughout the year (U.S. Fish and Wildlife Service 2010, p. 4-33). While predation remains a potential stressor to subpopulations, predation by coyotes is manageable and does not put the DPS at risk of extinction.

3.4 Hybridization

In areas where white-tailed deer and mule deer overlap, hybridization can occur. We do not have information on how hybridization specifically occurs between Columbian white-tailed deer and black-tailed deer. It is likely to occur in a similar fashion to areas where white-tailed deer and mule deer both reside in other locations. Typically, hybrids arise from a white-tailed deer buck mating with a mule deer female because of differences in mate searching behavior, courtship behavior, and male defense strategies of females (Geist 1998, pp. 294-295). However, mule deer bucks have been seen mating with white-tailed does that solicit mating (Geist 1998, p. 295). Removal of large mule deer bucks aids hybridization because it gives the smaller white-tailed bucks access to mule deer females that they normally would not have. When mating is successful, hybrid deer often resemble white-tailed deer with similar coloring and metatarsal glands.

Hybridization may impair a deer’s ability to escape predators, leading to higher mortality. When facing predators, white-tailed deer run in a fast rotary gallop and avoid obstacles, whereas mule deer run in a more efficient, yet slower transverse gallop, and seek obstacles out while also stotting (Geist 1998, pp. 282, 296). Stotting is when a deer springs into the air, lifting all four feet off the ground simultaneously. Hybrids cannot run as quickly as white-tailed deer; they do not stott correctly, often hitting obstacles; and they exhibit delayed decision responses, such as what to do when faced with a potential predator (dog)(Geist 1998, p. 296).

In Columbian white-tailed deer, Gavin and May (1988, p. 6) found evidence of hybridization in 6 of 33 samples on the JBH Mainland Unit and surrounding area by analyzing electrophoretic loci. A later study employing mtDNA analysis revealed evidence of hybridization on Tenasillahe Island, but not the JBH Mainland Unit (Piaggio and Hopken 2009, p. 18). On Tenasillahe Island, 8 of 25 deer (32 percent) tested and identified as Columbian white-tailed deer contained black-tailed deer haplotypes. Preliminary evidence shows some hybrids predominantly exhibit white-tailed deer features with the exception of a stubby tail in some, but not all, individuals. This suggests molecular analysis may be the only evaluative tool available to track hybridization trends. These data suggest that these genes may have been due to a single hybridization event that is continuing to affect successive generations of deer through the Tenasillahe Island population.

Given the history of translocation activities, it is possible that some level of hybridization already exists throughout the DPS, yet white-tailed deer and black-tailed deer naturally stratify themselves in the environment. White-tailed deer generally prefer flat terrain near edges and lower elevation areas with gradients less than 20 degrees whereas mule deer prefer steeper slopes and more densely forested areas (Geist 1998, p. 292). Where the two species overlap, different antipredator strategies may also create natural segregation with white-tailed deer in areas of broken cover, grazing in open areas around dusk and dawn while mule deer will be in areas of unbroken cover, grazing in open areas in daylight in larger groups (Geist 1998, p. 292). Hybrid deer will stay with their mothers in small family groups so some intermixing will occur for a short time period. Refuge staff occasionally see Columbian white-tailed deer with black-tailed deer characteristics such as a short tail, but hybridization was likely an historical occurrence rather than a recent event (Hopken et al. 2015, p. 644). While hybridization is occurring, it is unlikely to rise to a subpopulation-level effect in this DPS given the behavior and habitat preferences of these two ungulate species.

3.5 Climate Change

Between 1895 and 2011, temperatures in the Pacific Northwest rose an average of 0.72 degrees Celsius (˚C) (1.3 degrees Fahrenheit (˚F)) and they are expected to continue to warm from 0.11 ˚C to 0.45 ˚C (0.2 ˚ to 1 ˚F) per decade (Mote and Salathe 2010, p. 29; Mote et al. 2014, p. 489). University of Washington researchers developed fine-resolution regional, predictive climate models that account for local terrain and other factors affecting weather (e.g., snow cover, cloudiness, soil moisture, and circulation patterns) in the Pacific Northwest (Salathe et al. 2010, entire). Collectively, the models project increased average temperatures across all seasons; warmer, drier summers and warmer, wetter autumns and winters, which will likely result in diminished snowpack; earlier snowmelt; and an increase in extreme heat waves and precipitation events such as flooding over the next 50 to 100 years (Mote et al. 2008, pp. 203-204; Salathe et al. 2010, pp. 72-73; Doppelt et al. 2009, entire; U.S. Fish and Wildlife Service 2017, p. B-3).

Of the various climate change-induced impacts predicted to affect habitats in the Pacific Northwest, climate change-induced sea level rise (SLR) is expected to be the most immediately impactful to coastal habitats and tidally influenced river systems, such as the lower Columbia River (Jay et al. 2018, p. 43). Rising sea levels represent a long-term stressor for Columbian white-tailed deer occupying low-lying habitat that is not adequately protected by well-maintained dikes. Sea level changes are influenced by many variables including changes in winds, air pressure, air-sea heat variability, and ocean currents. Rates of sea level change from 1992-2016 show a large west-to-east difference in sea level rise rates across the Pacific Basin with trends being much lower (<1 mm/year) in regions of the U.S. West Coast than the global rate of 3.4 ± 0.4 mm/year (Sweet et al. 2017, pp. 8-9). Given the uncertainty of how much sea level rise would occur and over what timeframe, it is difficult to determine the overall impact of sea level change on Columbian white-tailed deer in the Columbia River DPS. Rising sea levels over the next century could degrade or inundate current habitat, forcing Columbian white-tailed deer to move out of currently occupied habitat along the Columbia River into marginal or more developed habitat or into areas currently dominated by black-tailed deer. The lower Columbia River and estuary are influenced by ocean tides with tidal wetlands being created where the influences of ocean tide and upstream river flow result in periodic inundation by water. As sea levels rise, the range of tides would shift higher in elevation resulting in permanent, rather than temporary, inundation and permanent habitat loss for deer. It can also create wetlands at higher elevation, shifting the habitat available for deer, or result in more frequent flooding events, eliminating deer habitat temporarily or permanently.

The riparian habitats, bottomlands, and tidelands that Columbian white-tailed deer occupy are vulnerable to periodic major flooding events. Flooding influences Columbian white-tailed deer viability when grazing and fawning grounds become inundated for prolonged periods, and the risk of large flooding events could increase with impacts of climate change. In the past, significant flooding events have caused large-scale Columbian white-tailed deer mortality and emigration from the JBH Mainland Unit (U.S. Fish and Wildlife Service 2007, p. 1). The JBH Mainland Unit has experienced three storm-related floods since 1996. These flooding events have been associated with a sudden drop in population numbers followed by a recovery over the next few years. In 1996, deer were in poor condition prior to flooding that resulted in an estimated loss of 50 percent of the deer, with starvation due to the flooding of habitat being the major cause of death rather than drowning (U.S. Fish and Wildlife Service 1996, unpublished data). During some historical flooding events, Columbian white-tailed deer have left low-lying areas and did not return (particularly in areas that continued to sustain frequent flooding, for example Karlson Island). An increased rate of occurrence of flooding events, however, could hinder the ability of subpopulations to rebound. The potential for increased numbers of flooding events could also lead to increases in the occurrence of hoof disease and other deer maladies.

A large proportion of occupied Columbian white-tailed deer habitat is land that was reclaimed from tidal inundation by construction of dikes and levees for agricultural use in the early twentieth century (U.S. Fish and Wildlife Service 2010, p. 4-22). While levees prevent direct flow of water into large portions of the Columbian white-tailed deer range, leaching of water through the levee does occur. As tide levels rise with sea level, this leaching will also increase, raising ground water levels. A rise in groundwater levels could lower forage quality and allow invasive plants to expand their range into new areas.

Maintaining the integrity of existing water barriers that protect Columbian white-tailed deer habitat will be important for the Columbia River DPS yet challenges exist. For instance, the Service does not own the levee that protects the JBH Mainland subpopulation. Therefore, we cannot use Service funding to alter the levee. Likewise, the current estimated cost to raise the height of the levee surrounding Tenasillahe Island is unattainable under current budget forecasts. Since 2009, three new tidegates have been installed on the JBH Mainland Unit to increase fish passage and facilitate water drainage. While helpful, the tidegates will not be sufficient to remove all the water in the event of another large-scale flood. Rather, the tidegates will open once the water recedes. Because of the imminent failure at a point of erosion in the Steamboat Slough Road dike, a setback dike was constructed in late 2013 and an estuarine buffer was created to provide additional protection from flooding to the JBH Mainland Unit.

Overall, Columbian white-tailed deer exposure to climate change may occur from increased flooding, increased extreme precipitation events, increased disease outbreaks, and sea level rise. Locating additional available habitat outside of forecasted flooding zones would likely be necessary for future translocations to help offset loss from sea level rise and future flooding events.

3.6 Conservation Measures

Conservation measures are ongoing efforts that offset negative influences on Columbian white-tailed deer viability. These actions are performed by Federal, State and County agencies; non-governmental organizations; and Tribes. Collectively, the entities that manage lands have acquired conservation easements and conducted management actions to benefit Columbian white-tailed deer and their habitat. Recovery actions for the Columbian white-tailed deer have focused on managing existing subpopulations, protecting habitat, and establishing new subpopulations.

Management practices to maintain or enhance Columbian white-tailed deer habitat include mowing and seeding to provide palatable grasses and legumes in managed fields; planting native trees and shrubs to increase the amount and distribution of woody vegetation; restoring emergent wetlands to provide a diversity of herbaceous vegetation; weed control and removal of nonnative plants; fence removal or installation depending on the usage; restricting public access to minimize disturbance to deer; seasonal cattle grazing; and controlling competing and predatory wildlife such as elk and coyotes.

As the refuge's name implies, JBH was established for, and managed specifically, to protect the Columbian white-tailed deer. The National Wildlife Refuge System Improvement Act of 1997 serves as the parent legislation for the Refuge System. This act identifies the mission of the Refuge System; requires the Secretary of the Interior to maintain the biological integrity, diversity, and environmental health of refuge lands; mandates a "wildlife first" policy on refuges; and requires comprehensive conservation planning. The purposes of a refuge are derived from legislative authorities that established the refuge. The purposes guide the long-term management of the refuge, prioritize land acquisition, and play a key role in determining the compatibility of proposed public uses. In accordance with the National Wildlife Refuge System Administration Act of 1966, as amended (16 U.S.C. § 688dd-688ee), all lands acquired subsequent to the establishment of a refuge retain the original purpose for which the refuge was established. Because JBH was originally established for the preservation and management of Columbian white-tailed deer, this purpose represents the highest priority for refuge management and new land added to the refuge would retain this purpose - the preservation of Columbian white-tailed deer and its habitat. Purposes for JBH are identified in legal documentation establishing and adding lands to the refuge and are described in detail in the JBH's 2010 Comprehensive Conservation Plan (CCP). The National Wildlife Refuge System Improvement Act of 1997 requires that every national wildlife refuge develop a CCP and revise it every 15 years, as needed. A CCP ensures that each national wildlife refuge unit is managed to fulfill the purpose(s) for which it was established. The plan also ensures the refuge's partnership with its surrounding communities. The JBH CCP lays out various goals and objectives for managing habitats in optimal condition for Columbian white-tailed deer and sets goals for deer demographics. Objective 2.9.5.2 calls for "*establishing healthy populations of Columbian white-tailed deer off of refuge lands.*", because existing refuge lands represent only a tiny fraction of the historical range of the Columbia River DPS and deer presently occupy only a small fraction of that range. Although much of the original habitat has been developed, there are still thousands of acres that could support reintroduced deer. The JBH Refuge is in the process of developing a Land Protection Plan and Environmental Assessment to evaluate alternatives for expansion of the refuge.

Since the publication of the recovery plan, restoration activities on the JBH Mainland Unit have improved the quality of habitat by establishing cover and providing forage for Columbian white-tailed deer. Roughly 40 ha (100 acres) were planted to establish woodland cover from 2000 to 2007, and an additional 81 ha (200 acres) were planted from 2007 to present. Currently about 121 ha (300 acres) of pasture enhancement occurs on a 5 to 7-year rotation (U.S. Fish and Wildlife Service 2010, p. 2-38). Cover species include willow, red alder (*Alnus rubra*), black cottonwood, Sitka spruce, western red cedar, cascara (*Rhamnus purshiana*), and big-leaf maple (*Acer macrophyllum*). An active cattle grazing regime on the JBH Mainland Unit reduces the presence of reed canary grass and keeps pasture grasses young and high in protein, which is preferable to Columbian white-tailed deer (Gavin 1979, p. 128). In 2022, cattle grazed approximately 281 ha (694 acres) of the JBH Mainland Unit and Tenasillahe Island annually (U.S. Fish and Wildlife Service, unpublished data). As of 2021, Ridgefield NWR has restored about 26 ha (65 acres) of pasture and reed canary grass swales to shrub/floodplain forest with the following species: willow, cottonwood, Oregon ash (*Fraxinus latifolia*), Indian plum (*Oemleria cerasiformis*), Nootka rose (*Rosa nutkana*), dogwood, and snowberry (*Symphoricarpos* spp). They have also established 20 standard apple trees, which provide both food and cover for deer, and have planted roughly 10 ha (25 acres) of buckwheat (*Fagopyrum esculentum*), sunflowers (*Helianthus annuus*), and plow down (a green manure crop of mixed legumes and grains) every year since 2016. Cattle grazing occurs on approximately 301 ha (745 acres) per year at Ridgefield NWR.

In 2003, Bonneville Power Administration (BPA) initiated a programmatic consultation for their Habitat Improvement Program. The consultation has gone through multiple iterations with the most recent one signed in 2020. The action area for this consultation is the Columbia River Basin within the contiguous United States and consists of land management activities that are within the range of Columbian white-tailed deer. The BPA funds habitat improvement activities to fulfill its obligations under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Public Law 96-501), and to meet its obligations under the Act. The programmatic consultation contains conservation measures to avoid, minimize, or mitigate affects to Columbian white-tailed deer or its habitat from BPA’s restoration projects in both Oregon and Washington.

The Service, BPA, and the U.S. Army Corps of Engineers (the parties) signed a Memorandum of Understanding (MOU) entitled “Promoting Columbia River Estuary Habitat Protection and Improvement for Anadromous Fish and Columbian White-Tailed Deer” in 2017. The intent of the MOU was to recognize that the parties’ all share interests in acquiring, protecting, and improving habitat in the Columbia River estuary, to benefit species listed for protection under the Act. Specifically, the parties intend to coordinate their efforts under this MOU to ensure that habitat improvement projects in the estuary consider the needs of both terrestrial and aquatic species with a goal to provide habitat protection and improvement that results in a more productive, resilient, and secure estuary ecosystem. The MOU expired in 2022 and at this time, BPA has opted not to move forward with a new or revised MOU.

Translocations have played a vital role in establishing new subpopulations or augmenting existing subpopulations. Since 1985, 396 deer have been moved throughout the DPS (Table 4). The recovery plan identified Puget Island and the Westport area as suitable sources for Columbian white-tailed deer translocations due in large part to their population stability. Subsequently, these two locations have been the donor source for numerous translocations over the last 35 years. The most recent translocations have focused on moving deer from Tenasillahe Island to create the new Columbia Stock Ranch (CSR) subpopulation. Removal of Columbian white-tailed deer from these locations on multiple occasions for the purpose of translocation has not resulted in any long-lasting decrease in donor population numbers. While the donor population declined with the removal of deer, the population estimates at the next survey point showed an increase in donor numbers (U.S. Fish and Wildlife Service, unpublished data).

Table 4. Translocation history of Columbian white-tailed deer.

Name of Unit Receiving Deer	Year	Number of Deer Moved	Source of Deer
JBH Mainland Unit	2006	5	Puget Island/Westport
	2009	20	Tenasillahe Island
	2010	8	Roseburg, OR
Tenasillahe Island	1985	17	Puget Island
	1986	21	Puget Island
	1987	20	Puget Island
	1988	22	Puget Island
Crims Island	1999	30	Puget Island/Westport
	2000	31	Puget Island/Westport
	2006	5	Puget Island/Westport
Lord/Walker Island	2003	16	Westport
	2004	8	Westport
	2006	9	Westport
Fisher/Hump Island	2003	12	Puget Island/JBH
	2004	11	Puget Island
	2006	10	Puget Island
Cottonwood Island	2010	15	Westport
	2013	12	Puget Island
Ridgefield NWR	2013	37	JBH Mainland
	2014	21	Westport, Puget Island
	2015	29	Westport, Puget Island
Columbia Stock Ranch	2020	15	Tenasillahe Island
	2021	12	Tenasillahe Island
	2022	10	Tenasillahe Island
Total		**396**	

In 2023, the Service created and signed a Disease Contingency Plan (DCP) with assistance from the Wildlife Health Office (part of the National Wildlife Refuge System's Natural Resource Program Center) and input from our State partners and Tribes. The DCP includes both JBH and Ridgefield NWRs, as well as information about lands adjacent to the Refuges. It provides a history of disease outbreaks and testing; prevention and surveillance techniques; disease management and response; communication and outreach; and more. It also contains an appendix specific to CWD. Although there is no cure for CWD, having a plan for prevention, surveillance, and response may minimize the likelihood that CWD enters the DPS or reduce the impacts of the disease once it is present on the landscape. The CWD appendix relies heavily on the Association of Fish and Wildlife Agencies Best Management Practices for Prevention, Surveillance, and Management of Chronic Wasting Disease created in 2018. In addition to the DCP, both Oregon and Washington States have CWD plans that follow similar guidelines.

The Washington Fish and Wildlife Commission listed the Columbian white-tailed deer as a State endangered species in 1980, protecting them from direct take and making it illegal to hunt, possess, or control the species in Washington. All State listed species are also priority species on the List of Priority Habitats and Species (Washington Department of Fish and 2008, entire). The list is used by WDFW, as well as voluntarily by others, to conserve sensitive species and their habitats. The priority habitat map for Columbian white-tailed deer was updated in early 2025. In 2004, WDFW published management recommendations to provide science-driven guidance for activities that could negatively impact this species and its habitat (Brookshier 2004, pp. 5-6). In 2023, WDFW completed a periodic status review for the Columbian white-tailed deer, which recommended reclassification to threatened (Azerrad 2023, p. 21). The Washington Fish and Wildlife Commission voted on January 27, 2023, which officially reclassified the Columbian white-tailed deer as threatened in Washington.

Columbian white-tailed deer are not currently known to inhabit forestlands managed by the Washington State Department of Natural Resources (DNR). However, DNR implements conservation measures for Columbian white-tailed deer and their habitat via policies that mandate general protection for riparian areas, wetlands, and upland wildlife habitat and specific commitments to respect state and federal requirements for protection of threatened and endangered species (Policies Nos. 20, 21, 22, and 23 of the Forest Resource Plan). Under the 1997 Washington State DNR State Lands Habitat Conservation Plan, all forest management activities in the area covered by this plan comply with state Forest Practices Rules and state wildlife regulations and are consistent with the policies set forth by the Board of Natural Resources. Additional conservation of Columbian white-tailed deer and their habitat on DNR-managed lands will result from the HCP riparian conservation strategy that describes management beneficial for the riparian and tidal forests that are potential deer habitat.

In 2009, the Service issued a Programmatic Biological Opinion for the Western Washington Regions of the Washington State Department of Transportation (WSDOT), which includes the counties west of the Cascades. To minimize impacts to Columbian white-tailed deer, the Department of Transportation agreed they would not alter suitable woodland habitat within the Columbia River corridor or tidal spruce forest communities, and they would not enable higher traffic speeds for projects located within Wahkiakum and Cowlitz Counties, on SR 4 west of Longview and east of Skamokawa, or on SR 409.

Under the Growth Management Act, all of Washington’s jurisdictions must adopt critical areas ordinances (CAO; RCW 36.70A.060) to protect fish and wildlife habitat conservation areas, including reducing urban sprawl and protecting habitat. Clark, Cowlitz and Wahkiakum Counties are all required to designate and protect Columbian white-tailed deer in riparian management zones used as habitat by the deer in their critical areas ordinances. Clark, Cowlitz, and Wahkiakum counties are required to revise their comprehensive plans and their critical areas ordinances by 2025, 2026 and 2027, respectively (Washington State Department of Commerce 2016, entire). The update process could include proposals to adjust where new development can occur and provides an opportunity to include recommendations beneficial for Columbian white-tailed deer.

Chapter 4. Recovery Planning

The recovery strategy, criteria, and actions proposed in the recovery plan are based on the following fundamental concepts for reducing the risk of extinction to Columbian white-tailed deer and ensuring, to the extent possible, the viability of the species into the foreseeable future:

1. Management of existing subpopulations and protection of their habitat,
2. Establishment of new subpopulations, and
3. Public education and outreach to foster greater understanding of Columbian white-tailed deer and its place in the natural environment of its historic range.

The actions described above contribute to resiliency (the ability to sustain populations through the natural range of favorable and unfavorable conditions), redundancy (the ability of a species to withstand catastrophes), and representation (the ability of a species to adapt to both near-term and long-term changes in its environment). As such, the actions outlined in the recovery plan that serve as the foundation for development of the recovery criteria for Columbian white-tailed deer can be interpreted as directly influencing the species' viability.

For delisting (i.e., removing the species from the Federal List of Endangered and Threatened Wildlife), the recovery plan (U.S. Fish and Wildlife Service 1983, pp. 31-33) established the following criteria:

1. Maintain a minimum of at least 400 Columbian white-tailed deer across the Columbia River DPS; and
2. Maintain 3 viable subpopulations, all located on secure habitat.

For the purposes of recovery, viable was defined as a minimum November population of 50 individuals or more in a subpopulation. A minimum viable population size of 50 deer in each subpopulation and of 400 total deer in the DPS would theoretically cancel out any deleterious effects of inbreeding. To determine minimum population sizes, the recovery plan used the formula $F = 1/(2N_e)$ where F is the inbreeding coefficient and N_e is the effective population size (i.e., the number of breeding individuals necessary for optimal genetic exchange) (U.S. Fish and Wildlife Service 1983, p. 72). Given potential barriers to genetic exchange within the Columbia River DPS, the recovery plan considered 2 percent to be the maximum reasonable inbreeding coefficient for a subpopulation and 0.25 percent to be a reasonable inbreeding coefficient for the total DPS population (U.S. Fish and Wildlife Service 1983, pp. 72-74). Using both the aforementioned formula and inbreeding coefficients, the effective population size would be a minimum of 50 deer per subpopulation and a minimum of 412 total deer in the DPS, after correcting for an unequal sex ratio (3 females to 1 male) and the percentage of the herd that are of breeding age (65 percent) (U.S. Fish and Wildlife Service 1983, p. 73).

In order to ensure subpopulations of at least 50 individuals, the recovery plan determined that protection would be necessary by securing habitat. Secure habitat was defined as free from adverse human activities in the foreseeable future and relatively safe from natural phenomena that would destroy the habitat's value to Columbian white-tailed deer (U.S. Fish and Wildlife Service 1983, p. 33). An example of a human activity that may cause adverse impacts to deer would be large-scale commercial development or large-scale conversion of deer habitat to estuary habitat for salmon. An example of natural phenomena that may destroy Columbian white-tailed deer habitat would be flooding. Specifically, the recovery plan states, "…protection and enhancement (of off-refuge Columbian white-tailed deer habitat) can be secured through local land use planning, zoning, easement, leases, agreements, and/or memorandums of understanding" (U.S. Fish and Wildlife Service 1983, p. 37). In 2013, the Service expanded the definiton of secure habitat to include locations that, regardless of ownership status, have supported subpopulations of at least 50 Columbian white-tailed deer for 20 or more years, and have no anticipated change to land management in the foreseeable future that would make the habitat less suitable to Columbian white-tailed deer (U.S. Fish and Wildlife Service 2013a, p. 12).

At the time of the recovery plan's publication, Puget Island, Westport/Wallace, and JBH Mainland all had viable subpopulations of deer; however, the JBH Mainland Unit subpopulation was the only one considered viable and secure (Table 5). The recovery plan recommended increasing the Tenasillahe Island subpopulation to a minimum of 50 deer, as well as maintaining a total population minimum of 400 deer, and securing habitat for one additional subpopulation (U.S. Fish and Wildlife Service 1983, p. 31).

Table 5. Estimated numbers of Columbian white-tailed deer in the Columbia River population in 1983 (U.S. Fish and Wildlife Service 1983, p. 6).

Subpopulation	Estimated number of deer	Viable (≥ 50 deer)	Secure habitat
Puget Island	50-75	Yes	No
Tenasillahe Island	30-40	No	No
JBH Mainland	150-200	Yes	Yes
Westport/Wallace	70-80	Yes	Partially*
Karlson Island	8-12	No	No
Total	308-407		

*Wallace Island is secure habitat that is part of JBH, however, the large Westport portion is not.

Chapter 5. Current Condition

5.1 Analytical Approach

As our analytical unit for resiliency, we chose to use the subpopulation groupings used in the Population and Habitat Viability Assessment (PHVA) (Miller et al 2020, p. 8). Ten subpopulations were divided into three groups based on their geographic locations and natural barriers to movement; however, subpopulation names have been simplified for the purposes of this SSA (Table 6). We used the three groups as our analytical units for representation. Group A consisted of four subpopulations: JBH Mainland, Tenasillahe Island, Puget Island, and Westport/Wallace. Group B consisted of three subpopulations: Willow Grove, Lord/Dibblee, and Cottonwood. Group C consisted of three subpopulations: Sauvie/Scappoose, CSR, and Ridgefield. Throughout the remainder of the document, Group A populations will be represented in orange, Group B in green, and Group C in blue.

Table 6. Analytical Units for this SSA report. Group represents representation areas while subpopulation name represents resiliency units.

Group	Subpopulation Name	Habitat Components
A	JBH Mainland	JBH Mainland Unit; Price Island; Hunting Island; adjacent Columbia Land Trust land; Elochoman Valley; Brownsmead; town of Cathlamet; Lois Island
A	Tenasillahe Island	Tenasillahe Island
A	Puget Island	Puget Island; Little Island; Whites Island; Bradwood
A	Westport/Wallace	Westport; Wallace Island; Marshland; Clatskanie; Crims Island
B	Cottonwood	Wasser–Winter property; Cottonwood; Kalama
B	Lord/Dibblee	Lord Island; Walker Island; Dibblee Flats
B	Willow Grove	Willow Grove; Fisher/Hump Islands; Longview Industrial lands
C	CSR	Columbia Stock Ranch; Deer Island; Sandy Island
C	Ridgefield	Morgan; Ridgefield National Wildlife Refuge; Shillapoo plus neighboring Columbia Land Trust land; private land near Shillapoo
C	Sauvie/Scappoose	Northern Sauvie; Southern Sauvie; Scappoose

Subpopulation descriptions

1. JBH Mainland

The JBH Mainland subpopulation contains Price Island, Hunting Island, JBH Mainland Unit of JBH, adjacent Columbia Land Trust land, Elochoman Valley, Brownsmead, and the town of Cathlamet. The JBH Mainland Unit of JBH resides on approximately 826 ha (2,041 acres), however, the total estimated area for this subpopulation is 2,863 ha (7,075 acres). The population has fluctuated in numbers since regular surveys began, with a high of 500 deer in 1987 to a low of 51 deer in 1996 (after a catastrophic flood event). When the refuge was established, a goal of approximately 125 deer for the JBH Mainland Unit was set to balance the density of deer given the amount of available habitat (U.S. Fish and Wildlife Service 2010, p. 2:62). Since 1997, the JBH Mainland Unit subpopulation has consistently maintained population numbers above the recovery criteria minimum of 50 deer and near the management goal of 125 individuals even though deer have been periodically removed for translocation to other subpopulations. Even with multiple flooding events, the population has been able to rebound successfully.

Prior to the creation of the JBH Refuge, the area was diked and ditched to allow for agriculture and to avoid tidal flooding because it is only 3 m (9.8 feet) above sea level (Verts and Carraway 1998, p. 480). Flooding on the JBH Mainland Unit has occurred three times over the history of the refuge, in 1996, 2006 and 2009, resulting in short-term population declines after each flood. In March of 2011, a geotechnical assessment determined that the dike that protects the Mainland Unit from flooding by the Columbia River was at "imminent risk" of failure (U.S. Fish and Wildlife Service 2013b, p. 2) and a breach at that location would result in the flooding of the JBH

Mainland Unit at high tides. The U.S. Army Corps of Engineers subsequently constructed a setback levee on the refuge to prevent flooding of the refuge and to restore salmonid habitat (U.S. Army Corps of Engineers 2013, p. 11). Though the set-back dike, completed in fall 2014, reduces available Columbian white-tailed deer habitat on the JBH Mainland Unit by approximately 28 ha (70 acres), or approximately 3.5 percent, it will reduce the likelihood of future flooding in this area. The setback levee only provides protection for a portion of the JBH Mainland Unit because there are other sections also experiencing erosion.

2. Puget Island

Puget Island is predominantly private land with some public land. The private land consists mainly of pasture for cattle and goats, residential lots, and hybrid cottonwood plantations that provide food and shelter for the deer. Farmers and ranchers on the island may implement predator (coyote) control on their lands to protect poultry and livestock. We do not know to what extent predator control occurs by private citizens, however this management activity likely benefits the Columbian white-tailed deer population on the island. In fact, Puget Island supports one of the largest and most stable subpopulations of Columbian white-tailed deer. While densities have historically been lower than refuge lands, the size of Puget Island (about 2,023 ha (5,000 acres)) has enabled it to support a robust number of deer. Since regular surveys began in 1984, the population at Puget Island has averaged between 175 and 200 deer, well above the minimum of 50 deer set in the recovery plan. The latest survey estimated the population at a high of 227 deer, which includes approximately 15 deer in Bradwood. Puget Island has supported a stable Columbian white-tailed deer population without active management in the midst of continued small-scale development for several decades.

3. Tenasillahe Island

Tenasillahe Island in Oregon is part of JBH comprising 788 ha (1,948 acres), of which 720 ha (1,778 acres) are protected from inundation by the Columbia River. A 9.7 km (6 mile) long dike constructed in 1914 encompasses the majority of the island except for a parcel at the upstream tip. Adjacent to this dike is an interior 1.6 km (1 mile) long levee that provides additional flood protection for the interior of the unit. Drainage of the island’s interior is accomplished using ditches, sloughs, and four tide gates in two locations. Tenasillahe Island also has 9.3 ha (23 acres) of designated critical habitat for the streaked horned lark (*Eremophila alpestris strigata*) on a small unnamed spit at the southeastern (upstream) tip of the island. The spit is currently occupied by streaked horned larks and provides the physical or biological features essential to their conservation. The site is owned by the Oregon Department of State Lands and is not part of JBH. The Corps uses this site for dredge material disposal as part of its maintenance of the Columbia River shipping channel.

The recovery plan recommended increasing the Tenasillahe Island subpopulation to a minimum herd of at least 50 deer. The Service has accomplished this recovery goal through several translocation efforts and habitat enhancement, and the island’s subpopulation, though still susceptible to flood events, has remained above 50 individuals since 1987. The most current FLIR survey at this location (in 2021) estimated the population at 216 deer, even with the removal of 27 deer to create the Columbia Stock Ranch subpopulation.

4. Westport/Wallace

In 1995, Wallace Island, Oregon, was purchased by the Service for Columbian white-tailed deer habitat. Though the habitat is now protected for the recovery of Columbian white-tailed deer, the 227-ha (562-acre) island alone is considered too small to support a population of 50 deer (U.S. Fish and Wildlife Service 2010, p. 4:39). Because it is located adjacent to Westport, Oregon, and anecdotal reports suggest that Columbian white-tailed deer traverse both areas, Wallace Island is considered part of the Westport/Wallace subpopulation. Acquisitions by JBH also include a 70-ha (173-acre) area of Westport called the Westport Unit. The remaining portion of Westport Island is private land. Habitat in the Westport area consists mainly of cottonwood/willow swamp and scrub-shrub tidal wetlands. Total estimated habitat for this subpopulation is 5,770 ha (14,259 acres).

The Westport/Wallace subpopulation was stable and relatively abundant from the time when regular surveys began until 2015. After reaching a peak of approximately 225 deer in 1995, the subpopulation remained high through 2015 even though ten deer were removed from the area to contribute to the 2014 translocation to Ridgefield NWR. After 2015, habitat management on private land in the area declined leading to increases in invasive reed canarygrass and Himalayan blackberry. This has resulted in a decline in the Columbian white-tailed deer subpopulation to the current estimate of 98 deer on the largest portion of Westport. However, the subpopulation division from the PHVA includes the Clatskanie Flats area, the Marshland district, and Crims Island. Prior to 2019, the first two areas were previously included in the Fringe Areas and Crims Island was counted as part of the Estuary Islands subpopulation. When taking those numbers into account, the subpopulation total is currently 211 deer. Even with the habitat changes, the subpopulation has remained over the goal of 50 individuals since 1984.

5. Cottonwood

The Cottonwood subpopulation includes Cottonwood Island and private lands around Kalama, Washington totaling 1,185 ha (2,929 acres). Although attempts have been made to translocate deer to Cottonwood Island, it does not contain 50 or more deer. The island is a recreational site for camping and fishing with the surrounding waters used for waterfowl hunting. Cottonwood Island has multiple landowners, primarily a coalition of ports administered by the Port of Portland, but there are no people living on the island and no known commercial interests (U.S. Fish and Wildlife Service 2013b, p. 15). It lies approximately 1.6 km (1 mile) upriver from Dibblee Point on the Washington side of the Columbia River. The 384-ha (948-acre) island was considered in the recovery plan as a potential relocation site; it was thought that the island could support up to 50 deer. In the fall of 2010, 15 deer were moved to Cottonwood Island from the Westport population in Oregon (Cowlitz Indian Tribe 2010, p. 1). Seven confirmed mortalities resulted from vehicle collisions as Columbian white-tailed deer dispersed off the island (Cowlitz Indian Tribe 2010, p. 3). Telemetry monitoring by WDFW personnel in the spring of 2011 detected three radio-collared Columbian white-tailed deer on Cottonwood Island and two on the Oregon mainland near Rainier, Oregon. A second translocation of 12 deer to Cottonwood Island (from Puget Island) occurred in conjunction with the 2013 emergency translocation effort (U.S. Fish and Wildlife Service 2013a, p. 24). All but four of these new Columbian white-tailed deer subsequently died or moved off the island, with five deer dying from vehicle strikes (U.S. Fish and Wildlife Service, unpublished data). We are uncertain why the deer moved off the island, but we suspect that either habitat quality or competition with black-tailed deer may have been a factor in the movement of Columbian white-tailed deer off the island. Approximately 6 ha (15 acres) of habitat was improved in 2013. Staff from JBH and staff representing the Cowlitz Indian Tribe continue to conduct periodic monitoring of Columbian white-tailed deer translocated to Cottonwood Island. Current estimates have 25 deer located on Cottonwood Island and another 42 are adjacent to the island in Washington for a total of 67 deer in the subpopulation.

6. Lord/Dibblee

Lord and Walker islands lie on the Oregon side of the Columbia River, from river mile 60 through 64, across from Longview, Washington. Lord Island is approximately 4 km (2.5 miles) long while Walker Island is approximately 1.9 km (1.2 miles) long. Dibblee Flats lies south of Lord and Walker Islands from approximately river mile 64 to 65. The majority of deer in this subpopulation occur in the Dibblee Flats area with 46 deer there, while the islands contain roughly 17 deer. Combined, this subpopulation occupies approximately 875 ha (2,163 acres).

7. Willow Grove

The Willow Grove subpopulation consists of the area between Willow Grove, Washington and Longview, Washington. This area is upstream of Crims Island and downstream of the town of Longview, Washington. Downstream of the Lord and Walker islands, close to the Washington shore, is the 2.4-km (1.5-mile) long Fisher Island at river mile 59 and 60 and the man-made Hump Island. The WDFW purchased Fisher Island in 1997 and it is an important nesting area for waterfowl. The WDFW manage Fisher Island and Hump Island as State Wildlife Areas with Columbian white-tailed deer as a focal species. The subpopulation had a total of 66 deer estimated in 2025 in 888 ha (2,194 acres) of habitat.

8. Columbia Stock Ranch

Columbia Stock Ranch (CSR) is the most recently created subpopulation of Columbian white-tailed deer. It is located on the Oregon side of the Columbia River in Columbia County, approximately 52 km (32 miles) north of Portland, Oregon. The CSR consists of two parcels of land (divided by Oregon Highway 30) totaling 378 ha (935 acres). Approximately 186 ha (460 acres) west of Highway 30 contain floodplain and lowland riparian habitats adjacent to the Columbia River, with 2.4 km (1.5 miles) of frontage to the river. The remaining 192 ha (475 acres) consist of upland habitats dominated by mixed Douglas-fir and hardwood forests located west and upslope of Highway 30.

Approximately 27 deer were translocated from Tenasillahe Island to CSR in 2019 and 2020. Another ten deer from Tenasillahe Island were moved to CSR in between December 2021 and March 2022 to supplement the subpopulation. Adjacent to the CSR property is Deer Island, Oregon, beginning at river mile 77. Deer Island is approximately 8 km (5 miles) long and 3.2 km (2 miles) wide. It is comprised of private lands on roughly 1,215 ha (3,000 acres). Several tagged deer from the CSR translocation currently occupy Deer Island and credible sightings of other white-tailed deer and their fawns have occurred there. As of 2025, 31 deer occur in this subpopulation; however, the bulk of the subpopulation resides on CSR and Deer Island remains mostly uninhabited.

Columbia Land Trust purchased CSR with funding from BPA in 2012. In exchange for BPA’s funding, Columbia Land Trust granted BPA a perpetual conservation easement for restoration and future operation and maintenance. As part of translocation negotiations of deer from

Tenasillahe Island to CSR, BPA committed to protecting habitat on the property for the benefit of Columbian white-tailed deer in perpetuity. When BPA opted not to move forward with the MOU (discussed in *Section 3.6 Conservation Measures*), they also opted not to modify the language in the conservation easement that would specify management for the benefit of Columbian white-tailed deer. Further, BPA is actively pursuing restoration of the floodplain and side channel portion of the property to allow flooding from tides and high-water events. Such action is not compatible with Columbian white-tailed deer survival in this subpopulation.

9. Ridgefield
Ridgefield NWR is located in Clark County, Washington, approximately 108 km (67 mi) southeast of JBH, and is comprised of 2,111 ha (5,218 acres) of marshes, grasslands, and woodlands with about 1,537 ha (3,800 ac) of upland terrestrial habitat. When factoring in adjacent lands, this subpopulation resides on approximately 3,777 ha (9,334 acres) of habitat. As part of an emergency translocation, the Service moved 88 deer from the JBH Mainland Unit, Puget Island, and Westport to Ridgefield NWR between 2013 and 2015 (U.S. Fish and Wildlife Service 2016b, p. 71395). The subpopulation has expanded into areas adjacent to the refuge with a current estimated population of 318 deer. It has contained over 50 deer since 2015.

10. Sauvie/Scappoose
This subpopulation is located around the small town of Scappoose, Oregon on the western side of the Multnomah Channel of the Columbia River and Sauvie Island. Sauvie Island is the largest island in the Columbia River, located 16 km (10 miles) northwest of downtown Portland, Oregon. The 9,720-ha (24,000-acre) island is comprised of farmland, wineries, recreational beaches, and the Sauvie Island Wildlife Area, a state game area managed by the Oregon Department of Fish and Wildlife (ODFW) for protecting and improving waterfowl habitat and providing a public hunting area. The Sauvie Island Wildlife Area is 4,712 ha (11,643 acres), of which 3,299 ha (8,153 acres) are under fee title to ODFW and 1,412 ha (3,490 acres) are managed through a cooperative agreement with the Oregon Department of State Lands. The remaining lands on Sauvie Island are privately owned. Popular activities on the island include hunting, fishing, canoeing, kayaking, birdwatching, and hiking. This subpopulation was created when deer from the Ridgefield translocation crossed the Columbia River into the ODFW Wildlife Area. This subpopulation is small with roughly 20 deer estimated on Sauvie and 15 in Scappoose and is not closely monitored. Roughly 2,549 ha (6,299 acres) of habitat is available for Columbian white-tailed deer.

5.2 Methodology

We determined that to be sufficiently resilient, subpopulations would contain a minimum of 50 deer and an adequate level of secure habitat that includes an abundance of cover and forage distributed in a mosaic pattern with minimal amounts of invasive plants. Ideally, at the species level, resilient subpopulations would be distributed across the range of the DPS and have connectivity across the landscape (redundancy and representation). We then developed the demographic and habitat metrics by which to assess the resiliency of subpopulations and characterize current condition (Table 7).

Table 7. Condition metrics for assessing resiliency of subpopulations of Columbian white-tailed deer.

	Demographic Metrics			**Habitat Metrics**	
Condition Rank	Number of Deer	Fawn to Doe Ratio^	Annual Dispersal Probability (%)	Habitat Quantity (ha)	Protected or Secure habitat (%)
High	≥ 80	≥40	≥ 5	≥ 3,000	≥ 70
Moderate	50-79	20-39	2-4.99	1,000-3,000	40-70
Low	<50	<20	<2	<1,000	<40

^Based on most recent 5-year average. Data not available for every subpopulation.

Population abundance methodology

Delisting criteria in the recovery plan include maintaining a minimum of at least 400 Columbian white-tailed deer across the Columbia River DPS and maintaining three subpopulations of at least 50 deer each. At the time of the recovery plan publication in 1983, the number of deer in the Columbia River DPS was thought to be 300 to 400. The first estimates of Columbian white-tailed deer began in the 1970s and were based on ground counts. These counts were highly variable, did not account for visibility, and did not cover wooded areas. The first comprehensive survey effort in 1984 using fall ground counts throughout the DPS resulted in an estimate of 720 deer, suggesting that prior estimates were probably low. Since 1985, fall ground counts have been conducted to establish long-term trends by indicating gross population changes. In addition to annual fall ground counts, the Service began using Forward-Looking Infrared (FLIR) thermography camera systems affixed to a helicopter (or, in 2008, a fixed-wing Cessna 206) in 1996 to conduct aerial surveys within the Columbia River DPS. The limitations of FLIR are two-fold; there is the inability to determine the demographic structure of a population and the inability to differentiate between white-tailed and black-tailed deer. To address these limitations, ground counts are conducted to acquire demographic information and correction values are used to account for decreased detection probability due to tree and shrub cover. Correction values are based on detection likelihood in given types of habitats and both ground counts and photos from trail cameras are used to determine the ratio of white-tailed deer to black-tailed deer in a given area. For the latter, the number of Columbian white-tailed deer observed in the FLIR count is adjusted by the estimated percentage of white-tailed to black-tailed deer (based on a 3-year average). In areas where we do not have recent ratios, we will place cameras on the landscape and use the recent year of data instead for a more accurate reflection of current distribution. While we attempt FLIR surveys each year, we are not able to survey the entire DPS each year due to financial constraints, staff limitations, access to certain locations, equipment challenges, and weather. We conduct FLIR surveys on subpopulations within the DPS based on priority needs and then carry forward estimates for subpopulations we weren't able to survey in a given year, using ground counts and trail cameras to estimate whether there had been any unusual decrease or increase in a subpopulation. The last survey year included in this analysis is from 2022. We did not conduct FLIR surveys in 2023 because the biologist coordinating the surveys retired.

Fawn to Doe Ratios

Fawn to doe ratios are obtained in November by driving designated transects in occupied habitat. These ratios provide an estimate of reproductive success by approximating the number of yearlings to be recruited into the population. We do not have fawn to doe ratios for every subpopulation. Therefore, we only included these data where possible.

Annual Dispersal Probability
As previously stated, we do not know dispersal rates for Columbian white-tailed deer. A recent PHVA model predicted annual dispersal probabilities of Columbian white-tailed deer, expressed as percentages of candidate age-sex classes, assuming that dispersal would more likely occur between nearest-neighbor subpopulations. While dispersal is usually defined as a permanent emigration from a natal home range, the PHVA used a different definition because of the relatively small size of the DPS. The model defined dispersal rate as "the probability that an individual of the qualifying age and sex in the source population will disperse to a neighboring subpopulation in a given year of the simulation" (Miller et al 2020, p. 9). This allowed us to create an index to connectivity. The PHVA also defined the carrying capacity for each subpopulation as a fixed value based on the amount of suitable habitat and the expected deer density based on whether areas were managed or not. Suitable habitat was informed by a habitat connectivity analysis conducted by WSDOT, in partnership with the Service, Cowlitz Indian Tribe, ODFW, WDFW, and the Oregon Department of Transportation (Washington State Department of Transportation 2016). The analysis used a tool called Linkage Mapper to describe patterns of connectivity between core areas of Columbian white-tailed deer use, paths of least resistance to movement based on habitat characteristics, and nodes (unoccupied but suitable habitat) (Washington State Department of Transportation 2016, pp. 6, 10).

Habitat Quantity and Quality
Since Columbian white-tailed deer are generalist edge species, they can utilize a wide variety of habitat components. To determine habitat quantity and quality, we utilized the Columbian White-tailed Deer Habitat Model, which was developed in partnership with the Lower Columbia Estuary Partnership with funding from BPA (Butler et al 2014, entire). This additive geospatial model evaluated factors influencing habitat distribution of deer within their historical range based on distances from, and densities of, habitat variables influencing deer survival. The model sought to identify areas with cover, browse, forage, and limited human activity to identify potential suitable habitat for future reintroduction efforts, migration potential, and general habitat quality mapping. The habitat model used several different datasets including Digital Elevation Models for Oregon and Washington, publicly owned lands (provided by the Service's Regional Office), deer survey data from 2009 to 2012, National Land Cover Dataset Canopy Cover, and the National Oceanic and Atmospheric Administration's (NOAA) Coastal-Change Analysis Program for Oregon and Washington, which contained 23 land use classes. The land use classes were then consolidated to reflect biologically meaningful metrics for deer. The model considered 405 ha (1,000 acres) to be an acceptable size for a viable population, but several smaller patches proximally located could also provide enough habitat. Therefore, the model includes all areas over 40.5 ha (100 acres). While this model will not provide a quantitative assessment of high-quality habitat, it will provide a general idea of distribution of habitat. Quantitative habitat measurements will be identified by the amount of occupied habitat. When setting the current

condition thresholds, we considered habitat quantity, habitat quality, and connectivity in the amount of habitat necessary for resiliency.

Protected or Secure Habitat
As previously discussed in Chapter 4, the recovery plan for Columbian white-tailed deer emphasized management and protection of habitat. One criterion for delisting is to maintain three subpopulations with at least 50 deer, all located on secure habitat. Secure habitat is currently defined as free from adverse human activities in the foreseeable future and relatively safe from natural phenomena that would destroy the habitat's value to Columbian white-tailed deer. Secure habitat also includes locations that, regardless of ownership status, have supported subpopulations of at least 50 Columbian white-tailed deer for 20 or more years, and have no anticipated change to land management in the foreseeable future that would make the habitat less suitable to Columbian white-tailed deer.

5.3 Results

5.3.1 Current population abundance

As previously mentioned, we chose to use the ten subpopulation groupings based on geographic locations and natural barriers to movement used in the PHVA, which was initiated in 2018. In some instances, we did not collect survey data in all of these locations or these subpopulations did not yet exist. In other cases, the survey data would have been lumped into either the Upper Estuary Islands category, which contained Lord, Walker, Fisher, Hump, and Crims Islands, or into a category called Fringe Areas, which contained deer that did not belong to a particular subpopulation as they were known at the time. As such, it appears as though there are large gaps in the data; however, these data would be captured in individual reports going back to the early 2000's. As stated in Section 5.2 *Methodology*, we developed demographic and habitat metrics by which to assess the resiliency of subpopulations and characterize overall current condition. For the demographic metric of number of deer, subpopulations containing greater than or equal to 80 deer received a high rank, those with 50 to 79 deer received a moderate rank, and those with less than 50 deer received a low rank.

The total population of the Columbia River DPS has been maintained at over 400 deer annually since regular surveys began in 1984, with a 2025 population estimate of about 1,354 deer (U.S. Fish and Wildlife Service 2025; Table 8). Of the ten subpopulations, eight are considered viable as defined by the recovery plan and had a minimum of 50 deer in 2025. Those are the JBH Mainland, Puget Island, Tenasillahe Island, Westport/Wallace, Lord/Dibblee, Cottonwood, Willow Grove, and Ridgefield. Of those eight viable subpopulations, four of them have exceeded the minimum of 50 deer every year for the past 30 years.

Fifty-five years have passed since the Columbian white-tailed deer was federally listed as endangered, and the species is now more abundant and better distributed throughout the lower Columbia River Valley. The improvement is due in part to the maintenance and augmentation of existing subpopulations, and the establishment of new subpopulations via successful translocations within the DPS.

Table 8. Estimated population size of the Columbia River DPS by subpopulation (U.S. Fish and Wildlife Service 2016b, p. 71393; U.S. Fish and Wildlife Service 2025, unpublished data). Group A populations are represented in orange, Group B in green, and Group C in blue.

Year[a]	JBH Mainland	Puget Island	Tenasillahe Island	Westport/ Wallace	Cottonwood	Lord-Dibblee	Willow Grove	Columbia Stock Ranch	Ridgefield	Sauvie/Scappoose	Total
1984	360	170	40	150							720
1985	480	215	40	125							860
1986	500	195	55	125							875
1987	500	185	70	150							905
1988	410	205	80	150							845
1989	375	205	90	150							820
1990	345	200	105	150							800
1991	280	200	130	150							760
1992	280	200	165	175							820
1993	175	200	195	200							770
1994	140	200	205	225							770
1995	120	200	205	225							750
1996	51	200	125	225							610
1997	100	200	150	200							650
1998	110	200	200	200							710
1999	110	150	160	140							585
2000	120	150	135	150							610
2001	120	125	135	150							585
2002	125	125	100	140							545
2003	115	125	100	140							560
2004	110	110	100	140							555
2005	100	125	100	140							565
2006	81	n/a	86	104							
2007	59	n/a	82								
2009	74	138	97	146		7	32				593[b]
2010	68	n/a	143	164	15						630[b]
2011	83	171	90	n/a		18	18				603[b]
2014	88	227	154	154[c]		70			48		830[b]
2015	100	228	155	190		68			100		966[b]
2016	119	228	199	205		66	47		137		1,001
2019	131	217	187	189	61	66	42		244	35	1,170
2021	116	217	216	222	60	66	42	27	244	35	1,245
2022	142	227	216	206	60	54	65	29	262	35	1,296
2024	116	227	216	211	67	63	66	35	262	35	1,298
2025	116	227	216	211	67	63	66	35	318	35	1,354
Condition Rank	**High**	**High**	**High**	**High**	**Mod**	**Mod**	**Mod**	**Low**	**High**	**Low**	

[a] Estimates between 2006-2025 are derived from FLIR surveys. Survey results from 2008 produced anomalous data because an alternative technique was used and results from 2017 had complications from camera error. Thus, these data are not considered representative of actual numbers, and are not included in this table. Totals are not given in 2006 and 2007 due to incomplete data, and no surveys were conducted in 2012, 2013, 2018, or 2020. If surveys were not done for a subpopulation, the last estimate is carried forward.

[b] Includes estimates from residual populations in Cottonwood Island, Clatskanie Flats, Brownsmead, Willow Grove, Barlow Point, and Rainier.

[c] Approximate population estimate after 2014 translocation.

5.3.2 Fawn to Doe Ratios

Although not all subpopulations are surveyed for fawn to doe ratios, we do have data from across the DPS. The 5-year average of fawns per 100 does for several subpopulations are in Table 9. As stated in Section 5.2 *Methodology*, we developed demographic and habitat metrics by which to assess the resiliency of subpopulations and characterize overall current condition. For the demographic metric of fawn to doe ratios, subpopulations containing greater than or equal to a ratio of 40 received a high rank, those with 20 to 39 received a moderate rank, and those with less than 20 deer received a low rank.

Long-term trends of fawn to doe ratios show a generally similar pattern of variation for the four largest sites that have been continuously surveyed over time. These sites are managed differently, with two sites being on private land and two sites on refuge land. Additionally, two sites are on islands and two are not, yet they all comprise Group A subpopulations in the western portion of the DPS. Two subpopulations are represented from Group B in the middle portion of the DPS and one from Group C in the eastern portion of the DPS. Since the CSR subpopulation was created recently, we opted not to include it in this analysis; however, we will discuss their fawn to doe ratios in Section 5.4 *Summary of Current Condition*.

Of all the subpopulations regularly surveyed, Westport/Wallace has the highest fawn to doe ratios with a 5-year average of 44, meaning a large number of fawns were recruited into the subpopulation. The lowest fawn to doe ratios were found at JBH Mainland in Group A and at Lord/Dibblee in Group B with a 5-year average of 22. Puget Island has the second highest average fawn to doe ratios even though it is not formally set aside for the protection of Columbian white-tailed deer. All of the Group A, B, and C subpopulations had either a moderate or high fawn to doe ratio.

Table 9. Number of fawns per 100 does from subpopulations of Columbian white-tailed deer from 1996 to 2024. Group A populations are represented in orange, Group B in green, and Group C in blue.

Year	JBH Mainland	Puget Island	Tenasillahe Island	Westport/Wallace	Willow Grove	Lord/Dibblee	Ridgefield
1996	16	27	35	45			
1997	61	39	39	16			
1998	43	45	12	30			
1999	15	52	7	10			
2000	34	70	8	23			
2001	49	49	18	40			
2002	25	40	0	29			
2003	21	27	0	24	100		
2004	12	36	32	33	42	43	
2005	4	22	24	14	29	25	
2006	24	22	39	18	18	7	
2007	3	36	50	37	43	0	
2008	30	45	39	39	24	50	
2009	26	45	46	51	64	72	
2010	61	41	35	80	50	57	
2011	35	25	36	34		63	
2012	46	35	52	53	13	17	
2013	40	49	47	60	48	49	
2014	61	75	73	58	37	58	
2015	50	56	65	79	92	52	
2016	53	60	54	47	61	19	
2017	9	54	57	27	93	19	27
2018	59	52	51	49*	79	11	53
2019	15	61	45	31	60	13	45
2020	12	33	14	56	44	22	43
2021	34	42	23	35	50	41	52
2022	21	41	21	58	51	13	32
2023	12	47	38	33	18	15	21
2024	32	45	34	37	27	20	20
Most Recent 5-yr Average	**22**	**42**	**26**	**44**	**38**	**22**	**34**
Condition Rank	**Mod**	**High**	**Mod**	**High**	**Mod**	**Mod**	**Mod**

*A route was added in Marshland, which is part of the Westport/Wallace subpopulation. Fawn to doe ratios were averaged between the two locations in 2018 through 2024.

5.3.3 Dispersal and Connectivity

We do not know the extent of dispersal among the Columbia River DPS subpopulations. A recent PHVA model predicted annual dispersal probabilities of Columbian white-tailed deer, expressed as percentages of candidate age-sex classes. The model assumed that dispersal would more likely occur between nearest-neighbor subpopulations and that 90 percent of dispersing individuals would reach their destination (Miller et al 2020, p. 9). The model defined dispersal rate as "the probability that an individual of the qualifying age and sex in the source population will disperse to a neighboring subpopulation in a given year of the simulation" (Miller et al 2020, p. 9). It also defined the carrying capacity for each subpopulation as a fixed value based on the amount of suitable habitat and the expected deer density based on whether areas were managed or not. Specifically, the expected deer density on public land managed for deer was 35-40 deer/mi^2, on public land not managed for deer was 10-20 deer/mi^2, on private land managed for deer 20-25 deer/mi^2, and on private land not managed for deer 10-30 deer/mi^2. Suitable habitat was informed by a habitat connectivity analysis conducted by WSDOT in 2016. The analysis used a tool called Linkage Mapper to describe patterns of connectivity between core areas of Columbian white-tailed deer use, paths of least resistance to movement based on habitat characteristics, and nodes (unoccupied but suitable habitat) (Washington State Department of Transportation 2016, pp. 6, 10). Semi-permeable barriers to movement included an interstate highway (I-5), railroad tracks, dense tracts of forest (because these areas have high numbers of black-tailed deer), and industrial areas. While land use and structure likely impact dispersal rates, we did not have sufficiently detailed information to add this to the model. Using all of the above information, the PHVA predicted an index of connectivity assuming that dispersal would more likely occur between nearest-neighbor subpopulations (Figure 5).

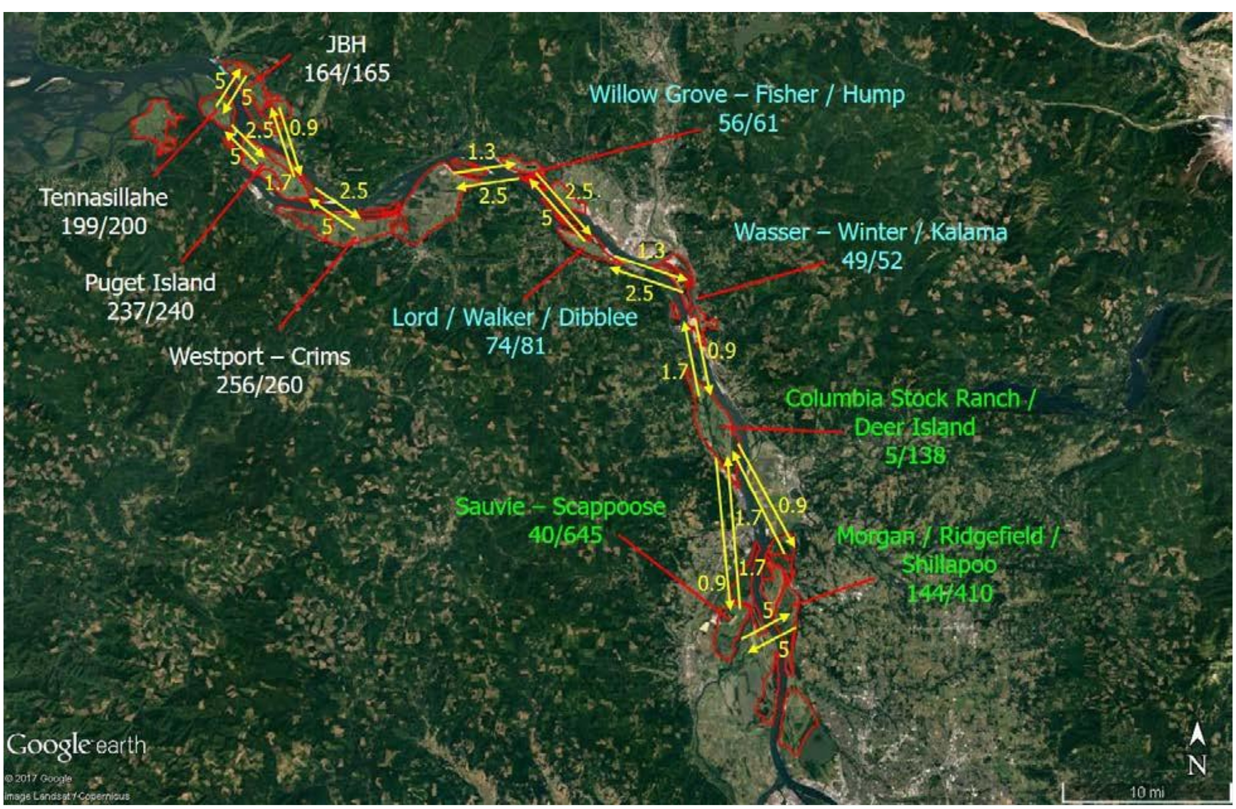

Figure 5. Annual dispersal probabilities for Columbian white-tailed deer across the Columbia River DPS. Color codes for subpopulation designations: white, Group A; cyan, Group B; green; Group C. For each subpopulation, the first numerical value gives the estimated deer abundance (Age-1 and older) as of January 2018, while the second value gives the estimated management-based carrying capacity. Yellow arrows depict directional annual dispersal probabilities (expressed as percentages of candidate age-sex classes) between subpopulations. (Primary data source and map courtesy of: P. Meyers, Service; taken from Miller et al. 2020).

As stated in Section 5.2 *Methodology*, we developed demographic and habitat metrics by which to assess the resiliency of subpopulations and characterize overall current condition. For the demographic metric of dispersal, subpopulations with an annual dispersal probability of greater than or equal to five percent received a high rank, those with 2 to 4.99 received a moderate rank, and those with less than 2 received a low rank. Every subpopulation has some level of connection between at least two other subpopulations and several connect to three other subpopulations (Table 10). The likelihood of movement between subpopulations is the same in some instance, such as between JBH Mainland and Tenasillahe Island. In other instances, likelihood of movement varies depending on the starting point. For instance, a deer is more likely to move from Puget Island to Tenasillahe Island rather than from Tenasillahe Island to Puget Island because the river current is most often moving downstream toward Tenasillahe. The most difficult area for deer dispersal appears to be the move from Group B subpopulations (Cottonwood) to the Group C subpopulations (CSR). Dispersal also appears challenging from CSR to other Group C subpopulations. This may represent a pinch point in the area near Longview, Washington, where there is a great deal of industrial activity. The lack of high dispersal probability likely reflects the fragmented nature of suitable habitat throughout the range of the Columbia River DPS.

Table 10. Connectivity between Columbian white-tailed deer subpopulations. Group A populations are represented in orange, Group B in green, and Group C in blue.

From	To	Dispersal Likelihood	Average for subpopulation	Condition Rank
JBH Mainland	Puget Island	0.9	3.0	Moderate
JBH Mainland	Tenasillahe Island	5		
Tenasillahe Island	JBH Mainland	5	3.8	Moderate
Tenasillahe Island	Puget Island	2.5		
Puget Island	Tenasillahe Island	5	3.1	Moderate
Puget Island	JBH Mainland	1.7		
Puget Island	Westport/Wallace	2.5		
Westport/Wallace	Willow Grove	1.3	3.2	Moderate
Westport/Wallace	Puget Island	5		
Willow Grove	Westport/Wallace	2.5	2.5	Moderate
Willow Grove	Lord/Dibblee	2.5		
Lord/Dibblee	Cottonwood	1.3	3.2	Moderate
Lord/Dibblee	Willow Grove	5		
Cottonwood	Lord/Dibblee	2.5	1.7	Low
Cottonwood	CSR	0.9		
CSR	Cottonwood	1.7	1.2	Low
CSR	Sauvie/Scappoose	0.9		
CSR	Ridgefield	0.9		
Sauvie/Scappoose	CSR	1.7	3.4	Moderate
Sauvie/Scappoose	Ridgefield	5		
Ridgefield	CSR	1.7	3.4	Moderate
Ridgefield	Sauvie/Scappoose	5		

5.3.4 Habitat Quantity

Much of the former range of the Columbian white-tailed deer in the Columbia River DPS still shows high-quality habitat remnants theoretically capable of supporting deer populations (Butler et al 2014, p. 22). The Columbian white-tailed deer habitat model does not provide a quantitative assessment of habitat where subpopulations exist. Rather, the habitat model predicts large amounts of high-quality habitat (as defined by model categories) greater than 40.5 ha (100 acres) (Butler et al 2014, p. 23). Invasive species such as reed canary grass and Himalayan blackberry were present and prevalent through much of the modeling area, however; datasets showing their extent on the landscape do not exist.

To determine current condition of this metric, we used the overall quantity of habitat available to Columbian white-tailed deer in occupied areas estimated using an ArcGIS analysis of land cover from 2021 (Table 11). This consists of low, moderate, and high-quality habitats. We eliminated urban areas from the calculations of habitat in ArcGIS. Based on the analysis, the majority of subpopulations have a moderate amount of available habitat. Areas with the least habitat are in the Lord/Dibblee and Willow Grove subpopulations. These areas contain a number of industrial areas. Areas with the most habitat were in the Ridgefield and the Westport/Wallace subpopulations. While the Ridgefield subpopulation is located primarily on Refuge lands, the Westport/Wallace subpopulation is mostly on private land that has seen many changes in land management over the past ten years.

Table 11. Estimated amount of habitat available within each Columbian white-tailed deer subpopulation as of 2021. Group A populations are represented in orange, Group B in green, and Group C in blue.

Subpopulation Name	Habitat Quantity (ha)	Condition Rank
JBH Mainland	2,863	**Moderate**
Puget Island	2,023	**Moderate**
Tenasillahe Island	1,066	**Moderate**
Westport/Wallace	5,770	**High**
Cottonwood	1,185	**Moderate**
Lord/Dibblee	875	**Low**
Willow Grove	888	**Low**
Columbia Stock Ranch	1,593	**Moderate**
Ridgefield	3,777	**High**
Sauvie/Scappoose	2,549	**Moderate**
Total	**22,589**	

5.3.5 Protected and Secure Habitat

In order to ensure subpopulations of at least 50 individuals, the recovery plan determined that protection would be necessary by securing habitat. Protection of off-refuge Columbian white-tailed deer habitat can be secured through local land use planning, zoning, easement, leases, agreements, and/or memorandums of understanding. Currently, there are 2,912 ha (7,196 acres) of protected habitat in Oregon, and 4,482 ha (11,075 acres) of protected habitat in Washington across a variety of land owners (Table 12). Combined across both states, 33 percent of deer habitat is protected. The majority of protected lands are under Federal ownership as part of the National Wildlife Refuge System.

Table 12. Hectares of protected habitat for Columbian white-tailed deer.

	Oregon	Washington
Easement	0	0
Federal Land	1,430	3,218
State Land	1,481	930
Non-Governmental Organization	1	7
County/Local Land	0	327
TOTAL	2,912	4,482

Habitat is also considered secure, regardless of ownership status, if it has supported subpopulations of at least 50 or more Columbian white-tailed deer for 20 or more years, with no anticipated change to land management in the foreseeable future that would make the habitat less suitable to Columbian white-tailed deer. An additional 2,023 ha (5,000 acres) is considered secure on Puget Island. If this is added to the hectares of protected habitat, then 42 percent of deer habitat is secure. Many subpopulations are comprised of multiple land ownerships with differing levels of security (Table 13). There are approximately 959 deer (71 percent of the DPS) located on protected or secure habitat. Over half of those deer (561 of 959) on secure habitat are in Group A, the subpopulations in the westernmost portion of the DPS. The middle portion of the range has very few deer on protected lands (49 of 959). The eastern portion of the DPS also has a large number of deer on protected lands (349 of 959). Half of the DPS would still be on protected/secure lands even if Puget Island was excluded from being considered secure (747 of 1,354 deer or 55 percent). When the recovery plan was published, approximately 150-200 deer were located on secure habitat in one subpopulation.

The distribution of secure and protected lands is concentrated on the easternmost and westernmost portions of the species range on Refuge lands (Table 13). The eastern portion of the range contains the Ridgefield NWR and the western portion contains JBH. The center of the range has the least amount of protected lands.

Table 13. Distribution of Columbian white-tailed deer based on secure habitat as of 2022. Group A populations are represented in orange, Group B in green, and Group C in blue.

Subpopulation Name	Number of deer on secure habitat	Number of deer on unsecured habitat	Amount of secure habitat (hectares)	Percent of habitat secured	Condition Rank
JBH Mainland	80	36	1,191	42	**Moderate**
Puget Island	212*	15	2,023^	98	**High**
Tenasillahe Island	216	0	1,049	98	**High**
Westport/Wallace	53	158	369	6	**Low**
Cottonwood	25	42	327	28	**Low**
Lord/Dibblee	17	46	253	29	**Low**
Willow Grove	7	59	109	12	**Low**
CSR	31	4	0	0	**Low**
Ridgefield	298	20	2,890	77	**High**
Sauvie/Scappoose	20	15	1,206	47	**Moderate**
Total	959	395	9,417	40	

^Considered secure although land is under private ownership
*Deer are located on private land that is considered secure

5.4 Viability Summary

Resiliency

Resiliency refers to the ability of populations to withstand stochastic events and is commonly determined as a function of metrics such as population size, growth rate, or habitat quality and quantity. We determined that to be resilient, subpopulations would contain a minimum of 50 deer (resiliency) and an abundance of cover and forage distributed in a mosaic pattern with minimal amounts of invasive plants. We did not have data to evaluate each of these measures for every subpopulation. However, we did quantify abundance; reproductive success (using fawn to doe ratios); dispersal and connectivity; habitat quantity; and the amount of protected and secure habitat.

Three of the ten Columbian white-tailed deer subpopulations were ranked as highly resilient while four were ranked moderate, and three were ranked low (Table 14). All three Groups contain subpopulations ranked as having either high or moderate resiliency.

- Within Group A, two subpopulations were ranked as high, and two were moderate.
- Within Group B, one subpopulation was ranked as moderate, and two subpopulations were low.
- Within Group C, one subpopulation was ranked as high, one as moderate, and one subpopulation was ranked as low.

Table 14. Current resiliency of subpopulations of Columbian white-tailed deer.

Subpopulation Name	Overall Resiliency	Condition Rankings				
		Demographic Metrics			Habitat Metrics	
		Number of Deer in 2025	Fawn to Doe Ratio^	Annual Dispersal Probability	Habitat Quantity	Secure habitat
JBH Mainland	Moderate	High	Moderate	Moderate	Moderate	Moderate
Puget Island	High	High	High	Moderate	Moderate	High
Tenasillahe Island	High	High	Moderate	Moderate	Moderate	High
Westport/Wallace	Moderate	High	High	Moderate	High	Low
Cottonwood	Low	Moderate	-	Low	Moderate	Low
Lord/Dibblee	Low	Moderate	Moderate	Moderate	Low	Low
Willow Grove	Moderate	Moderate	Moderate	Moderate	Low	Low
CSR	Low	Low	-	Low	Moderate	Low
Ridgefield	High	High	Moderate	Moderate	High	High
Sauvie/Scappoose	Moderate	Low	-	Moderate	Moderate	Moderate

^Based on most recent 5-year average. Data not available for every subpopulation.

Thus, each Group contains highly resilient and moderately resilient subpopulations that are likely to withstand stochastic events. Overall, the majority of subpopulations – 7 out of 10 – are ranked with either high or moderate resilience. A high degree of variability in subpopulation condition remains, with some subpopulations responding positively to translocations and/or active management, growing in abundance and expanding in extent over time (e.g., Ridgefield), while others are not doing as well despite management efforts and the availability of what appears to be suitable habitat for the species (e.g., Cottonwood). The latter situation indicates there is some stressor acting on the species that we do not yet recognize or have not sufficiently addressed at these particular locations. Subpopulations that ranked low all occur in the middle portion of the range, which could indicate a bottleneck or pinch point of some kind. Given that deer have only recently been translocated to CSR, we anticipate that the subpopulation there will expand and grow in the next several years as habitat restoration continues. Three years of fawn:doe ratios indicate the subpopulation is reproducing. The fawn:doe ratio was 62.5 in 2021, 122.2 in 2022, and 57.1 in 2023 (U.S. Fish and Wildlife Service 2023, p. 9). Fawns were not seen on CSR during surveys in 2024, however bucks and does were observed. Some of the adults did not have ear tags, meaning they were not translocated there. The area of the CSR subpopulation is expected to support about 25 deer; however, the surrounding habitat is extensive, and this area could support a much larger subpopulation as long as the floodplain is not converted to fish habitat. If the CSR subpopulation grows and habitat improves, connectivity may also improve. On its current trajectory, the subpopulation is likely to increase to a moderate condition, which will increase the resiliency in the middle portion of the range. If deer habitat is converted to fish habitat, then the subpopulation will remain at a low resiliency.

Every subpopulation has some level of connection between at least two other subpopulations and several connect to three other subpopulations (Table 10). The most difficult area for deer dispersal appears to be the move from Group B subpopulations (Cottonwood) to the Group C subpopulations (CSR). Dispersal also appears challenging from CSR to other Group C subpopulations. This may represent a pinch point in the area near Longview, Washington, where there is a great deal of industrial activity. The lack of high dispersal probability likely reflects the fragmented nature of suitable habitat throughout the range of the Columbia River DPS. If existing habitat is converted to fish habitat, then dispersal may be further inhibited in those locations.

Redundancy

Redundancy is defined as a species' ability to withstand catastrophic events and is determined as a function of the number of populations, as well as their distribution and connectivity. Ideally, at the species level, resilient subpopulations would be distributed across the range of the DPS (redundancy and representation) and have connectivity across the landscape (redundancy and representation).

The presence of multiple highly and moderately resilient subpopulations distributed across the geographic range of the Columbia River DPS increases the likelihood that the species will be able to adapt to environmental changes as well as to withstand catastrophic events. Examples of this have already occurred. During past flooding events, Columbian white-tailed deer have left low-lying areas that flooded frequently and did not return (e.g., Karlson Island). In other areas where intermittent flooding events occurred, deer numbers have bounced back. The JBH Mainland Unit has experienced three large storm-related floods since 1996. Each of these flooding events have been associated with a sudden drop in population numbers with recovery over the following few years.

When considering redundancy across the DPS range, Group A has two moderate and two highly resilient subpopulations. It also has the largest overall number of deer, the most deer on protected land, and the most available habitat (Table 15). Group C also has high numbers in these three aforementioned categories, yet subpopulation condition is more variable with one in low, one with moderate, and one with high resilience. Group B has lower numbers of deer, few deer on protected land, and less habitat than the other groups, putting it most at risk of impacts from catastrophic events. Overall, species redundancy is high and has increased from 5 subpopulations in the range of the Columbia River DPS at the time of listing to 10 subpopulations currently across the DPS range.

Table 15. Comparison of redundancy across the range of the Columbia River DPS of Columbian white-tailed deer.

Group	# of subpopulations	Total # of deer (2025)	# deer on protected or secure land	Available habitat (ha)
A	4	770	561	11,722
B	3	196	49	2,948
C	3	388	349	7,919

Representation

Representation refers to the ability of a species to adapt to change, and is based upon considerations of geographic, genetic, ecological, and niche diversity. Species adapt to novel changes in their environment by either [1] moving to new, suitable environments or [2] by altering their physical or behavioral traits (phenotypes) to match the new environmental conditions through either plasticity or genetic change (Beever et al. 2016, p. 132; Nicotra et al. 2015, p. 1270). We consider the Columbian white-tailed deer to have representation across the known range of the DPS. Although no direct measures of genetic or ecological diversity are available, there are multiple subpopulations distributed relatively evenly across the geographic range of the DPS (four in Group A, three in Group B, and three in Group C), and with representation of all known habitat types (upland, wetland, and oak savannah). Each subpopulation has some level of connectivity to another subpopulation, which increases the species ability to move if habitat becomes unsuitable in the future. There are also areas within the current range, such as Pacific County, which do not have subpopulations of deer yet that could offer refugia in the future. The deer have not moved there naturally, however, and would require translocations to these areas, along with substantial amounts of habitat restoration and protection needed from sea level rise.

Representation has increased relative to the time of listing, with new subpopulations in and around Ridgefield NWR (representing the easternmost extent of the species' range). No known ecological settings for the species have been lost, although the deer would benefit from moving to more upland areas. Having multiple subpopulations distributed across the range of the DPS, in a variety of habitat types and elevations, increases the adaptive capacity of Columbian white-tailed deer and the ability of species to respond to environmental change.

Summary of Current Condition

The available information indicates that the status of Columbian white-tailed deer has improved since it was listed as an endangered species under the Endangered Species Act on October 13, 1970 (35 FR 16047). At the time of listing, only 300 to 400 Columbian white-tailed deer were thought to reside in the Columbia River DPS in five subpopulations. The recovery criteria established in the 1983 recovery plan were to maintain a minimum of at least 400 Columbian white-tailed deer across the Columbia River DPS and maintain three viable subpopulations (50 or more deer), all located on secure habitat. We estimate the current DPS to contain 1,354 deer across 10 subpopulations in just under 23,000 ha (56,834 acres) of habitat. Of those deer, 959 (71 percent) reside on secure habitat. There are currently three subpopulations considered both viable and secure: Puget Island, Tenasillahe Island, and Ridgefield. Overall, the majority of subpopulations – 7 out of 10 – are ranked with either high or moderate resilience. There is some uncertainty regarding the amount of habitat alteration that may convert deer habitat to fish habitat. While this may occur throughout the range of the Columbia River DPS, it would have the greatest impact to Group B subpopulations in the middle of the range.

Columbian white-tailed deer numbers have grown across the DPS as a result of subpopulation creation via translocations, habitat improvement, and natural expansion following translocations. The presence of Columbian white-tailed deer in new areas, such as Ridgefield NWR, increases both the geographic range of the species and connectivity throughout the landscape. This in turn has increased species redundancy and representation. An increased number of subpopulations, composed of a greater number of individuals and with expanded distribution and connectivity across the species range, means the Columbian white-tailed deer has a greater chance of withstanding stochastic events (resiliency), surviving potentially catastrophic events (redundancy), and adapting to changing environmental conditions (representation) over time.

Chapter 6. Future Viability

Here, we consider the viability of the Columbia River DPS of Columbian white-tailed deer 50 years into the future, taking into consideration the current condition of the DPS and the identification of any new stressor not considered at the time of listing or recovery plan development. Viability is then assessed in terms of anticipated subpopulation resiliency, redundancy and representation under these future conditions. In the case of Columbian white-tailed deer, modeling has been conducted to forecast population viability and impacts from climate change, specifically sea level rise. While CWD may become a significant stressor if it is detected in the DPS, we do not have information that would allow us to forecast the scope, intensity, or species response to this potential stressor.

6.1 Population Modeling and Results

In 2012, minimum viable population (MVP) sizes were explored for Columbian white-tailed deer on a 50-year extinction rate timeframe using a stochastic two-sex Leslie matrix model and Monte Carlo simulations. The model suggested that the probability of extinction for the Columbia River DPS with three subpopulations of 50 Columbian white-tailed deer each is less than 1 percent over the next 50 years (Skalski 2012, pp. 5-8). The model incorporated major flooding events every 5, 10, or 20 years. As the rate of flood events increased, the probability of extinction increased when all other factors were constant (Skalski 2012, p. 3). Depending on the growth rate and frequency of flood event, the MVP for the three subpopulations ranged from 77 to 170 deer for a 50-year timeframe (Skalski 2012, p. 4).

In 2017, the WDFW contracted the Conservation Planning Specialist Group, part of the Species Survival Commission of the International Union for Conservation of Nature, to conduct a population viability analysis (PVA) workshop with state wildlife management experts from WDFW, ODFW, the Service, and the Cowlitz Tribe. The PVA process was then followed by a PHVA workshop to assist in long-term conservation planning for the DPS. For the PVA, a computer modeling tool known as Vortex was used to construct multiple scenarios simulating Columbian white-tailed deer population growth, threats to long-term population stability (i.e.

habitat loss and flooding), and the potential impacts of management alternatives designed to improve that stability. Assumptions were made for model input parameters using existing data and best professional judgement. For instance, although there is some uncertainty whether the buck to doe ratio is 1:3 given that this is not a hunted population, we used these values in the model because they remain the best available information.

The PVA tool explored plausible future scenarios over the next 50 to 100 years. Model scenarios described alternative rates of potential future subpopulation growth (low, medium, and high) based on assumed responses to broad threat mitigation activities, primarily predator (coyote) control, that would result in corresponding changes in fawn survival. The results of the PVA were presented by quasi-extinction thresholds, which provide the probability that the mean subpopulation abundance will be below a given amount at a defined time in the future (Miller et al 2020, p. 20).

The first three model scenarios explored the impact of connectivity on the DPS using a large subpopulation (JBH Mainland) and a small subpopulation (CSR). One scenario assumed no dispersal, another assumed baseline dispersal based on the values previously discussed in Section 5.3.3 of this SSA, and the final scenario assumed restricted dispersal with half the amount of dispersal previously predicted. Results suggested that having at least some connectivity decreased extinction risk, smaller subpopulations were influenced more so by connectivity than large subpopulations, and that viability of small subpopulations, especially those in Group B, could be improved through greater connectivity by expanding suitable habitat (Miller et al 2020, p. 22).

The second set of model scenarios explored the impact of population growth on the DPS under both low and medium growth rates assuming baseline dispersal and current influences on viability remaining the same (status quo scenario). Under both low and medium-low growth rate scenarios, group A subpopulations maintained at least 50 deer into the future albeit with less growth likely as habitat reached carrying capacity; group B subpopulations were more likely to decline in numbers than other subpopulations given that their carrying capacities were already limited; and group C subpopulations increased in abundance, although uncertainty existed for the newly created CSR subpopulation (Miller et al 2020, pp. 23-28). When increased amounts of flooding and habitat loss were introduced into these simulations, results differed. For group A and C subpopulations, severe flooding and habitat loss resulted in fewer deer than in the status quo scenario due to depressed growth rates, yet the extinction risk remained low (Miller et al 2020, pp. 23, 25). On the other hand, group B subpopulations dwindled to 10 to 23 deer as flooding and habitat loss increased under low growth conditions (Miller et al 2020, p. 24). These numbers were slightly higher under medium growth rate scenarios, but were still likely to stay under 50 deer (Miller et al 2020, p. 27). Looking at the entire DPS under low growth conditions, the PVA estimated there would be roughly 1,700 deer under the status quo scenario and 800 deer in the event of severe flooding and habitat loss at year 50, with a 7.5 percent risk that the DPS would fall below the threshold of 400 deer set in the recovery plan (Miller et al 2020, p. 26). If the entire DPS under medium growth conditions is considered, then there would be roughly 2,000 deer under the status quo scenario and 1,100 deer in the event of severe flooding and habitat loss at year 50, with a negligible risk that the DPS would fall below the threshold of 400 deer set in the recovery plan (Miller et al 2020, p. 29). There would also be a negligible risk that the DPS would fall below the threshold of 400 deer under high growth conditions, with roughly 2,100 deer estimated under the status quo scenario and 1,200 deer estimated in the event of severe flooding and habitat loss at year 50 (Miller et al 2020, p. 33).

Given that group B subpopulations were smaller and at greater risk than the other subpopulations, additional scenarios were run focused on targeted habitat management. Lord/Dibblee and Cottonwood subpopulations were at greatest risk from habitat loss and severe flooding, with the probability of persistence declining around year 45 and falling to 0.7 at year 100 (Miller et al 2020, p. 45). By increasing the habitat capacity 25 percent, probability of persistence improved as a result of higher abundance and greater connectivity (Miller et al 2020, p. 45). Thus, habitat enhancement and management could decrease the risk of extinction to the group B subpopulations.

There are some conclusions from the PHVA that may need further evaluation. For instance, the PHVA stated that the Cottonwood subpopulation was twice carrying capacity and suggested that the population would respond by declining in the face of resource limitations (Miller et al 2020, p iii). This is not consistent with white-tailed deer biology and we have no evidence that white-tailed deer populations are self-limiting. White-tailed deer populations can remain at high densities that cause dramatic shifts in plant community composition while continuing to reproduce. Refuge staff are seeing plant composition changes on the Ridgefield NWR. Likewise, the subpopulation on Tenasillahe is well above its targeted density in the Refuge CCP. It is more likely that we see declines in body condition rather than reduced abundance.

Overall, the PVA determined a 97 percent probability that the DPS would remain over 400 individuals in the next 50 years even when taking into account the possibility of severe flooding and additional habitat loss.

6.2 Climate Change Modeling and Results

According to studies that have modeled future climate change in the Pacific Northwest, climate effects could include but are not limited to: increased wildfire frequency and severity, increased drought frequency, rain-snow regime changes, and increased flooding (Halofsky et al. 2020, p. 11; Jay et al. 2018, p. 43). Additionally, non-climate stressors such as habitat composition change, changes in invasive species distribution, and habitat fragmentation could occur as a result of climate change (Halofsky et al. 2020, p. 13). However, of the various climate change-induced impacts predicted to affect habitats in the Pacific Northwest, climate change-induced sea level rise (SLR) is expected to be the most immediately impactful to coastal habitats and tidally influenced river systems, such as the lower Columbia River (Jay et al. 2018, p. 43). This SSA modeled resilient landscapes for the Columbian white-tailed deer by combining the Lower Columbia Estuary Partnership's (LCEP) Columbian White-tailed Deer Habitat Suitability Model (https://www.estuarypartnership.org/columbian-white-tailed-deer-habitat-suitability-modeling) with four different SLR studies.

Sea level rise is primarily driven by two factors: 1) increased volume of seawater due to thermal expansion of the ocean as it warms, and 2) increased mass of water in the ocean due to melting ice from mountain glaciers and the Antarctic and Greenland ice sheets (Sweet et al. 2017, p.

335). Regardless of future scenario, it is virtually certain that global average sea level will continue to rise throughout the 21st century (Fox-Kemper et al. 2021, p. 1216) and well beyond 2150 (Sweet et al. 2022, p. 26), reflecting the latency in response of the ocean system. Over the next 30 years, relative sea level along the contiguous U.S. coastline is expected to rise on average 0.25-0.3 meters (m) (0.82-0.98 feet), which is as much as it has risen over the last 100 years (1920-2020)(Sweet et al. 2022, p. 60).

The Columbia River is susceptible to climate change-induced increases in water temperature and SLR in part because of habitat alteration from dredging, dike construction, flood control, dam creation, and other infrastructure activities that began in the mid-1800's (Glick et al. 2007, p. 2). The National Wildlife Federation model predicted a range of SLR between 0.34 to 1.6 m (1.1-5.2 feet) by 2100 in the Willapa Bay, Columbia River Estuary, and Tillamook Bay region (Glick et al. 2007, p. 29). For this region, a 0.34-m (1.1-foot) rise in sea level equates to a loss of at least 5,000 ha (12,355 acres) of dry land, extensive loss of tidal flats, and area beaches (Glick et al. 2007, p. 72). By 2100, the region could lose 32 percent of its brackish marsh, 31 percent of tidal swamp, 47 percent of estuarine beach, and 63 percent of tidal flats. Given the extensive size of the study site in this model (566,560 ha or 1.4 million acres), it is unclear how much of the area where Columbian white-tailed deer reside would be impacted.

The NOAA Office for Coastal Management developed a web-based mapping tool in 2017 that visualized community-level impacts from coastal flooding and SLR (hereafter called the NOAA SLR Tool; https://coast.noaa.gov/digitalcoast/tools/slr.html). The model predicts the elevation of the mean higher, high water (MHHW) based on a low SLR scenario of 0.2 m (0.7 feet) to a high SLR scenario of 2 m (6.6 feet) by 2100. The MHHW is the average of the higher, high water height of each tidal day observed over the National Tidal Datum Epoch. The present National Tidal Datum Epoch is 1960 through 1978. It is reviewed annually for possible revision and must be actively considered for revision every 25 years. In 2022, the Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Interagency Task Force produced a report that updated the information utilized by NOAA in their 2017 modeling efforts (Sweet et al. 2022, entire). The new model goes out to the year 2150 and provides an Interagency Sea Level Scenario Tool (hereafter referred to as N-SLCT SLR Tool; https://sealevel.nasa.gov/task-force-scenario-tool/). The five SLR scenarios from the updated 2022 Technical Report correspond to five different emissions scenarios, called Shared Socioeconomic Pathways (SSPs) (Fox-Kemper et al. 2021, p. 1216; Sweet et al. 2022, pp. 21-27).

- Low SLR scenario corresponds to SSP1-1.9, with low greenhouse gas emissions and with anthropogenic carbon dioxide emissions cut to net zero around 2050.
- Intermediate-Low SLR scenario corresponds to SSP1-2.6, with intermediate to low greenhouse gas emissions and with carbon dioxide emissions cut to net zero around 2075.
- Intermediate SLR scenario corresponds to SSP2-4.5, with intermediate greenhouse gas emissions and with anthropogenic carbon dioxide emissions staying around current levels until 2050, then falling steadily to reach net zero by 2100.
- Intermediate-High SLR scenario corresponds to SSP3-7.0, with intermediate to high greenhouse gas emissions and with anthropogenic carbon dioxide emissions doubling by 2100.
- High SLR scenario corresponds to SSP4-8.5 with high greenhouse gas emissions and with anthropogenic carbon dioxide emissions continuing to increase at their current rate,

thereby tripling by 2075. This SSP is most comparable to representative concentration pathway (RCP) 8.5. Under RCP 8.5, there is projected to be a 3-8°F increase in average surface air temperature by 2100 compared to historical averages.

The 2022 Technical Report predicts the elevation of the MHHW, based on predicted increases in the global mean sea level (GMSL) between a low scenario of 0.3 m (0.96 feet) to a high scenario of 2.0 m (6.56 feet) by 2100 (Sweet et al. 2022, p. 4). The predicted rises in GMSL were then used to develop local relative sea level rise (RSL) scenarios by considering regional changes in ocean circulation, changes in Earth's gravity field due to ice melt redistribution, and local vertical land motion. A RSL scenario for Astoria, Oregon, which is the closest such scenario to the Columbian white-tailed deer DPS, determined that year-to-year variability in RSL corresponds most closely with the Intermediate-High emissions scenario (Sweet et al. 2022, pp. 20, 83). The Intermediate-High RSL scenario for Astoria from the aforementioned NOAA SLR Tool predicts 1.17 m (3.84) feet of SLR by 2100 (NOAA 2018, no page number) while the same scenario and location with the N-SLCT SLR Tool predicts 1.16 m (3.81) feet of SLR by 2100 (N-SLCT 2022, no page number). This aligns with the Service's determination that refuge managers should explicitly plan for 1 m to 1.5 m (3.2 to 4.9 feet) of sea level rise by 2100 (Czech et al. 2014, p. 31). However, given the uncertainty of climate change legislation, being close to one scenario early in the century does not imply that real-world behavior will follow that scenario throughout the century.

The following figures illustrate areas that may become inundated given different amount of SLR. In each figure, areas that are hydrologically connected to the river are shown in shades of blue (with darker shades of blue indicating greater water depths; low-lying areas that are hydrologically unconnected to the river, but may flood with increasing high tides are displayed in green).

Impacts from SLR would be greater in the westernmost portion of the DPS where Group A subpopulations reside because tidal influence decreases with distance upriver. Therefore, we chose to focus on how these land areas would change under different SLR scenarios. With 0.3 m (1.0 feet) SLR, the MHHW begins to inundate Horseshoe, Wallace, Welch, Crims, and Lord Islands (Figure 6a). JBH Mainland is shown as being inundated, or nearly so, although a small portion of this area may be protected by the existing setback levee. The MHHW is entering the low-lying areas between Clatskanie and Westport/Midland Marsh. With 0.9 m (3.0 feet) SLR, those same islands are further inundated and water is now present during MHHW over a greater portion of the Westport/Midland Marsh (Figure 6b). The low-lying area northeast of Clatskanie is beginning to be inundated. With 1.5 m (5.0 feet) SLR, Tenasillahe Island is inundated as well as most of the Westport/Midland Marsh and the Clatskanie area (Figure 6c). While these maps appear to show an extensive loss of habitat, the NOAA model does not take into account the existence and height of dikes and levees in the Columbia River estuary. Therefore, impacts are unlikely to be as extensive as shown in any of these SLR scenarios.

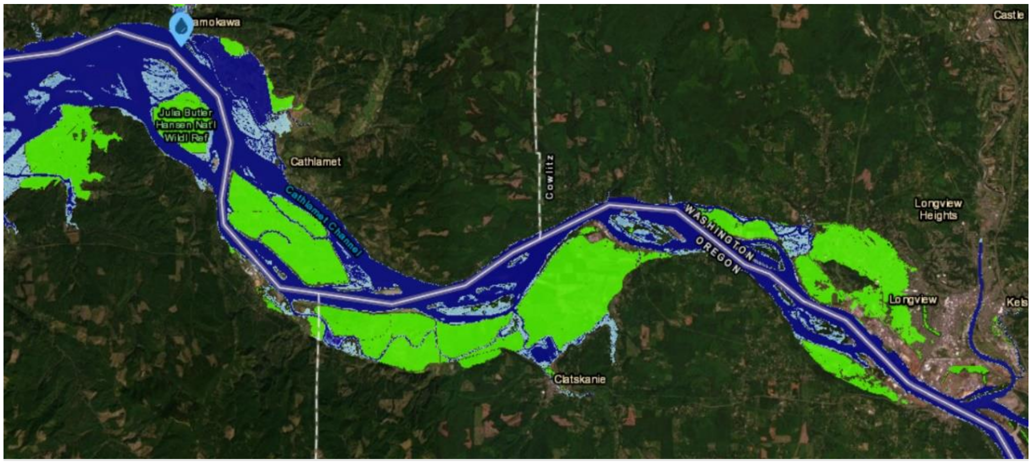

Figure 6a. Changes in a subset of the Columbia River DPS with a sea level rise of 0.3 m (1.0 feet). Source: NOAA Office of Coastal Management

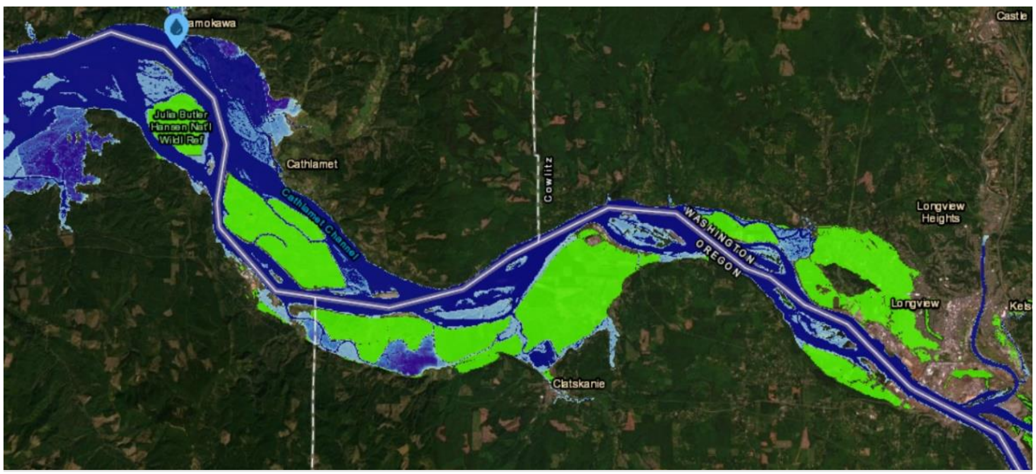

Figure 6b. Changes in a subset of the Columbia River DPS with a sea level rise of 0.9 m (3.0 feet). Source: NOAA Office of Coastal Management

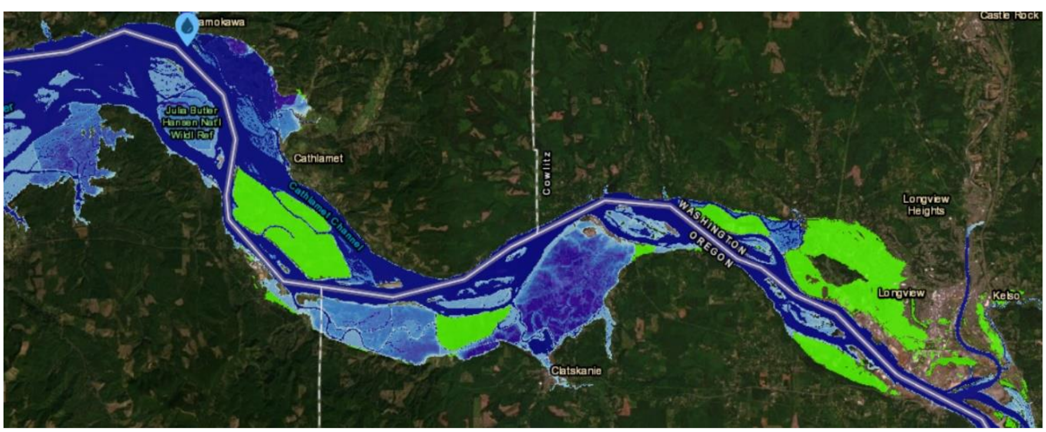

Figure 6c. Changes in a subset of the Columbia River DPS with a sea level rise of 1.5 m (5.0 feet). Source: NOAA Office of Coastal Management

Some studies have shown that the SLR projections in the Pacific Northwest may be too high given that SLR is influenced by land changes such as tectonic movement along with many other variables. A 2015 study predicted that SLR would be between 0.1 and 1.43 m (0.3-4.7 feet) by 2100 along the Washington, Oregon, and California coasts north of Cape Mendocino (NRC 2015, p. 3). A 2018 study determined Absolute SLR to be 1.66 mm/year (0.07 inches/year) for the Pacific coast between Astoria and South Bend, Oregon after correcting for vertical land motion measurements (Montillet et al. 2018, p. 1207). This average equates to a SLR increase of 0.14 m (0.5 feet) by 2100. A study that created representative SLR scenarios found that future SLR was reduced in the Pacific Northwest and Alaska compared to other coastal locations due to proximity to the Alaskan glaciers from both ongoing glacial isostatic adjustment to past glacier shrinkage and to the static-equilibrium effects of projected future losses (Sweet et al. 2017, p. 644). If these estimates are accurate, then the changes in the preceding figures, especially, the changes in Figure 6c, are less likely to occur.

While the NOAA and N-SLCT SLR tools provide valuable insight, the LCEP created a locally predictive SLR model using hydrologic processes and local flow barriers such as levees and dikes specific to the Columbia River (hereafter referred to as LCEP SLR Tool; https://lcep.maps.arcgis.com/apps/webappviewer/index.html?id=90de906767444d3b97cebf7491c1d74d). These barriers have disconnected a large percentage of former tidal wetland systems from tidal influence (Marcoe and Peha 2020, p. 1) and they also provide continuing habitat for Columbian white-tailed deer. Assessing levee response, including potential overtopping of levees, is critical when analyzing how the habitats along the lower Columbia River will be affected by SLR. The model results indicate the probability of a loss of current wetlands through permanent water inundation or levee overflow at the different sea level depths. Overall, most stretches of the river will lose a small percentage of current riparian wetlands from permanent water inundations under the three assessed scenarios. There are specific stretches of the river that may gain additional wetlands with various SLR. In addition, the increase in ground water levels resulting from the permeability of levees is likely to cause changes in vegetation, leading to more wetland habitat and more difficulty in controlling wetland invasive plants such as reed canarygrass. With 1.5 m (5 feet) of SLR, JBH Mainland, Tenasillahe Island, and some small islands are inundated as well as most of the low-lying areas between Clatskanie and Westport.

Ultimately, the Columbia River estuary is susceptible to climate change-induced increases in water temperature and SLR in part because of altered flow volumes and water dynamics. Much of the habitat currently used by Columbian white-tailed deer is below the high-tide level and is protected by flood control and drainage infrastructure. Under each of the aforementioned SLR scenarios, habitat would be lost and there would likely be flooding over low-lying, tidally-influenced lands such as Tenasillahe Island and the JBH Mainland Unit. Impacts from SLR would be greater to Group A subpopulations because tidal influence decreases with distance upriver. Even under the worst-case SLR scenario, however, suitable habitat would remain in the DPS, albeit in lower quantities than current levels. Connectivity between some subpopulations would also likely decrease depending on the distance between suitable habitat patches.

6.3 Summary of Future Resiliency, Redundancy, and Representation

Population modeling determined a subpopulation MVP to be between 77 and 170 deer for a 50-year timeframe depending on growth rates and flood frequency (Skalski 2012, p. 4). Modeling also determined that there is a 97 percent probability that the Columbia River DPS would remain over 400 individuals in the next 50 years even when taking into account the possibility of severe flooding and additional habitat loss (Miller et al 2020, pp. 26-33). For Group A and C subpopulations, predictions of severe flooding and habitat loss resulted in fewer deer than in the status quo scenario due to depressed growth rates, yet the extinction risk remained low (Miller et al 2020, pp. 23, 25). While Group B subpopulations were smaller and at greater risk, the PVA demonstrated that habitat enhancement and management could decrease the risk of extinction to these subpopulations.

Population modeling indicated that at least some connectivity decreased extinction risk (Miller et al 2020, p. 22). Gradual changes in SLR over time will slowly alter the habitat and possibly create opportunities for deer to shift their movements to other areas as long as some connectivity persists. For instance, there are large swaths of County lands along the east fork of the Lewis River in Washington that do not contain Columbian white-tailed deer, yet do contain habitat and security. There are also areas within, and adjacent to, the CSR, Ridgefield, and Sauvie/Scapoose subpopulations that contain portions of unoccupied suitable habitat. Protected lands will also continue to manage habitat and maintain levees as much as possible to reduce or prevent impacts from SLR. Pressure from development and competing land uses may constrain the deer's ability to disperse to alternative locations.

Gradual changes in sea level rise over time will slowly alter the habitat. These changes are likely to result in habitat loss and fragmentation, although we do not know the extent of possible habitat impacts and the resulting effects to Columbian white-tailed deer. Much of the habitat currently used by Columbian white-tailed deer is below the high-tide level and is protected to some extent by flood control and drainage infrastructure. Moving deer to upland habitat and improving flood control measures could improve viability. Given tidal influences in the Columbia River, Group A subpopulations are most likely to be affected by future changes in sea level. However, these subpopulations have also shown the repeated ability to rebound from stochastic and catastrophic events over the past 50 years. Given that Group A subpopulations are all in moderate or high condition currently and sea level rise is a gradual change on the landscape, it is unlikely that these four subpopulations would all decrease to low condition or extinction even with environmental changes on the landscape. However, this will be somewhat dependent upon maintaining, or potentially raising, the existing levees.

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