PNNL-13745

Hanford Site Ecological Quality Profile

G. R. Bilyard
M. R. Sackschewsky
S. A. Tzemos

February 2002

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161
ph: (800) 553-6847
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

This document was printed on recycled paper. (8/00)

PNNL-13745

Hanford Site Ecological Quality Profile

G. R. Bilyard
M. R. Sackschewsky
S. A. Tzemos

February 2002

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Preface

This ecological quality profile was prepared by Pacific Northwest National Laboratory. Staff from the Center for Risk Excellence, Oak Ridge National Laboratory, and Argonne National Laboratory provided helpful comments and criticisms of earlier drafts. The authors thank Amoret Bunn for her excellent technical advice during the development of the GIS-based ecological profiling tool, and for her technical review of this report. In addition, William Andrews provided valuable programmatic oversight and insightful perspectives on the need for the tool and the management objectives that the tool should satisfy. Finally, we thank James R. Weber for assistance in the production of this report.

Comments and criticisms of this draft should be addressed to:

Gordon Bilyard
Pacific Northwest National Laboratory
P.O. Box 999; MS K8-03
Richland, Washington 99352
Phone: (509) 372-4219
Fax: (509) 372-4995
Email: gordon.bilyard@pnl.gov

The primary sources of information and data for this profile are Neitzel et al. (2000) and the Hanford Geographic Information System.

Key Attributes of Ecological Resources at the Hanford Site

- The Hanford Site occupies and area of about 1517 km^2 (~586 mi^2).
- The terrestrial ecosystem is characterized as shrub-steppe, with a shrub overstory and a grass understory.
- The last free-flowing section of the Columbia River within the United States flows through the Site.
- Native terrestrial and aquatic habitats in undeveloped areas (94% of the Site) are relatively undisturbed because of DOE's long-standing management practices.
- Native habitats on the Hanford Site play a key role in the entire Columbia River ecosystem by offering broad-based preservation benefits.
- Native habitats provide a refuge for native species.
- Native habitats support, or have supported three species that are listed by the Federal government as threatened or endangered, plus many other species considered sensitive by the Federal government and the State of Washington.
- Native habitats provide a stopping place for migratory birds, and spawning habitat for migratory fish.
- Hanford Site environmental and ecological resources are a recreational and educational resource.
- Ecological resources on the Hanford Site have high existence value.

Contents

Introduction

This quality profile, prepared by the Pacific Northwest National Laboratory,[a] characterizes impacts and hazards to ecological resources on the Hanford Site, which is managed by the U.S. Department of Energy and the U.S. Fish and Wildlife Service. It includes descriptions of critical ecological assets, ecological resources within the four major regions of the site, threatened and endangered species, surface hazards, and risks due to those hazards.

The Hanford Site occupies an area of about 1517 km^2 (~586 mi^2) within the Pasco Basin of the Columbia Plateau in southeastern Washington State. It has a mid-latitude semi-arid climate (Critchfield 1974). Terrestrial portions of the site are characterized as a shrub-steppe ecosystem (Daubenmire 1970), which has a shrub overstory with a grass understory. The last free-flowing section of the Columbia River within the United States above Bonneville Dam flows through the site, providing habitat not found outside Canada. Groundwater beneath the Hanford Site is found in both an upper unconfined aquifer system and deeper basalt-confined aquifers. The Columbia River is the primary discharge area for the unconfined aquifer.

Located on the Site are more than 1500 waste management units and four groundwater contamination plumes that have been grouped into 62 operable units. Each unit has complementary characteristics of such parameters as geography, waste content, type of facility, and relationship of contaminant plumes. The 62 operable units have been aggregated into four areas: 22 in the 100 Area, 33 in the 200 Areas, 3 in the 300 Area, and 4 in the former 1100 Area.

Only about 6% of the Hanford land area has been disturbed or is actively used by DOE. The remaining land area provides a buffer for the smaller areas currently used for storage of nuclear materials, waste storage, and waste disposal. The ecological resources in these buffer areas remain relatively undisturbed as a result of DOE's long-standing management practices, including:

- a high degree of access control
- a practice of "restricted development and non-intrusive land use" (DOE 1996a)
- the creation and maintenance of large tracts of land and associated habitat as "buffer" areas between DOE facilities, between major areas of the site (e.g., the 100 and 200 Areas), and between developed areas of the site and offsite areas (e.g., the Wahluke Slope)
- the prohibition of all residential and nearly all commercial development within the site boundary.

(a) Pacific Northwest National Laboratory is operated by Battelle for the U.S. Department of Energy under Contract DE-AC06-76RL01830.

The Hanford Site

The critical nature of many Hanford Site ecological resources and the high degree of ecological integrity displayed by those ecological resources are directly attributable to the absence of agricultural, industrial, and residential development that has occurred elsewhere throughout the region. Thus, DOE's management practices have resulted in the maintenance of intact, relatively undisturbed native terrestrial and aquatic ecological resources. As development continues throughout the region, these ecological resources become increasingly rare and important.

Critical Ecological Assets

The critical nature of Hanford Site ecological resources is directly attributable to three characteristics: they extend over a large geographic area; they are relatively undisturbed; and they are increasingly rare within the region and throughout the western United States. All of the highly valued plants and animals on the Site exist as a result of these characteristics, examples being native shrub-steppe vegetation, elk, bald eagles, and salmon. To discuss individual species as critical assets is misleading. A more accurate depiction is afforded by describing the six major types of benefits provided by these large tracts of relatively undisturbed habitat.

- *Native habitats on the Hanford Site play a key role in the entire Columbia River ecosystem by offering broad-based preservation benefits.* Native habitats on the site have helped maintain the integrity of the original ecological landscape, including much of the original biological diversity. Their importance of terrestrial habitats is further enhanced because it does not appear that native shrub-steppe habitats can fully recover from human-induced changes (Scott et al. 1998).

- *Ecological resources on the Hanford Site provide a refuge for native species.* For many native species, the Hanford Site is the last area in the region where they exist as functional populations. Specifically, native grasslands, shrublands, and riparian areas provide food, cover, reproductive habitat, migration corridors, and habitats for species of concern. Trees provide cover, raptor roosts, reproductive habitat, and habitat for other species of concern. The free-flowing Columbia River provides habitat for a rich assemblage of plants and animals, including species of concern.

- *Habitats on the Hanford Site provide a stopping place for migratory birds, and spawning habitat for migratory fish.* Migratory birds use native terrestrial flora on the site as a stopping place during their spring and fall migrations. Similarly, the free-flowing river with its gravel bottom provides the last spawning habitat for salmon and steelhead in the Columbia River.

- *Hanford Site environmental and ecological resources are a recreational and educational resource.* The relatively undisturbed terrestrial and aquatic habitats that exist on the Hanford Site are used, or may be used, for recreational and educational purposes, including boating, hiking, fishing, hunting, ecological research, and teaching. The obliteration of native habitats throughout much of the surrounding area serves only to enhance the importance of site resources for recreation and education.

- *Ecological resources on the Hanford Site have high existence value.* As relatively undisturbed terrestrial and aquatic habitats decrease in quantity and quality, the public and stakeholders increasingly value the knowledge that undisturbed resources exist. The present "existence value" of the natural resources on the Hanford Site is high because of their high quality and rarity, at least among some stakeholder groups (e.g., Native Americans, environmental groups, research ecologists).

- *Habitats on the Hanford Site support, or have supported, Federally listed threatened and endangered species.* These include three species of birds and two species of fish. In addition, the shrub-steppe on the Hanford Site is considered a priority habitat by the State of Washington because of its rarity, and numerous species of plants and animals found on the site or in the Columbia River are considered sensitive by the Federal government or the State of Washington.

Ecological Resources

The Hanford Site is often divided into four major areas:

- Wahluke Slope, managed by the U.S. Fish and Wildlife Service
- Arid Lands Ecology Reserve (ALE), managed by the U.S. Fish and Wildlife Service
- Columbia River Corridor, a navigable waterway of the United States
- Central Plateau and adjacent areas (central portion), managed by DOE.

The Wahluke Slope and ALE are essentially undeveloped buffer areas for the Central Plateau and adjacent areas that are managed by the DOE. What little contamination existed in these areas has been remediated, and no further cleanup

The Hanford Site is home to abundant natural plant life

activities are planned in either location. The central portion and adjacent areas constitutes that part of the site used by the DOE from 1943 to the present. Nearly all of the DOE-generated activities, infrastructure, facilities, and environmental contamination are found within this area.

Terrestrial Resources

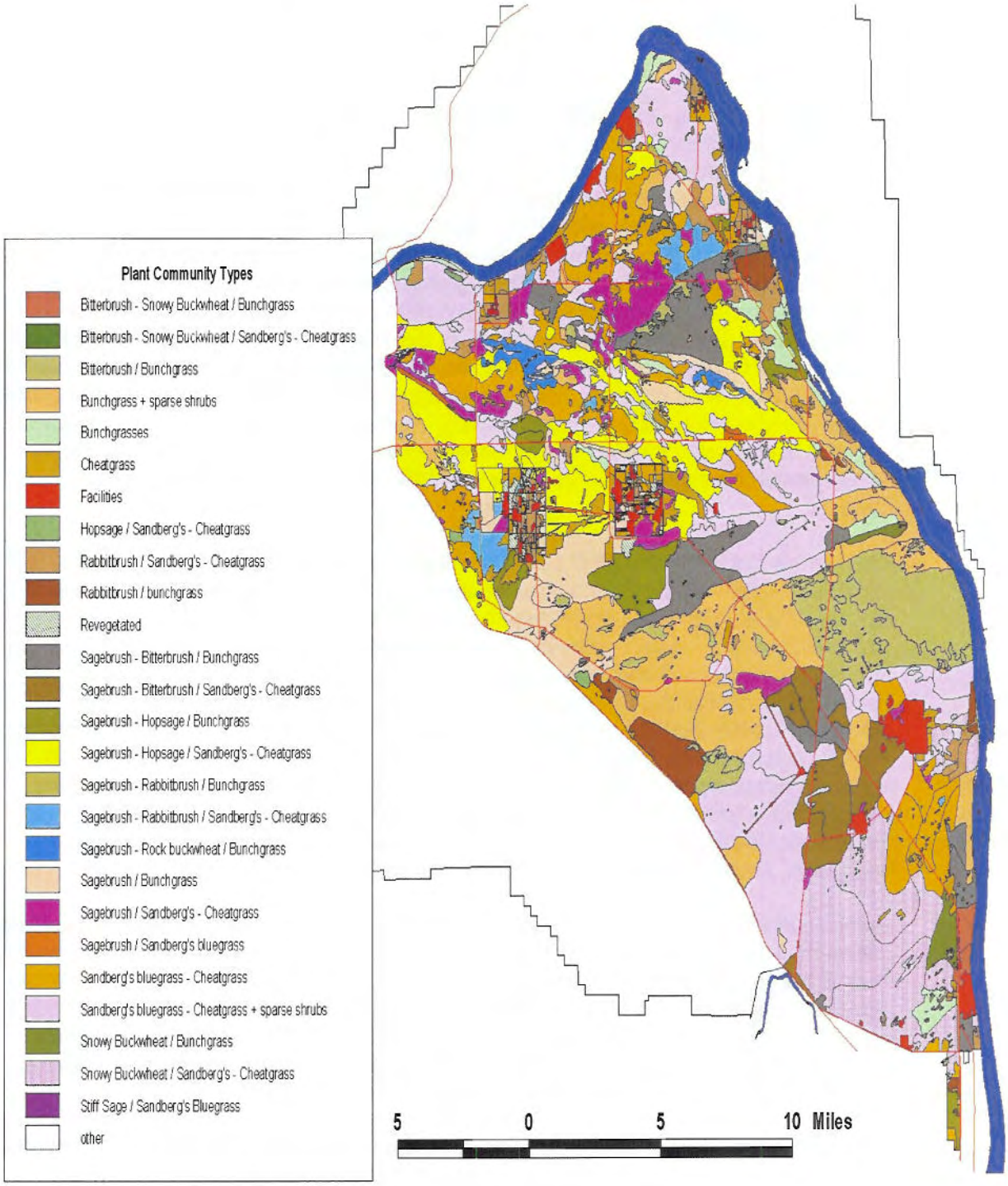
Terrestrial resources are valued for their diversity, abundance, and general high quality throughout most of the Hanford Site. The shrubland and grassland plant communities on the site support diverse wildlife (e.g., insects, birds, and mammals), and are the foundation for the six major benefits described above. The integrity of these plant communities is especially critical because unlike plant communities in many other parts of the nation (e.g., Savannah River Site), arid land communities do not recover from major impacts, including physical disturbance. Communities of lower value that are dominated by invasive alien species replace them. Of the 590 species of vascular plants recorded for the Hanford Site, approximately 20% of all species are considered non-native (Sackschewsky et al. 1992). Cheatgrass is the dominant non-native species. It colonizes aggressively and has become established across the site (Rickard and Rogers 1983). As cheatgrass and other alien species become established, harm to native communities is essentially irreversible, and is accompanied by significant reductions in wildlife species dependent on native habitats.

The Nature Conservancy (Hall 1998) conducted plant surveys and tentatively identified 16 terrestrial "potential" plant communities – i.e., communities that would exist in an area if it were free of disturbance. In addition, they found a total of 112 populations or occurrences of 28 rare plant taxa. Shrublands occupy the largest numbers of acres and comprise seven of the nine major plant communities on the Hanford Site (Sackschewsky et al. 1992). Of the shrubland types, sagebrush-dominated communities are the predominant type, with other shrub communities varying with changes in soil and elevation. Most grasses occur as understory in shrub-dominated plant communities. The diversity of native grass species is very high, including dominant species such as bluebunch wheatgrass, Sandberg's bluegrass, needle-and-thread grass, Indian ricegrass, thickspike wheatgrass, bentgrass, meadow foxtail, lovegrasses, and reed canarygrass (DOE 1996a).

Before settlement, the Hanford Site landscape lacked trees and the Columbia River shoreline supported a few scattered cottonwoods or willows. Homesteaders and staff at the former military installations and staff in the industrial areas of the site planted many trees, such as the black locust, Russian olive, cottonwood, mulberry, sycamore, and poplar that are now found on the site. Many serve as functional components of the riparian zone (DOE 1996a), providing nesting habitat, thermal cover, and roosting areas for many species of mammals and birds.

Wetlands, bluffs, dunes, and spring streams are special habitats on the Hanford Site. Wetlands within the Saddle Mountain National Wildlife Refuge and the Wahluke Wildlife Area have extensive stands of cattails and are used as resting sites by waterfowl. Bluffs provide perching, nesting, and escape habitat for several bird species on the Hanford Site. The terrain of the Hanford dunes provides habitat for a variety of valued species of mammals, birds, and reptiles. Small spring streams,

such as Rattlesnake and Snively Springs, are extremely productive (Cushing and Wolf 1984). They support diverse aquatic vegetation, are water sources for terrestrial animals, and provide foraging habitat for a variety of species of bats (Becker 1993).



Habitat Types Within the Central Portion the Hanford Site

The diversity of terrestrial vertebrates on the Hanford Site is remarkable and is a direct benefit of diverse, abundant, and expansive native terrestrial habitats. About 300 species have been observed, including approximately 40 species of mammals, 246 species of birds, 4 species of amphibians, and 9 species of reptiles (Soll and Soper 1996, Brandt et al. 1993). Terrestrial habitats support abundant populations of large game animals such as Rocky Mountain elk and mule deer, predators such as coyote, bobcat, and badger, and herbivores such as deer mice, harvest mice, grasshopper mice, ground squirrels, voles, and black-tailed jackrabbits. There are also nesting and foraging habitats for many passerine bird species, including long-billed curlews, vesper sparrows, western meadowlarks, horned larks, burrowing owls, sage sparrows, sage thrashers, and loggerhead shrikes (Cadwell 1994, DOE 1996a). Terrestrial habitats at Hanford support upland gamebird species (e.g., chukar partridge, California quail, and Chinese ring-necked pheasant) and raptors (e.g., ferruginous hawks, Swainson's hawks, red-tailed hawks, and endangered peregrine falcons). Diverse and abundant populations of reptiles (e.g., side-blotched lizards, short-horned lizards, sagebrush lizards, gopher snakes, yellow-bellied racers, Pacific rattlesnakes), and amphibians (e.g., Great Basin Spadefoot Toads, Woodhouse's Toads, Pacific tree frogs, and bullfrogs) also thrive on the Hanford Site (Soll and Soper 1996; Brandt et al. 1993).

Elk can be found on the Hanford Site

Columbia River Corridor

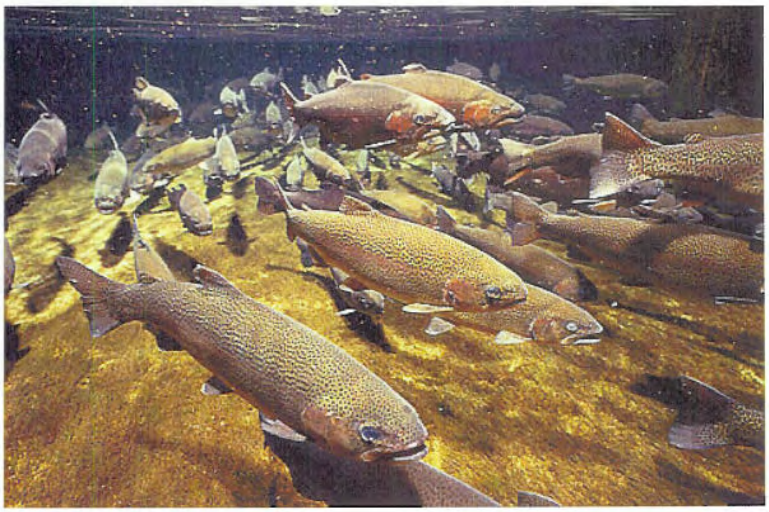
The Columbia River's passage through the Hanford Site creates an area known as the Hanford Reach, arguably the most treasured and widely recognized ecological resource in the region. The first of nine recommendations made by the Hanford Future Site Uses Working Group in 1992 was to "protect the Columbia River." One of the most popular bumper stickers in the region is "Save the Reach". As part of the Columbia River goal, the Hanford Strategic Plan states that "sensitive ecological ...resources will be protected" (DOE 1996b). The high value placed on the Reach is attributable to diverse and abundant plant and animal populations associated with the free-flowing river, and the aesthetic, economic, recreational, and cultural benefits they provide to the region.

A curlew on the Hanford Site

Rich communities of plankton and sessile algae in the Hanford Reach constitute most of the base of the aquatic food web in the Reach. Phytoplankton (free-floating algae) and zooplankton (free-floating animal) populations at the Hanford Site are largely transient, flowing through the Reach. Sessile algae develop on solid substrata wherever light is sufficient for photosynthesis. Together, they provide food for herbivores such as immature insects, which in turn are consumed by larger predaceous species such as salmon and trout. Peaks of production occur in spring and late summer (Cushing 1967).

Macrophytes are sparse in the Columbia River because of strong currents, the rocky bottom, and frequently fluctuating water levels. However, rushes and sedges occur along shorelines of slack-water sloughs and are present along gently sloping shorelines that are subject to flooding and daily fluctuating river levels. Where they exist, they are very important because they provide food and shelter for juvenile fish and spawning areas for some species of warm water game fish.

Rainbow trout occur in the Hanford Reach



All major freshwater benthic (i.e., bottom-dwelling) taxa are represented in the Columbia River. The most common are insect larvae such as caddisflies, midge flies, and black flies. These and other benthic organisms (e.g., limpets, snails, sponges, crayfish) are important as food items for juvenile and adult fish.

Gray and Dauble (1977) listed 43 species of fish in the Hanford Reach of the Columbia River, and one additional species has been collected since that time. Of these species, chinook salmon, sockeye salmon, coho salmon, and steelhead trout are the most important culturally and economically. The Hanford Reach is critically important to these species as a migration route to and from upstream spawning areas. Additionally, fall chinook salmon and steelhead trout spawn in the Hanford Reach (see Dauble and Watson 1990). Sedimentation of other mainstream Columbia spawning grounds by dams has increased the relative importance of Hanford Reach spawning (Watson 1970, 1973). Shad, mountain whitefish, white sturgeon, smallmouth bass, crappie, catfish, walleye, and yellow perch are also important sport fish in the Reach.

Island and riparian are special habitats within the river corridor because they support diverse and increasingly rare plant and animal communities. Island habitat accounts for approximately 474 ha (1170 acres) of terrestrial habitat (Hanson and Browning 1959) and 64 km (40 mi.) of river shoreline within the main channel. Shoreline areas include sloughs, backwaters, shorelines, riffles, gravel bars, cobble shorelines, and palustrine areas associated with the Columbia River flood plain. The largest wetland habitat is in the riparian zone that borders the Columbia River, which includes extensive stands of willows, grasses, and various aquatic macrophytes. These emergent habitats occur infrequently along the Hanford Reach and are of increasing importance because of the net loss of wetland habitat elsewhere in the region. In addition, they support 13 of the 19 rare plant species on the Hanford Site (Soll and Soper 1996). Four new species previously not listed at Hanford were found in the 31wetland areas surveyed by The Nature Conservancy (Hall 1998).

Riparian areas are important because they provide nesting habitat, foraging habitat and escape cover for birds and mammals. The terrestrial and aquatic insects are abundant in emergent grasses and provide forage for fish, waterfowl (e.g., Canada geese), and shorebirds (e.g., Forster's tern). The vegetation provides nesting habitat for passerines (e.g., mourning doves). Mammals that occur primarily in riparian areas include rodents, bats, mink, weasels, porcupine, raccoon, skunk, and mule deer, which use the islands as fawning and foraging areas. The Columbia River also provides foraging habitat for most species of bats including myotis, small-footed myotis, silver-haired bats, and pallid bats that feed on emergent aquatic insects (Becker 1993).

This list of bird species that are dependent on the riparian habitats is very long. Among the more common are the American robin, black-billed magpie, song sparrow, dark-eyed junco, ring-necked pheasant, and California quail (Cadwell 1994). Predatory birds found along the river include the common barn owl and great horned owls. Species known or expected to nest in riparian habitat are the Brewer's blackbird, mourning dove, black-billed magpie, northern oriole, lazuli bunting, eastern and western kingbird, western wood peewee, California gulls, ring-billed gulls, and Forster's terns. Bald eagles have wintered on the Hanford Site since 1960, using trees in the riparian habitat as perches. Great blue herons and black crowned night herons are also associated with trees in the riparian habitat, using groves or individual trees for perching and nesting.

Great blue herons can be seen nesting along the shores of the Columbia River

The Hanford Site is located in the Pacific Flyway, and the Hanford Reach serves as an important resting and wintering area for neotropical migrant birds, migratory waterfowl, and shorebirds (Soll and Soper 1996). During the fall and winter months, ducks and Canada geese use the shorelines and islands along the Hanford Reach, as do white pelicans, egrets, double-crested cormorants, coots, and common loons.

Threatened and Endangered Species

Threatened and endangered plants and animals identified on the Hanford Site, as listed by the Federal government (50 CFR 17) and Washington State (Washington Natural Heritage Program 1997), are shown in the following table. No plants or mammals on the Federal list of threatened and endangered wildlife and plants (see 50 CFR 17) are known to occur on the site. There are, however, three species of birds and two species of fish on the Federal list of threatened and endangered species. In addition, several species of both plants and animals are under consideration for formal listing by the Federal government and Washington State.

Pristine shrub-steppe habitat is considered priority habitat by Washington State because of its relative scarcity in the state, and because it is nesting/breeding habitat for several state and Federal species of concern. Several recent publications describing the distribution of threatened and endangered species on the Hanford Site have been prepared by Becker (1993), Cadwell (1994), Downs et al. (1993), Fitzner et al. (1994), Frest and Johannes (1993), Pabst (1995), and Hall (1998).

Federal or Washington State Listed Threatened (T) and Endangered (E) Species Occurring on the Hanford Site

Common Name	Scientific Name	Federal	State
Plants			
Columbia milkvetch	*Astragalus columbianus*	Sc[(b)]	T
Dwarf evening primrose	*Camissonia (=Oenothera) pygmaea*		T
Hoover's desert parsley	*Lomatium tuberosum*	Sc	T
Loeflingia	*Loeflingia squarrosa* var. *squarrosa*		T
Persistent sepal yellowcress	*Rorippa columbiae*	Sc	T
Umtanum desert buckwheat	*Eriogonum codium*	C[(c)]	E
White Bluffs bladderpod	*Lesquerella tuplashensis*	C	E
White eatonella	*Eatonella nivea*		T
Fish			
Spring-run chinook	*Oncorhynchus tshawytscha*	E	C
Steelhead	*Oncorhynchus mykiss*	E	C
Birds			
American white pelican	*Pelecanus erythrorhychos*		E
Bald eagle[(d)]	*Haliaeetus leucocephalus*	T	T
Ferruginous hawk	*Buteo regalis*	SC	T
Sandhill crane	*Grus canadensis*		E
Western sage grouse	*Centrocercus urophasianus phaios*	SC	T

(a) Washington Natural Heritage Program 2000 (http://www.nwr.noaa.gov); http://www.wa.gov/wdfw/hab/ (Soll et al. 1999).
(b) SC = Species of concern (http://www.fws.gov).
(c) C = Candidate, 50 CFR 17 (http://www.fws.gov).
(d) Currently under review for change in status (http://www.fws.gov).

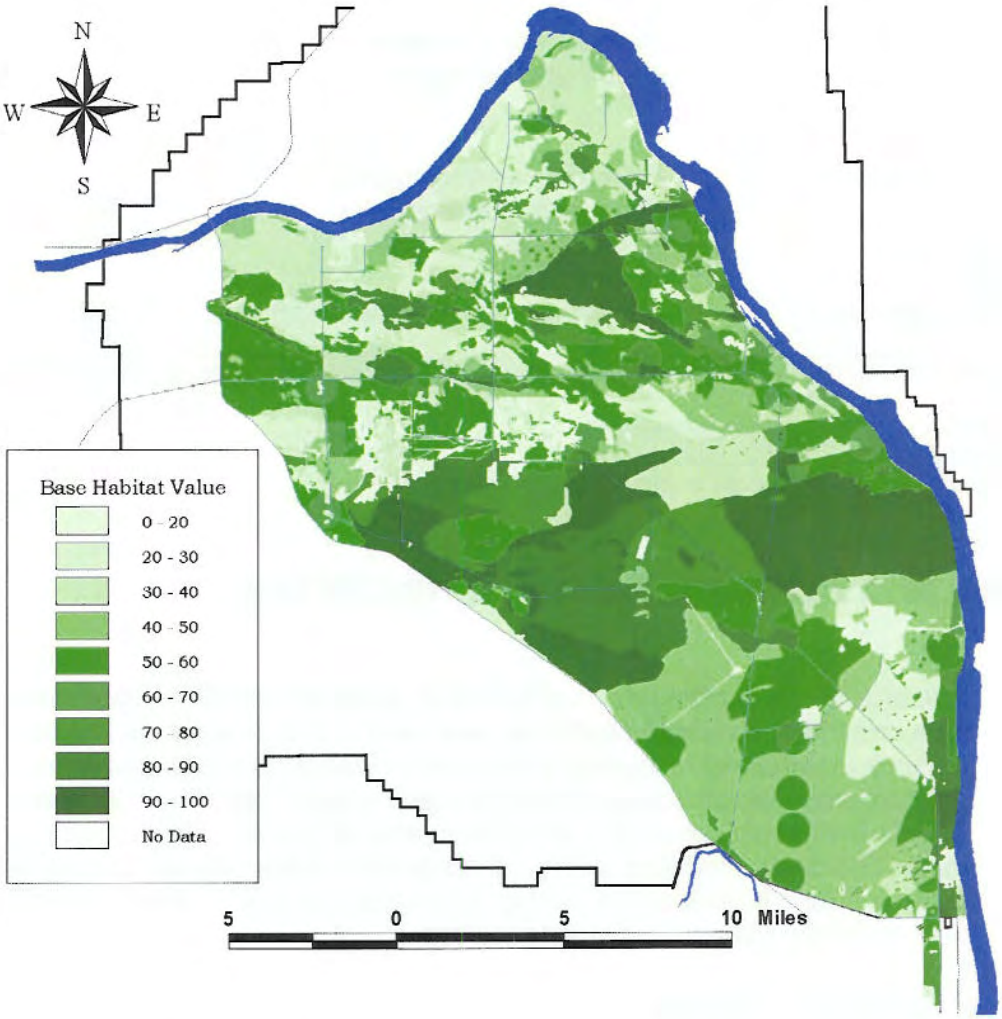
Hazards and Risks to Terrestrial Resources

A habitat quality profiling method, based on geographical information system (GIS) data and PNNL-developed software, was used to characterize the impacts and hazards to terrestrial resources in the Central Plateau and adjacent areas. This method uses "habitat value units" to measure existing habitat quality and to reflect risks to the habitat across any geographic area of interest. Three maps are prepared by the GIS-based software during the application of the method: a base habitat value profile, a hazard profile, and an ecological risk profile. Each is described below for the Central Plateau and adjacent areas.

Base Habitat Value Profile

The base habitat value map is an evaluation of how well existing plant communities or habitats resemble presumed pristine conditions. Factors include the degree of similarity between dominant plant species (e.g., overstory shrubs and understory grasses) in affected and pristine habitats, overall community or habitat condition in terms of alien species and soil structure (determined by the element occurrence [EO] rank), and the presence of plant or animal species of concern (i.e., threatened,

endangered, sensitive, etc.). The method starts by assuming that all of the habitat is ideal or pristine, and then modifies habitat values based on the user-defined effects for different factors. The overall base habitat value is calculated by multiplying the factor effects together. For instance, a selected point may have a shrub effect of 0.75, an understory effect of 1.0, an EO rank effect of 0.75, and a rare species effect of 1.25. Therefore, the overall base habitat value for that pixel is 0.75 * 1.0 * 0.75 * 1.25 = 0.70, or 70% of the potential habitat value for that point. This would also indicate that the habitat value is 30% less than the potential value simply because of the land-use and disturbance history. This does not include potential effects of waste sites or contaminants. Importantly, base habitat values reflect historical impacts to terrestrial communities from agriculture that was conducted prior to 1943 when the Manhattan Project acquired the site, as well as impacts caused by DOE and its predecessor agencies. At this time, data are not available to separate pre-1943 impacts from post-1943 impacts.

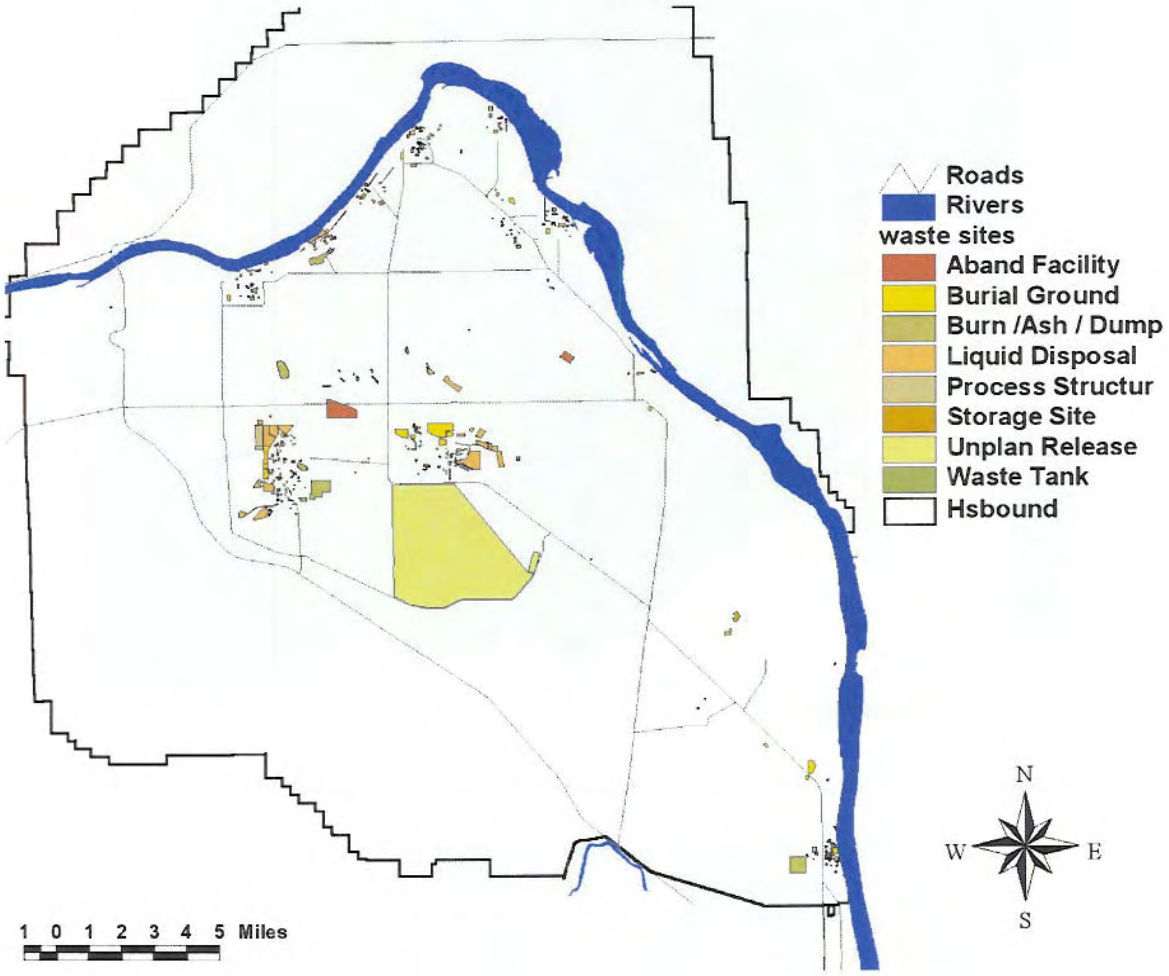


Habitat Value Distribution (as % of Potential Value) in the Central Portion of the Hanford Site

Hazard Profile

The hazard profile is based on the types and distribution of waste sites (or contamination) within the area of interest. For the entire Hanford Site, nearly 1200 waste sites of nearly 50 different types are present, consisting primarily of abandoned facilities, roads and other infrastructure, and various types of waste sites. For prototype modeling purposes, these have been classified into eight broad categories. The method assumes that a waste site will have an adverse effect on the habitat beyond its borders, and that the effect will decrease with distance from the waste site. Thus, the hazard profile includes not just direct radiological and toxicological hazards, but also other effects, such as habitat disturbance, disruption of behaviors, and all other potential effects of DOE operations on plants and animals.

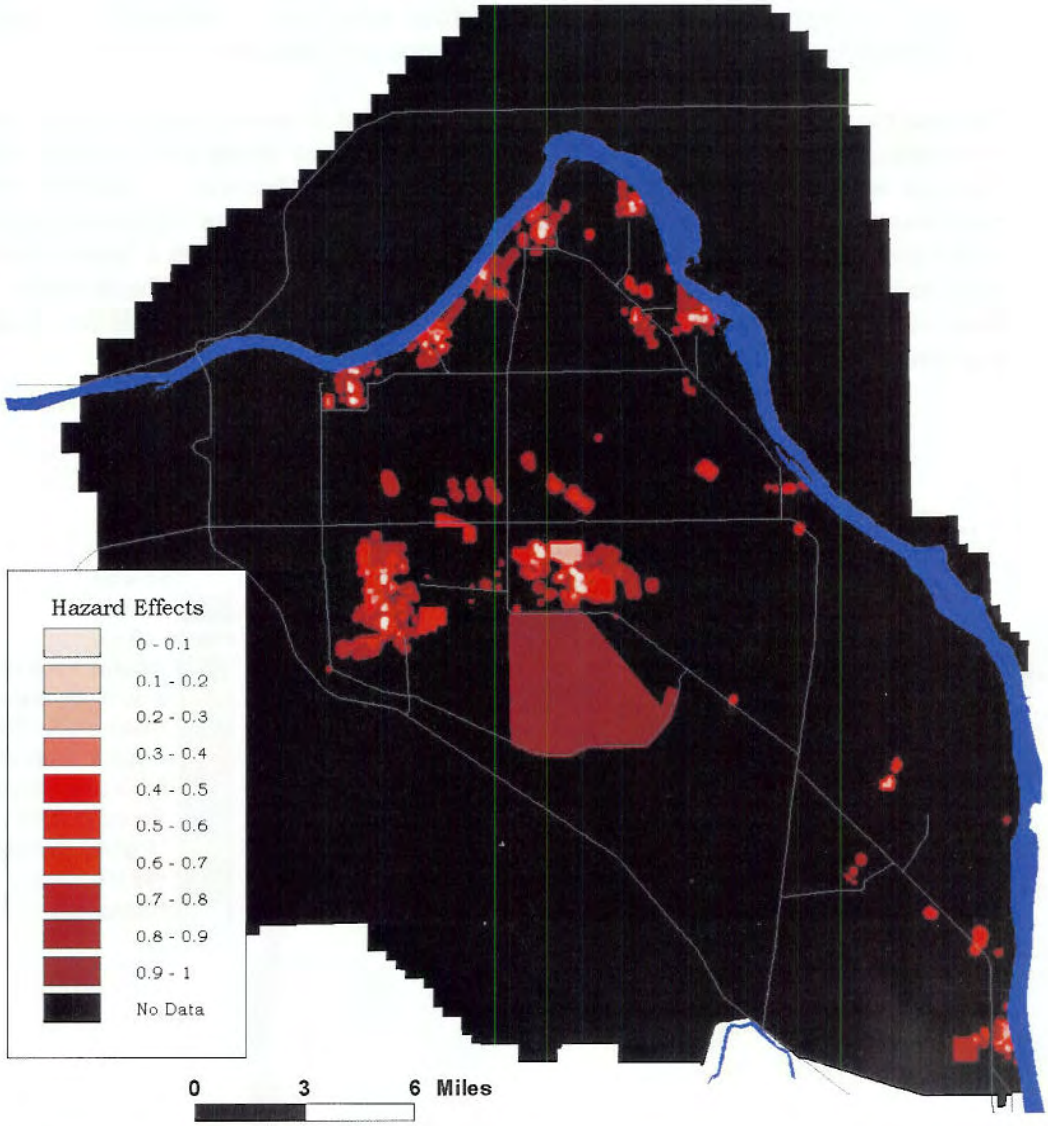
For each type of waste site, the GIS-based software is used to estimate the maximum effect on habitat value observed within or near the waste site, and the distance from the waste site where the effects will no longer be observed. A specific model is then selected to estimate the effects by distance (e.g., linear or log-linear decrease with distance). For example, the software user might specify that a burial ground will have maximum effect of 35% reduction in habitat value, and the effects will be observable for 250 meters from the edge of the burial ground, and will decrease in a log-linear fashion.



Waste Site Map for the Hanford Site

Ecological Quality Profile

The ecological quality profile is created by multiplying numerical values in the base habitat profile by values in the hazard profile. It can be presented as a map or a table. It depicts the distribution and magnitude of adverse habitat impacts. Values in a map represent the proportions of the potential habitat value that are present in the central portion of the Hanford Site after accounting for both existing ecological conditions and hazards.



Hazard Profile for the Hanford Site – Greatest hazard effects are shown in lightest colors

The table below quantifies the amount of habitat value lost because of the current and/or historical land-use patterns, disturbance history, and the presence of the wastes or other hazards. Data can be tabulated for a site as a whole or for areas of interest within the site. The table gives data on habitat value units in the 100, 200, and 300 Areas, within which are located nearly all of the waste sites and other hazards in the central portion of the Hanford Site. In all three areas, most of the

Reduction of Habitat by Area of the Hanford Site

Site Position	Total Area (ha)	Base Habitat Value (HU's)	Reduction Due to Land-Use (HU's)	% Due to Land-Use	Final Habitat Value (HU's)	Reduction Due to Hazards (HU's)	% Due to Hazards
100 Areas	5237	1988	3249	62	1865	123	2
200 Areas	10243	4995	5248	51	4716	279	3
300 Area	1336	639	697	52	617	22	2
Total	16816	7622	9194	55	7198	424	3

reduction in habitat value is due to land use, i.e., 51-62% reductions in values. Reductions due to hazards, given the specific model used to estimate effects as a function of distance, are an additional 2-3%.

Changes in the overall ecological quality profile will occur as sites are remediated or as habitat is improved or disturbed. Tabulated data on habitat value will, therefore, allow DOE to quickly evaluate the overall ecological quality profile that will result from various scenarios for clean-up, restoration, and future land-use, or to document quantitatively changes in habitat value that have occurred as a result of completed activities on the site.

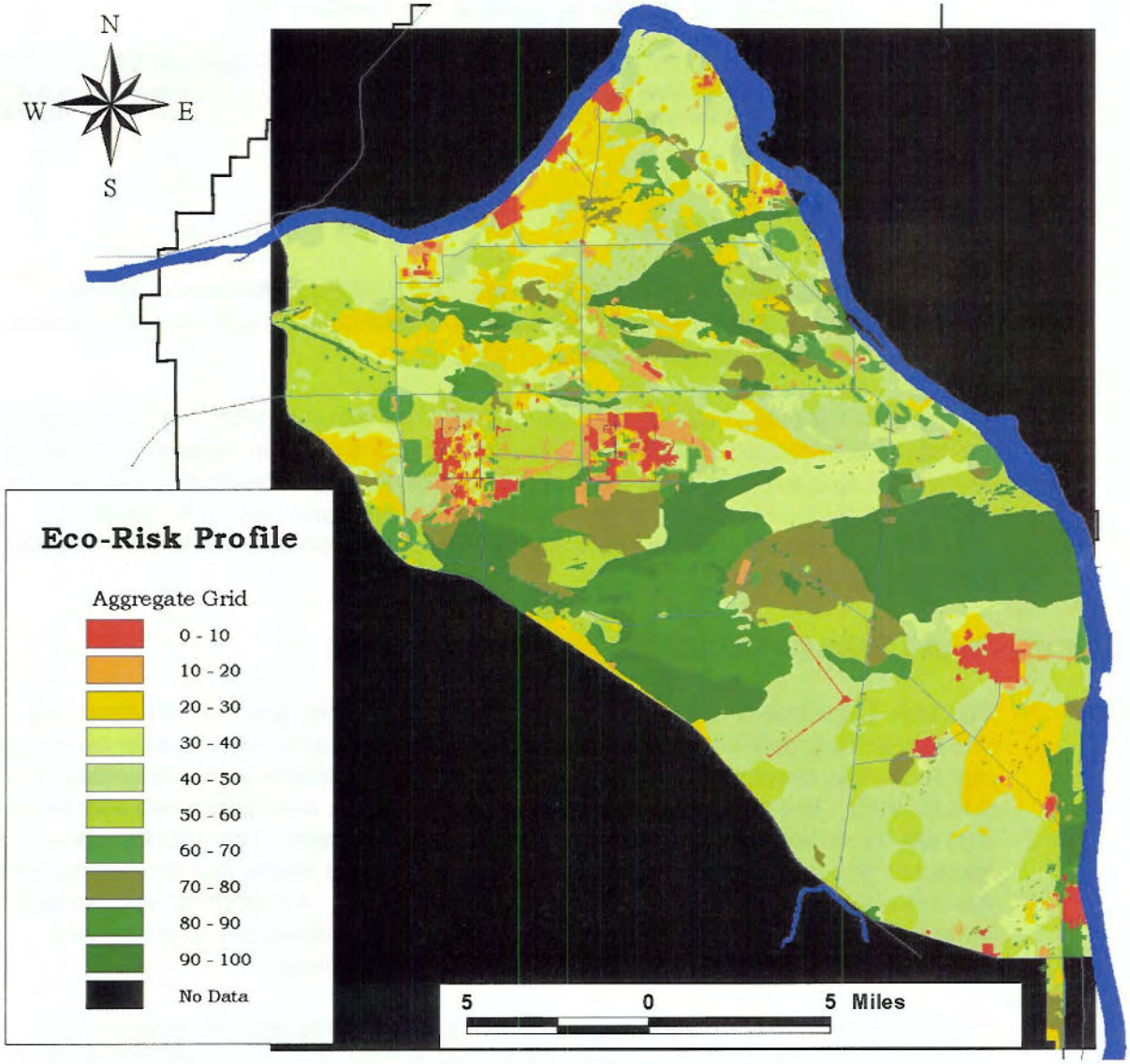
Hazards and Risks to Columbia River Resources

The U.S. Department of Energy, in consultation with other government agencies, citizens groups, and Tribal Nations, recently completed a comprehensive ecological risk screening assessment for Hanford-derived contaminants in the Columbia River (DOE 1998). The team identified 28 organic, inorganic, and radioactive substances that are hazards to aquatic and riparian plants and animals. The substances are known to occur in at least one of the four environmental media that were considered: groundwater, surface water, sediment, and seep water. A total of 52 species were selected as potential receptors, including aquatic and terrestrial plants, aquatic invertebrates, amphibians, reptiles, fish, birds, and mammals.

The screening assessment found that some contaminants pose potential risks to ecological receptors in some areas. More specifically, they documented potential risks to some plants, herbivores, omnivores that consume riverine organisms (especially insects as prey), and weasels in some areas.

Aquatic species that are potentially most at risk include Columbia pebblesnail, freshwater shrimp, crayfish, Woodhouse's toad, suckers, clams, mussels, juvenile salmon and trout, and water fleas. Most of these organisms are at potential risk because they have a benthic lifestyle, i.e., they spend all or most of their life in direct contact with potentially contaminated sediment and/or pore water.

Terrestrial organisms that are potentially most at risk include swallows, mallard ducks, American coots, harvest mice, Canada geese, and raccoons. However, potential risks that were estimated to be above reference levels occur only in a few locations within the study area. Other species are at low risk. The key exposure pathway was found to be consumption of aquatic species with high body burdens of contaminants. This pathway exists because of high concentrations of contaminants that enter the Columbia River through pore waters in the nearshore environment.



Ecological Quality Profile for the Central Portion of the Hanford Site

References

Becker, J. M. 1993. *A Preliminary Survey of Selected Structures on the Hanford Site for Townsend's Big-Eared Bat (Plecotus townsendii).* PNL-8916, Pacific Northwest Laboratory, Richland, Washington.

Brandt, C. A., C. E. Cushing, W. H. Rickard, N. A. Cadoret, and R. Mazaika. 1993. *Biological Resources of the 300-FF-5 Operable Unit.* WHC-SD-EN-TI-121, Westinghouse Hanford Company, Richland, Washington.

Cadwell, L. L. 1994. *Wildlife Studies on the Hanford Site: 1993 Highlights Report.* PNL-9380, Pacific Northwest Laboratory, Richland, Washington.

Critchfield, H. J. 1974. *General Climatology.* Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Cushing, C. E., Jr. 1967. "Periphyton Productivity and Radionuclide Accumulation in the Columbia River, Washington, USA." *Hydrobiologia* 29:125-139.

Cushing, C. E., and E. G. Wolf. 1984. "Primary Production in Rattlesnake Springs, a Cold Desert Spring-Stream." *Hydrobiologia* 114:229-236.

Daubenmire, R. 1970. *Steppe Vegetation of Washington.* Technical Bulletin 62, Experimental Station, Washington State University, Pullman, Washington.

Dauble, D. D., and D.G. Watson. 1990. *Spawning and Abundance of Fall Chinook Salmon (Oncorhynchus tshawytscha) in the Hanford Reach of the Columbia River, 1948-1988.* PNL-7289, Pacific Northwest Laboratory, Richland, Washington.

Downs, J. L., W. H. Rickard, C. A. Brandt, L. L. Cadwell, C. E. Cushing, D. R. Geist, R. M. Mazaika, D. A. Neitzel, L. E. Rogers, M. R. Sackschewsky, and J. J. Nugent. 1993. *Habitat Types on the Hanford Site: Wildlife and Plant Species of Concern.* PNL-8942, Pacific Northwest Laboratory, Richland, Washington.

Fitzner, R. E., S. G. Weiss, and J. A. Stegen. 1994. *Threatened and Endangered Wildlife Species of the Hanford Site Related to CERCLA Characterization Activities.* WHC-EP-0513, Westinghouse Hanford Company, Richland, Washington.

Frest, T. J., and E. J. Johannes. 1993. *Mollusc Survey of the Hanford Site, Benton and Franklin Counties, Washington.* PNL-8653, Pacific Northwest Laboratory, Richland, Washington.

Gray, R. H., and D. D. Dauble. 1977. "Checklist and Relative Abundance of Fish Species from the Hanford Reach of the Columbia River." *Northwest Science* 51:208-215.

Hanford Future Site Uses Working Group. 1992. *The Future of Hanford: Uses and Cleanup.* Richland, Washington.

Hall, John A. (ed.). 1998. *Biodiversity Inventory and Analysis of the Hanford Site, 1997 Annual Report.* The Nature Conservancy, Seattle, Washington.

Hanson, W. C., and R. L. Browning. 1959. "Nesting Studies of Canada Geese on the Hanford Reservation, 1953-1956." *J. Wildlife Manage.* 23:129-137.
Neitzel, D.A. (ed). 2000. *Hanford Site National Environmental Policy Act (NEPA) Characterization.* PNNL-6415, Rev. 12, Pacific Northwest National Laboratory, Richland, Washington.

Pabst, R.J. (ed.). 1995. *Biodiversity Inventory and Analysis of the Hanford Site, 1994, Annual Report.* Nature Conservancy, Seattle, Washington.

Rickard, W. H., and L. E. Rogers. 1983. "Industrial Land Use and the Conservation of Native Biota in the Shrub-Steppe Region of Western North America." *Environ. Conserv.* 10:205-211.

Sackschewsky, M. R., D. S. Landeen, G. I. Baird, W. H. Rickard, and J. L. Downs. 1992. *Vascular Plants of the Hanford Site.* WHC-EP-0554, Westinghouse Hanford Company, Richland, Washington.

Scott, M. J., G. R. Bilyard, S. O. Link, C. A. Ulibarri, H. E. Westerdahl, P. F. Ricci, and H. E. Seeley. 1998. "Valuation of Ecological Resources and Functions." *Environmental Management* 22(1): 49-68.

Soll, J. A., and C. Soper (eds.). 1996. *Biodiversity Inventory and Analysis of the Hanford Site, 1995 Annual Report.* The Nature Conservancy, Seattle, Washington.

U.S. Department of Energy (DOE). 1996a. *Hanford Site Biological Resources Management Plan. Draft.* DOE/RL-96-32, Rev. 0, U.S. Department of Energy, Richland, Washington.

U.S. Department of Energy (DOE). 1996b. *Hanford Strategic Plan.* DOE/RL-96-92, U.S. Department of Energy, Richland, Washington.

U.S. Department of Energy (DOE). 1998. *Screening Assessment and Requirements for a Comprehensive Assessment – Columbia River Comprehensive Impact Assessment.* DOE/RL-96-16, Rev. 1, U.S. Department of Energy, Richland, Washington.

Washington Natural Heritage Program. 1997. *Rare Species County List.* Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, Washington.

Watson, D. G. 1970. *Fall Chinook Salmon Spawning in the Columbia River Near Hanford 1947-1969.* BNWL-1515, Pacific Northwest Laboratories, Richland, Washington.

Watson, D. G. 1973. *Fall Chinook Salmon Population Census.* BNWL-1750, Pacific Northwest Laboratories, Richland, Washington.