7.2 Ecosystem Monitoring (Plants and Wildlife)

L. L. Cadwell, D. D. Dauble, J. L. Downs, M. A. Simmons, and B. L. Tiller

The Hanford Site is a relatively large, undisturbed area of shrub-steppe that contains a rich, natural diversity of plant and animal species adapted to the region's semiarid environment. Terrestrial vegetation on the site consists of 10 major plant communities: 1) sagebrush/ bluebunch wheatgrass, 2) sagebrush/cheatgrass or sagebrush/Sandberg's bluegrass, 3) sagebrush-bitterbrush/cheatgrass, 4) grease wood/cheatgrass-saltgrass, 5) winterfat/Sandberg's bluegrass, 6) thyme buckwheat/Sandberg's bluegrass, 7) cheatgrass-tumble mustard, 8) willow or riparian, 9) spiny hopsage, and 10) sand dunes (PNNL-6415, Rev. 10). Nearly 600 species of plants have been identified on the site (WHC-EP-0054). Recent work by The Nature Conservancy of Washington has further delineated 36 distinct plant community types (Soll and Soper 1996) from within those 10 major communities.

There are two types of natural aquatic habitats on the Hanford Site. One is the Columbia River and associated wetlands and the second includes upland aquatic sites. The upland sites include small spring streams and seeps located mainly on the Fitzner/ Eberhardt Arid Lands Ecology Reserve on Rattlesnake Mountain (e.g., Rattlesnake Springs, Dry Creek, Snively Springs) and West Lake, which is a small, natural pond near the 200 Areas.

More than 1,000 species of insects (Soll and Soper 1996), 3 species of reptiles and amphibians (PNNL-6415, Rev. 10), 44 species of fish (Gray and Dauble 1977; PNNL-6415, Rev. 10), 214 species of birds (Soll and Soper 1996), and 39 species of mammals (PNNL-6415, Rev. 10) have been found on the Hanford Site. Deer and elk are the major large mammals, coyotes are plentiful, and the Great Basin pocket mouse is the most abundant mammal. Waterfowl are numerous on the Columbia River, and the bald eagle is a regular winter visitor along the river. Salmon and steelhead are the fish species of most interest to sport fishermen and are commonly consumed by local Native American tribes.

Although no Hanford Site plant species have been identified from the federal list of threatened and endangered species (Title 50, Code of Federal Regulations, Part 17, Section 12 [50 CFR 17.12]), recent biodiversity inventory work conducted by The Nature Conservancy of Washington identified 100 populations of 30 different rare plant taxa (Hall 1998). The U.S. Fish and Wildlife Service lists the peregrine falcon as endangered and the bald eagle and Aleutian Canada goose as threatened (50 CFR 17.11). The peregrine falcon and Aleutian Canada goose are rare migrants through the site, and the bald eagle is a common winter resident and has initiated nesting on the site but has never successfully produced offspring. Several plant species, mammals, birds, molluscs, reptiles, and invertebrates occurring on the site are candidates for formal listing under the Endangered Species Act of 1973. Appendix F lists special-status species that could occur on the site.

7.2.1 Chinook Salmon

Chinook salmon are an important resource in the Pacific Northwest; they are caught commercially and for recreation. Salmon are also of cultural importance to Native American tribes. Today, the

most important natural spawning area in the mainstem Columbia River for the fall chinook salmon is found in the free-flowing Hanford Reach. In the early years of the Hanford Site, there were few spawning nests (redds) in the Hanford Reach (Figure 7.2.1). Between 1943 and 1971, a number of dams were constructed on the Columbia River, their reservoirs eliminating most mainstem spawning areas, resulting in increased numbers of salmon spawning in the Hanford Reach. Fisheries management strategies aimed at maintaining spawning populations in the mainstem Columbia River also have contributed to the observed increases. The number of fall chinook salmon redds counted in the Hanford Reach increased through the decades of the 1960s, 1970s, and 1980s until reaching a high in 1989 of nearly 9,000 (see Figure 7.2.1). In the early 1990s, redd counts declined to approximately one-third of the 1989 peak, but they appear to have rebounded in recent years. In 1998, approximately 5,370 redds were observed, or approximately 70% of the 1996 and 1997 totals. It should be noted that aerial surveys do not yield absolute counts of redds because visibility varies, depending on water depth and other factors, and because the number of redds in high-density locations cannot be counted accurately. However, redd survey data generally agree well with adult escapement figures obtained by counting migrating adult fish at fish ladders on the Columbia River.

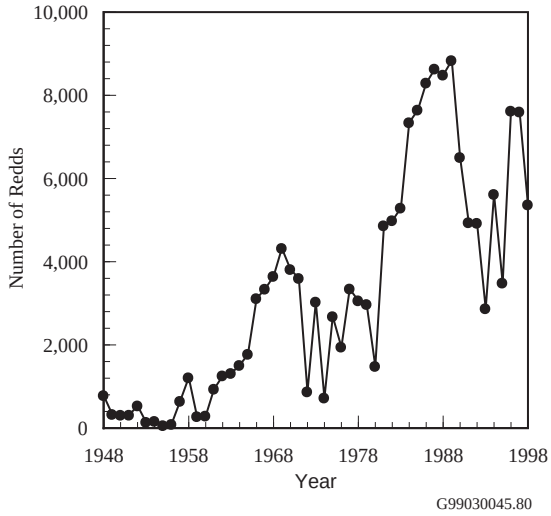

Figure 7.2.1. Chinook Salmon Spawning Redds in the Hanford Reach, 1948 Through 1998

7.2.2 Bald Eagle

The bald eagle is listed as a federally threatened species (50 CFR 17.11) and also a Washington State threatened species (Washington State Department of Wildlife 1994). Protection for bald eagles on the Hanford Site is guided by the management plan contained in DOE/RL-94-150 and coordinated with representatives of the U.S. Fish and Wildlife Service.

Historically, bald eagles have wintered along the Hanford Reach of the Columbia River. The wintering eagles originate from various places, including interior Alaska, British Columbia, Northwest Territories, Saskatchewan, and even possibly Manitoba. However, when monitoring began in the early 1960s, numbers were low (Figure 7.2.2). Following the passage of the Endangered Species Act, the number of wintering bald eagles has generally increased. Primary reasons for the observed increase are 1) reduced persecution in Alaska, 2) protection of bald eagles at nesting locations, and 3) nationwide elimination of dichlorodiphenyltrichloroethane (DDT) as an agricultural pesticide in 1972.

The number of nesting eagles was estimated approximately 25,000 in the lower 48 states when the bird was adopted as our national symbol in 1782. From fewer than 450 nesting pairs in the early 1960s, there are now >4,000 nesting pairs in the lower 48 states. When eagles were federally listed as endangered, recovery goals included at least 800 nesting pairs collectively in California, Idaho, Montana, Oregon, Utah, and Washington (i.e., the Pacific

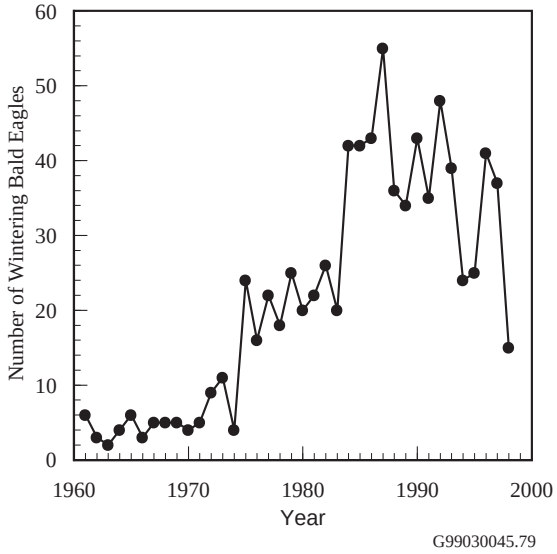

Figure 7.2.2. Bald Eagles Observed Along the Hanford Reach, 1948 Through 1998

states). In 1997, the wildlife experts estimated >1,200 nesting pairs in the Pacific states region. Only three pairs of nesting eagles are known to occur in eastern Washington. One of these pairs occurs on the Hanford Reach of the Columbia River.

Several nest-building attempts by bald eagles have been observed on the Hanford Site. In 1998, a pair of adult eagles built two separate nests in the vicinity of the White Bluffs (see Figure 1.0.1). All Hanford-related activities were prohibited from occurring within 800 m (2,600 ft) of either nest site. Nest tending activities and territorial displays were documented at these two sites in late December 1998 and continued through April 1999.

A single maximum count of only 15 bald eagles was documented on the Hanford Reach and typically only 5 were observed in the winter of 1998. Wintering eagle numbers similar to those observed in 1998 along the Hanford Reach were last seen in the 1970s (see Figure 7.2.2). The low counts observed on the Hanford Reach this winter are consistent with reports from the upper Columbia River at Rocky Reach and Rock Island Reservoirs, the Clearwater River in Idaho, and the lower Snake and Columbia Rivers of Oregon and Washington. A wildlife researcher working for the Washington State Department of Fish and Wildlife noted that many of the eagles fitted with satellite transmitters did not move their typical 1,200-km (745-mi) distance for the wintering period but, rather, stayed near their nesting territories in Alaska, British Columbia, and the Northwest Territories (Watson, personal communication 1999). The underlying cause(s) for reduced winter migration of eagles during the winter of 1998-1999 have not been fully examined. However, availability of food sources for eagles may have played a major role. Chum salmon (a major food of wintering eagles) were so abundant along the Fraser River (British Columbia) that wintering eagles may have elected to use the Fraser River area and tributaries rather than the mid-Columbia River. Also, an atypically high snow fall occurred in some portions of Alaska, resulting in an increase in winter-killed big game (another major food source for eagles that typically migrate south for the winter). Recent studies conducted along the Skagit River in northwestern Washington indicate increased recreational activities negatively affect the number of wintering eagles there (Stalmaster and Kaiser 1998).

Changes in the number of eagles on the Hanford Site have generally corresponded to changes in the number of returning fall chinook salmon, a major fall and winter food source for eagles (compare Figures 7.2.1 and 7.2.2 to see similarity in the patterns of salmon redd counts and bald eagle counts).

7.2.3 Hawks

The undeveloped land of the semiarid areas of the Hanford Site provides nest sites and food for three species of migratory buteo hawks: Swainson's, red-tailed, and ferruginous. Under natural conditions,

these hawks nest in trees, on cliffs, or on the ground. Power-line towers and poles also can serve as nest sites, and these structures are used extensively by nesting hawks on the site because of the relative scarcity of trees and cliffs. The ferruginous hawk is a Washington State threatened species (Washington State Department of Wildlife 1994) as well as a U.S. Fish and Wildlife Service candidate species for listing as threatened or endangered (50 CFR 17.11). Approximately one quarter of the state's ferrguinous hawk nesting territories are located on the site.

In recent years, the number of ferruginous hawks nesting on the Hanford Site has remained stable (10 active nests in 1998, range of 7 to 12 since 1995). The site continues to provide hawk nesting habitats that are administratively protected from public intrusion. An evaluation of selected aspects of ferruginous hawk ecology on the site and adjacent lands was completed in 1996 (Leary 1996). That work suggested that ferruginous hawks nest on the site because of suitable, disturbance-free habitat, but that much of the foraging for prey species occurred on adjacent, privately owned, agricultural fields. Male ferruginous hawks were observed to travel up to 15 km (9.3 mi) from their Hanford Site nests to hunt, making several trips each day to deliver prey to their mates and offspring. These results showed that small rodents such as northern pocket gophers, which can be serious agricultural pests, are the primary prey of ferruginous hawks.

7.2.4 Rocky Mountain Elk

Rocky Mountain elk did not inhabit the Hanford Site when it was established in 1943. Elk were first observed on the Fitzner/Eberhardt Arid Lands Ecology Reserve in the winter of 1972. A few animals stayed and reproduced. Since that time, the herd has grown and now occupies portions of the Hanford Site, the United States Army's Yakima Training Center, and private land along Rattlesnake Ridge. Herd size was estimated from census data at 742 animals prior to the 1998 hunting season (Figure 7.2.3). Although accurate counts of elk harvest on adjacent private lands are not available, the harvest appears to be small, with <5% of the herd being harvested and the majority of the harvest consisting of bulls. The 1998 harvest consisted of approximately 18 adult bulls and 15 cows. Thus, growth of the herd is largely unconstrained, and increasing damage to natural plant communities on the site and to crops on adjacent private land is likely. Several observations were made in 1996 and 1997 of elk having crossed to the northern side of State Highway 240. Four vehicle collisions with elk were documented near Hanford in 1998 alone. As the herd continues to grow, there are two safety-related concerns that will increase. The first is the potential for an increase in vehicle-elk collisions on local highways; the second is the possibility that elk will range into the recently enlarged radiologically controlled area (BC Cribs) immediately south of the 200-East Area.

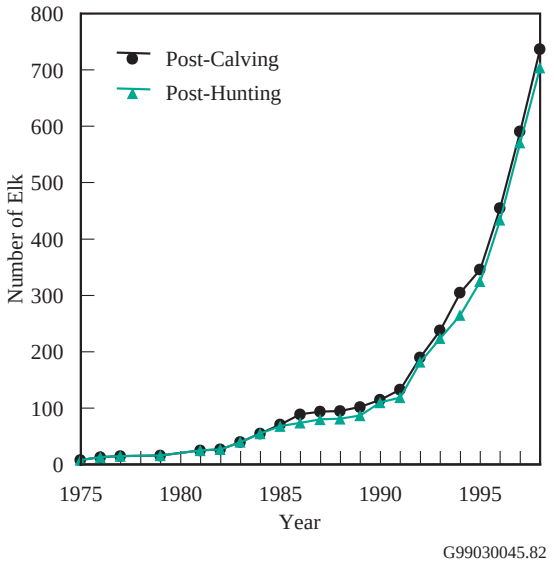

Figure 7.2.3. Elk on the Hanford Site: Post-Calving (August through September) and Post-Hunting (December through January) Periods, 1975 Through 1998

7.2.5 Mule Deer

Mule deer are a common resident of the Hanford Site and are important because of the recreational (offsite hunting) and aesthetic values they provide. Because mule deer have been protected from hunting on the site for approximately 50 yr, the herd has developed a number of unique population characteristics different from most other herds in the semiarid region of the northwest. These characteristics include a large proportion of old-age animals (older than 5 yr) and large-antlered males.

Because mule deer are often hunted and eaten, they can contribute to the radiation dose received by members of the public that consume game animals (PNL-7539, MacLellan et al. 1993). On the Hanford Site, deer are also of interest to environmental monitoring programs because they can provide useful information that can be used in contaminant cleanup efforts (Eberhardt and Cadwell 1983, PNL-10711, PNNL-11518).

The onsite deer population was estimated in 1996 by marking several Hanford Site deer and counting the ratio of marked to unmarked animals along the Columbia River. In addition, relative deer densities were determined throughout the remainder of the site by comparing the frequency of fecal pellet groups found within each region. Approximately 330 deer were estimated to reside in the region of the site bordering the Columbia River, and the total site mule deer population, exclusive of the lands lying north of the Columbia River, was estimated at 650.

Age and sex classes of deer that reside along the Columbia River of the Hanford Site have been monitored yearly since 1993. Roadside surveys have been conducted on an established route that is >64 km (40 mi) long. The route is driven several times during the post-fawning season (July-September) and the post-hunting season (December-February) to get a precise estimate of the ratio of bucks (antlered deer) to adult females (adult antlerless deer) and the ratio of fawns to adult female deer. The buck-to-doe ratios seen in this region have remained relatively stable since 1993 (20 to 40 bucks per 100 does) and are higher than ratios typically observed throughout the northwest (10 to 30 bucks per 100 does). Fawn-to-doe ratios demonstrated a significant downward trend through 1997 (Figure 7.2.4); however, in 1998, the fawn ratio appeared to be increasing again (20 fawns to 100 does). Although the causes of fluctuating fawn numbers are not known on the site, several factors that may play a role include neonatal losses, unhealthy newborns, and predation. Coyote predation on fawns is known to occur on the site and is likely a primary regulating factor for population growth.

7.2.6 Plant Biodiversity Inventories

Surveys and mapping efforts conducted by The Nature Conservancy of Washington and Pacific Northwest National Laboratory Ecosystem Monitoring Project document the occurrence and extent of rare plant populations and plant community types on the Hanford Site (Soll and Soper 1996, Hall 1998). These populations include taxa listed by Washington State as endangered, threatened, or sensitive and the locations of populations of taxa that are listed as review group 1 (i.e., taxa in need of additional field work before status can be determined) (Washington Natural Heritage Program 1997). The data provide information that is critical to site planning processes and land-use policy development.

Figure 7.2.5 delineates the known locations of more than 100 rare plant populations of 30 different taxa (Caplow and Beck 1996, Hall 1998). Five of these 30 taxa (including the two new species,

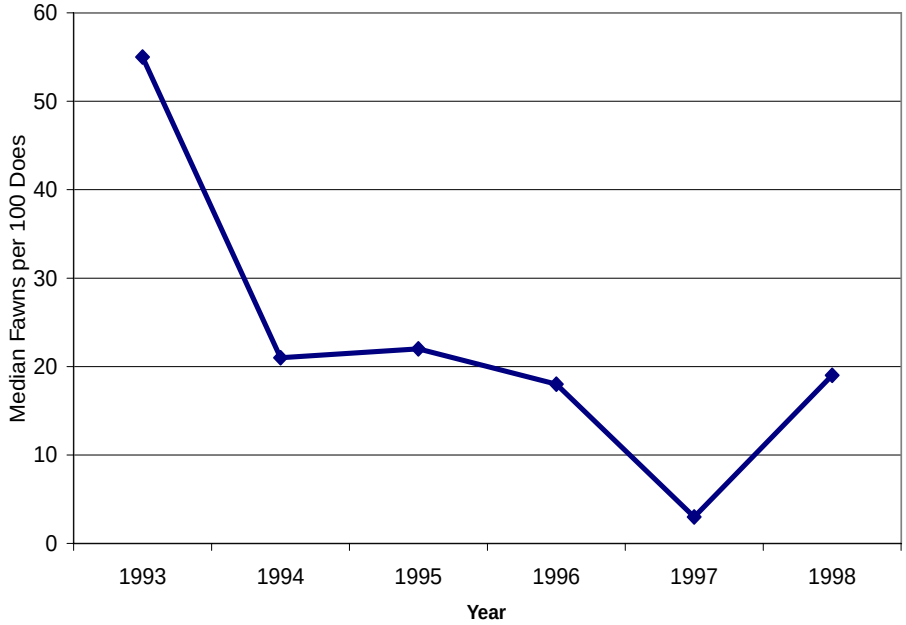

Figure 7.2.4. Median Number of Fawns Observed per 100 Adult Does During Roadside Surveys, 1993 Through 1998

Eriogonum codium and *Lesquerella tuplashensis*) have been designated as species of concern in the Columbia River Basin Ecoregion by the U.S. Fish and Wildlife Service. In addition to the rare plant populations, several areas on the Hanford Site are designated as special habitat types with regard to potential occurrence of plant species of concern. These include areas that could support populations of rare annual forbs found in adjacent habitat. The degree of protection from disturbance afforded to the site over the past 50 yr has resulted in an "island of biodiversity" for plant resources (Caplow and Beck 1998).

Populations of another species of concern in the Columbia River Basin Ecoregion, *Rorippa columbiae* (persistent sepal yellowcress), may be declining as a result of the high river flow levels over the past 3 yr. *Rorippa columbiae* is a rhizomatous perennial found in moist soils along the Columbia River within the Hanford Site. This species is often inundated by river flows, but little is known concerning long-term survival under continuous inundation. Surveys in 1998 identified far fewer stems at several locations on the Hanford Reach than previously documented (Table 7.2.1).

7.2.7 Sagebrush Die-Off

Big sagebrush (*Artemisia tridentata* subspecies *wyomingensis*) is the most common shrub component of shrub-steppe vegetation associations on the Hanford Site. These sagebrush stands represent an important resource for sagebrush-obligate wildlife species such as black-tailed jackrabbits, sage sparrows, sage thrashers, and loggerhead shrikes. Since 1993, site biologists have documented areas of sagebrush die-off in stands near the 100-D Area, the cause of which is not known. Shrub die-offs are not uncommon in the intermountain west and such episodes have been reported from British Columbia, Idaho, Nevada, Utah, and Wyoming (Dobrowolski and Ewing 1990). Die-off of shrubs has been attributed to severe rootlet

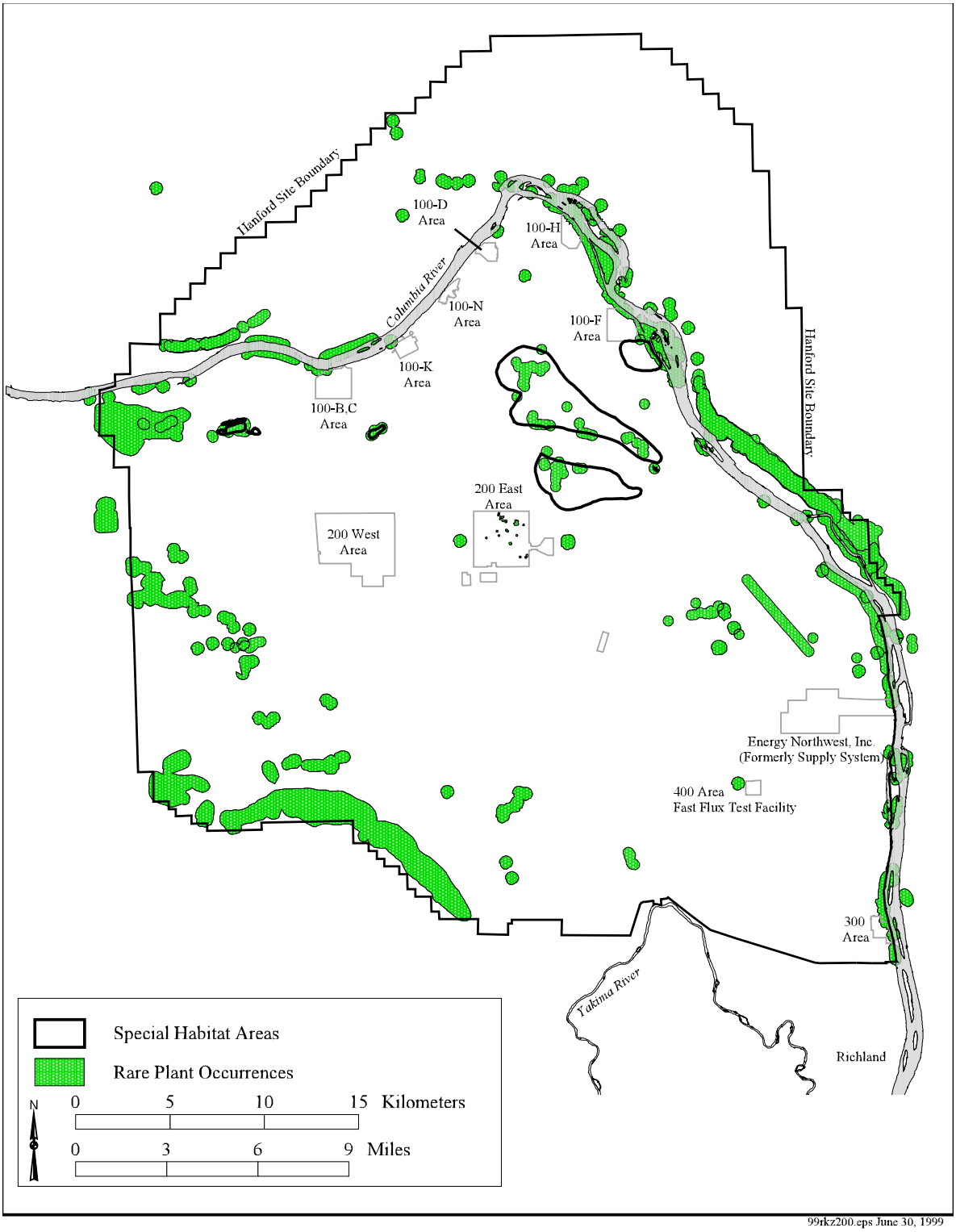

Figure 7.2.5. Rare Plant Locations on the Hanford Site Based on 1994, 1995, 1997, and 1998 Surveys Conducted by The Nature Conservancy of Washington

Table 7.2.1. Numbers of *Rorippa Columbiae* Stems Counted Along the Hanford Reach of the Columbia River, 1994 and 1998

Survey Location	1994 Counts	1998 Counts
100-F beach	>15,000	70
Locke Island	>10,000	117
Island 18[(a)]	>10,000	0

(a) Located in the Columbia River at the 300 Area.

mortality, root rot, soil salinity and anaerobiosis, and vascular shoot wilt induced by fungal pathogens (Nelson et al. 1989, Weber et al. 1989).

The extent of the die-off on the Hanford Site was mapped and survey data were collected in 1996 and 1997 to establish a baseline for monitoring future expansion of the die-off (PNNL-11700). That report indicated that a total area of 1,776 ha (4,388 acres) showed evidence of sagebrush decline, with a central portion of 280 ha (692 acres) where shrub death was estimated to be approximately 80% or greater. Surveys in 1997 and 1998 of shrubs within the die-off areas indicate that sagebrush plants are continuing to decline. Observations of shrub vigor (percent canopy defoliation) show continuing declines in shrub health in the die-off areas and along the boundary of the die-off area.

The cause of sagebrush die-off on the Hanford Site remains undetermined. Possible causes of shrub death that have been evaluated include insect infestation, rodent damage, and high levels of soil salinity. Repeated surveys and observations have failed to document any obvious and consistent level of insect damage across the die-off areas. Field observations do not document any rodent damage or removal of sagebrush bark from plant stems at and below ground level. Limited soil analyses show no evidence of increased soil salinity or differences in nutrient levels in die-off areas versus similar soils outside the die-off areas. Although previous observations documented the presence of fungal rust species on leaf material from sagebrush in the die-off area, rust infestation does not appear to be the cause of shrub death. Consultations with the shrub pathologist at the U.S. Department of Agriculture Shrub Sciences Laboratory (part of the U.S. Forest Service Intermountain Research Station), Provo, Utah, indicate that the most likely pathogen is a soil fungus or virus. These pathogens are difficult to isolate and sample and often contribute to an overall decline in shrub health that may lead to death.

Pathological tests of sagebrush samples from the die-off area produced 29 fungal isolates from the upper root zone and base of the shrubs. Isolates included *Fusaria* sp., *Sclerocium* sp., and *Altenaria* sp.; all fungal isolates previously observed on sagebrush. Fungal pathogens are common in the soil and the air but may not have the ability to penetrate shrub defenses and impact shrub health until the shrub is weakened by another stress or stresses brought on by drought and/or cold temperatures. Continuing pathological investigation will reveal whether the fungal isolates can successfully infect sagebrush in the absence of secondary stress. These tests may help identify the agent or agents responsible for the sagebrush decline on the Hanford Site.

To understand whether and how sagebrush may recolonize the die-off areas, seedling growth and survival were examined by transplanting 133 container-grown seedlings (averaging 3.5 cm [1.4 in.] in height) into the field. One-half of the plants were transplanted in the central die-off area (80% or greater shrub mortality) and one-half in the control plot distant from the die-off area (south of the Wye Barricade). Seedlings were planted in mid-March 1998 on north-facing slopes in sandy loam soils and watered with a dilute nutrient solution. Heights and diameters were recorded after planting.

The seedlings were measured in August 1998, January and April 1999 to determine survival and growth. Approximately 50% of the transplanted shrubs in the central die-off area and in the control area distant from the die-off area died within the first 6 mo. After 1 yr, transplanted shrub survival in the central die-off area was 39%, while survival at the control plot was 51%. Growth measurements after 1 yr reveal an overall increase in shrub height of 3 cm (1.2 in.) at the control plot (average shrub height = 7.0 cm [2.9 in.]) and a 3.7-cm (1.48-in.) increase at the die-off plot (average shrub height = 7.3 cm [2.92 in.]). There was no significant difference in seedling growth between the areas, and no differences in shrub vigor were observed for shrubs in either area.

Shrubs were classified by the amount of canopy: dead, <50% live, 50%-90% live, and >90% live. These measurements indicated that, though few shrubs actually died along each measured transect (Table 7.2.2), 10% to 35% of shrubs measured declined by at least one category.

Table 7.2.2. Decline of Shrub Conditions Measured Along Six Transects Within and Along the Boundaries of the Sagebrush Die-Off Area on the Hanford Site

Transect	% Dead at First Measurement	% Dead at Last Measurement	% Canopy >90% Live at First Measurement	% Canopy >90% Live at Last Measurement	Percentage of Shrubs Declining
1 (n=27)	95.0	95.0	5.0	0.0	5.0
2 (n=34)	18.0	18.0	41.0	35.0	35.3
3 (n=31)	81.0	84.0	10.0	0.0	12.9
4 (n=50)	48.0	48.0	14.0	4.0	10.0
5 (n=61)	15.0	16.0	43.0	15.0	28.0
6 (n=51)	18.0	19.0	54.0	9.0	27.9

Number of shrubs measured in parentheses.