8.2 Ecosystem Monitoring and Ecological Compliance

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The Hanford Site is a relatively undisturbed area of shrub-steppe that contains a rich, natural diversity of plant and animal species adapted to the region's semi-arid environment. In a summary document based on 5 years of intense study, The Nature Conservancy of Washington (1999) reported that "The Hanford Site Biodiversity Inventory has produced remarkable findings in each of the biological subject areas that were addressed: plant communities, rare plants, noxious weeds, small mammals, insects (aquatic and terrestrial), amphibians and reptiles, and soil mosses and lichens (the microbiotic crust)." In 2000, the biodiversity of Hanford was further recognized as a national asset when portions of the site were designated as the Hanford Reach National Monument (65 FR 114). Ecosystem monitoring and ecological compliance have multiple objectives that support completion of Hanford's waste management and environmental restoration mission:

- assuring Hanford Site operational compliance with laws and regulations including the *Endangered Species Act of 1973*, the *Bald and Golden Eagle Protection Act*, and the *Migratory Bird Treaty Act*
- providing data for environmental impact and ecological risk assessments
- providing maps and information useful for biological resource impact mitigation during facility expansion
- supporting Hanford Site land-use planning
- protecting natural resources within the DOE-operated portions of the Hanford Site including the DOE-managed portion of the Hanford Reach National Monument
- providing information useful to the tribes, Hanford natural resource stakeholders, and the public on the status of some of Hanford's most highly valued biological resources.

8.2.1 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 8.2.1). Between 1943 and 1971, a number of dams were constructed on the Columbia River. Their reservoirs eliminated 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 increases.

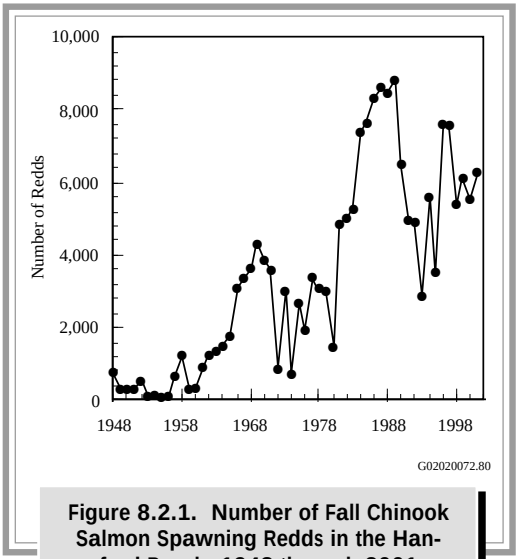

Figure 8.2.1. Number of Fall Chinook Salmon Spawning Redds in the Hanford Reach, 1948 through 2001

The number of fall chinook salmon redds counted in the Hanford Reach by aerial surveys increased during the 1960s, 1970s, and 1980s until reaching a high in 1989 of nearly 9,000 (see Figure 8.2.1). In the early 1990s, redd counts declined to approximately one-third of the 1989 peak. The number of redds peaked again in 1996 and 1997 and has once again declined. In 2001, ~6,248 redds were observed, an increase of 741 from 2000 and ~80% of the 1996 and 1997 totals. The main use areas were similar to previous years with the majority of redds occurring near Locke Island, the Columbia River islands between river miles 365-368 (Islands 8 through 10), and Vernita Bar. Aerial surveys do not yield absolute redd counts because visibility varies, depending on water depth and other factors, and because the number of redds in high-density locations cannot be counted with absolute accuracy. However, redd survey data generally agree with adult numbers obtained by counting migrating adult fish at fish ladders on the Columbia River. The Hanford Reach remains the largest spawning area for fall chinook salmon in the mainstem Columbia River.

8.2.2 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. The Rattlesnake Hills elk herd now occupies portions of the Hanford Site, the United States Army's Yakima Training Center, and private land along Rattlesnake Ridge. Total herd size was estimated from census data during the 1999 post-calving season at 838 animals and at 747 after the 1999 hunting season (Figure 8.2.2). A roundup conducted by the U.S. Fish and Wildlife Service and Washington Department of Fish and Wildlife in mid-March 2000 resulted in the removal of 171 animals. The fall 2000 hunting season that followed the summer 2000 fire was abnormally successful with the harvest of over 200 animals bringing the post-hunting season herd size to ~440 animals. In 2001, calving increased from 32 calves produced per 100 cows in 2000 to an estimated 46 calves per 100 cows. Also in 2001, the total Rattlesnake Hills elk harvest declined to ~75 animals. The net result for 2001 was a decrease in the post-calving estimate to 561 animals from 660 in 2000. However, the reduced hunting season harvest resulted in an increase in the 2001 post-hunting estimate to 484 animals. Barring additional herd reduction actions by either the Washington Department of Fish and Wildlife or the U.S. Fish and Wildlife Service, continued population growth of the herd is anticipated in the future. The Washington Department of Fish and Wildlife has primary responsibility for management of the elk herd and works cooperatively with the U.S. Fish and Wildlife Service, which has primary land management responsibility for the Hanford Reach National Monument land that encompasses much of the Rattlesnake Hills elk herd range.

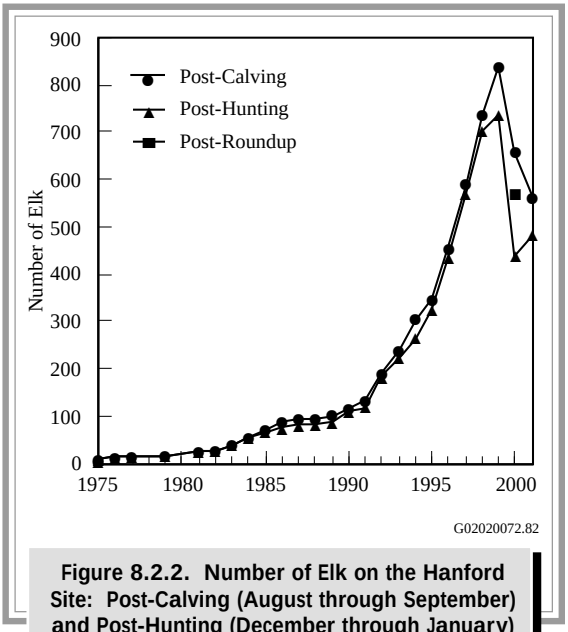

Figure 8.2.2. Number of Elk on the Hanford Site: Post-Calving (August through September) and Post-Hunting (December through January) Periods, 1975 through 2001

There were three elk/vehicle collisions in calendar year 2001 (Figure 8.2.3). The collision sites generally corresponded to the location of elk/vehicle collisions from previous years.

8.2.3 Mule Deer

Systematic roadside observations of mule deer have been conducted during the post-hunting (December-January) periods since 1993. The surveys are conducted to monitor trends in age and sex ratios of mule deer, to examine trends in the relative abundance of deer on the Hanford Site, and to monitor the frequency of testicular atrophy in mule deer. The survey route is divided into a north and south region just north of the Hanford town site.

Epidemiological data and microscopic examinations of mule deer (*Odocoileus hemionus*) tissue samples from the Hanford Site in the early 1990s revealed that nearly one quarter of the mule deer (bucks) had undergone some level of testicular atrophy (degeneration of the testicles after maturity). A special study was initiated in 1992 to describe the occurrences on a spatial scale and to examine possible influences of contaminants from the Hanford Site. Although the results of this study (Tiller et al. 1997; PNNL-11518) found no single factor as the primary cause, analyses of the affected and normal animal's contaminant levels, physiology, behaviors, histology of tissues, and other indicators of population health, indicated Hanford-derived contaminants were not likely a causative agent.

Tiller et al. (1997) described a positive relationship between the frequency of the anomaly and the age class distribution within the population. Severely degenerative/atrophic testes were found to occur only in 5- to 12-year-old bucks. Since hunting is not allowed on Hanford Site, deer survival rates are high and there is a corresponding increase in the number of animals in the older (5+ years) age classes, thus magnifying the frequency of this condition in the Hanford Site deer population.

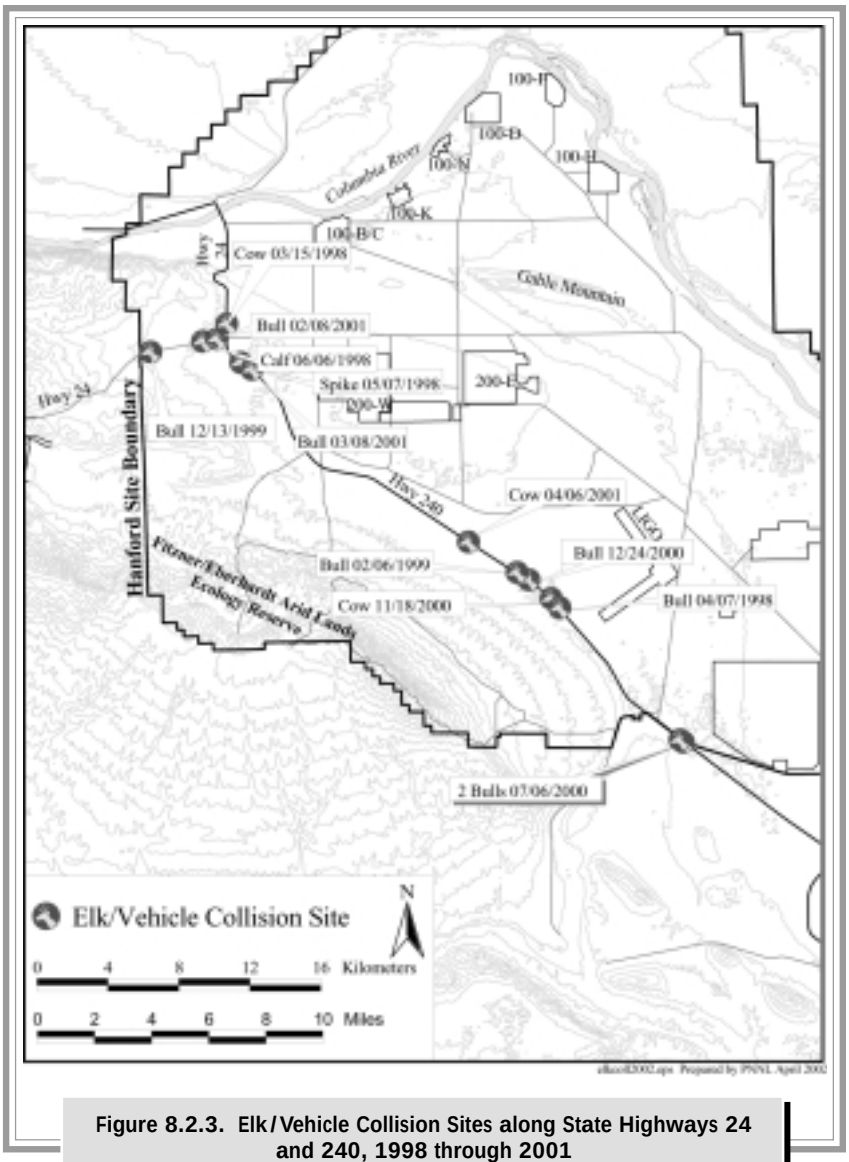

Figure 8.2.3. Elk/Vehicle Collision Sites along State Highways 24 and 240, 1998 through 2001

Figure 8.2.4 illustrates trends in the observed frequency of bucks (number of affected males per 100 males) that exhibited signs of testicular atrophy (velvet-covered antlers) and atrophic (shrunken) testicles during the post-hunting roadside surveys from 1994 through 2001. In 1993, an estimated 15% of the males were affected on the Hanford Site (Tiller et al. 1997). Ten affected animals were euthanized in 1994 and 1995 to obtain a variety of tissue samples for chemical and histological examination. Between 1994 and 1997, the percentage of affected males decreased to around 5% and remained relatively constant; however, survey results in 1998 and 1999 indicated the frequency of the anomaly returned to 1993 levels (15%). Also, more animals in the southern region of the site appeared to be affected (see Figure 8.2.4). Survey results obtained in 2001 indicate the frequency of bucks with testicular atrophy continues to decline with only a single affected animal observed this year in the southern region and none in the northern region of the Hanford Site.

The number of fawns surviving the first year after birth is used to estimate the annual rate of young successfully added to the deer herds. Figure 8.2.5 illustrates trends in fawn:doe ratios from 1994 through 2001 in the northern and southern region deer herds. In both regions of the Hanford Site, fawn survival declined substantially from over 20 fawns per 100 does in 1994 to less than 10 fawns per 100 does in 1997. Since 1997, fawn survival has recovered to ~30 fawns per 100 does in 2001, which is similar to other mule deer populations in a shrub-steppe environment (Tiller et al. 1997).

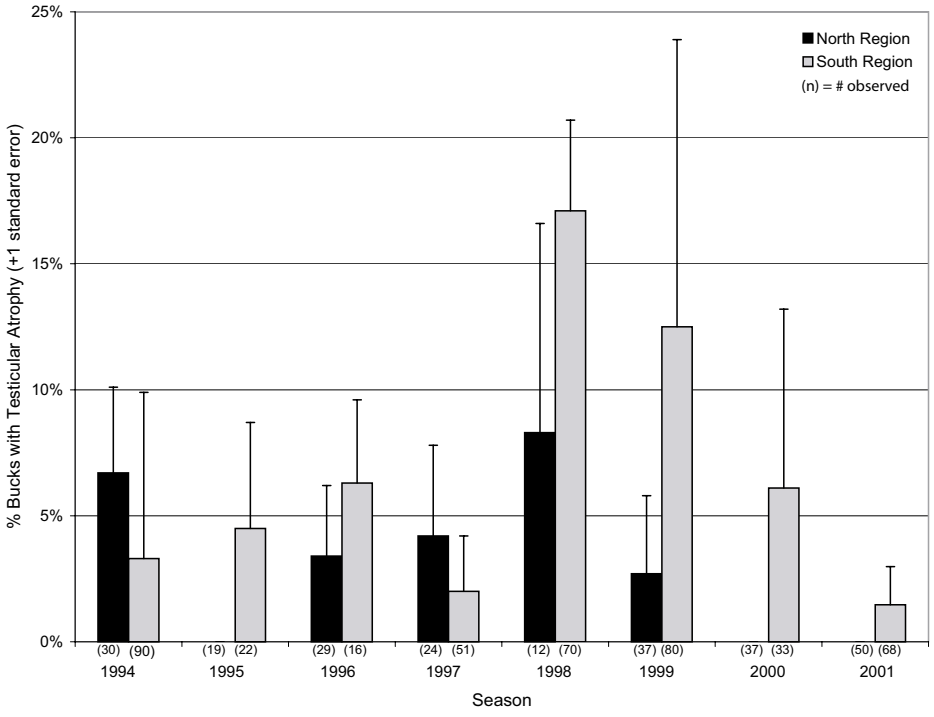

Figure 8.2.4. Percent of Mule Deer Bucks with Testicular Atrophy on the Hanford Site, 1994 through 2001 (see Figure 4.5.1 for region locations)

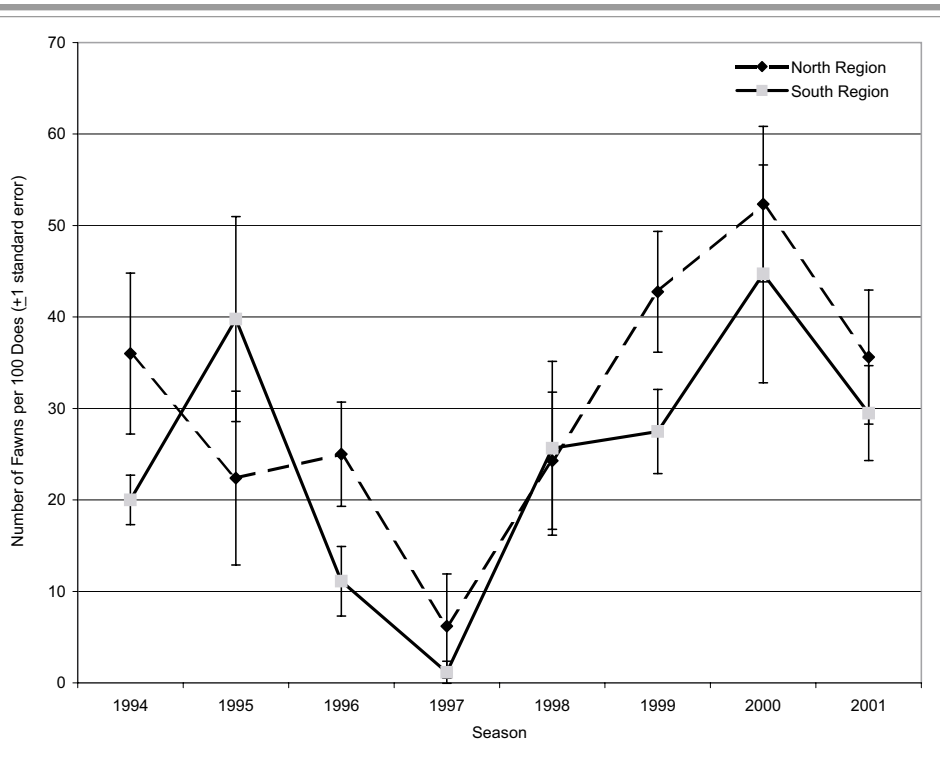

Figure 8.2.5. Roadside Survey Results for Trends in Fawn:Doe Ratios seen per Survey on the Hanford Site, 1994 through 2001 (see Figure 4.5.1 for region locations)

Continued roadside surveys to monitor both the frequency of testicular atrophy and to document the demographic trends of mule deer on the Hanford Site will allow project scientists to evaluate the health of the deer population and attempt to isolate factors contributing to any observed changes.

8.2.4 Plant Biodiversity Inventories

The Hanford Site contains biologically diverse shrub-steppe plant communities that have been protected from disturbance, except for fire, over the past 55 years. This protection has allowed plant species and communities that have been displaced by agriculture and development in other parts of the Columbia Basin to thrive at Hanford. Surveys and mapping efforts have documented the occurrence and extent of rare plant populations and plant community types on the Hanford Site (Nature Conservancy 1999). Populations of rare plants include taxa listed by Washington State as endangered, threatened, or sensitive (see Appendix G) and the locations of species 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). Data are collected for plant populations and plant communities to develop baseline information and to monitor any changes resulting from Hanford operations. The data provide information that is used for site planning processes and land-use policy development.

More than 100 rare plant populations of 31 different taxa are found at the Hanford Site (Figure 8.2.6). The U.S. Fish and Wildlife Service has designated five of these 31 taxa (including the two new species, Umtanum buckwheat [*Eriogonum codium*] and White Bluffs bladderpod [*Lesquerella tuplashensis*]) as species of concern in the Columbia River Basin Ecoregion. These two new species are proposed as candidates for federal listing. 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 listed by Washington State. These are areas that potentially support populations of rare annual forbs that have been documented in adjacent habitat.

Surveys in 2001 continued to indicate increases in the numbers of Piper's daisy (*Erigeron piperianus*), a species of concern occurring in the 200 Areas. One subpopulation in the 200 Areas was eliminated through inadvertent overspray of herbicides. Populations of another species of concern in the Columbia River Basin Ecoregion, persistent sepal yellowcress (*Rorippa columbiae*), do not appear to have experienced significant recovery after declining as a result of the high river flow levels from 1995 through 2000. Persistent sepal yellowcress is a rhizomatous perennial found in moist soil 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 2001 continued to show low numbers of stems at a cobble beach adjacent to the 100-F Area on the Hanford Reach and on Island 18 across from the 300 Area (Table 8.2.1), and no stems were observed in flower between 1997 and 1999. Number of stems found in 2001 on Locke Island did increase from previous years with >25% of the plants producing flowers. Fluctuating river flow levels appear to influence population fluctuations of this species.

Maps showing the extent and distribution of types of vegetation cover found on the Hanford Site have been updated to include recent work delineating the plant communities in central Hanford (Salstrom and Easterly 1997; Nature Conservancy 1999). The updated maps were merged with existing maps for the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit, the Wahluke Unit, and the Saddle Mountain Unit of the Hanford Reach National Monument. The plant community map was updated in 2001 to reflect the changes in plant community composition resulting from the wildfire in June 2000 and to incorporate riparian areas mapped by Salstrom and Easterly in 1995. Updated vegetation maps can be viewed on the Ecosystem Monitoring Project web page (www.pnl.gov/ecology/ecosystem).

8.2.5 Sagebrush Die-Off

Big sagebrush (*Artemisia tridentata subspecies wyomingensis*) is the most common shrub component of shrub-steppe vegetation on the Hanford Site. Sagebrush stands represent an important resource for wildlife that are dependent on sagebrush habitat to survive and successfully reproduce, such as black-tailed jackrabbits, sage sparrows, sage grouse, and loggerhead shrikes. Since 1993, areas of sagebrush die-off have been documented in stands near the 100-D Area, the cause of which is not known. Shrub die-off is not uncommon in

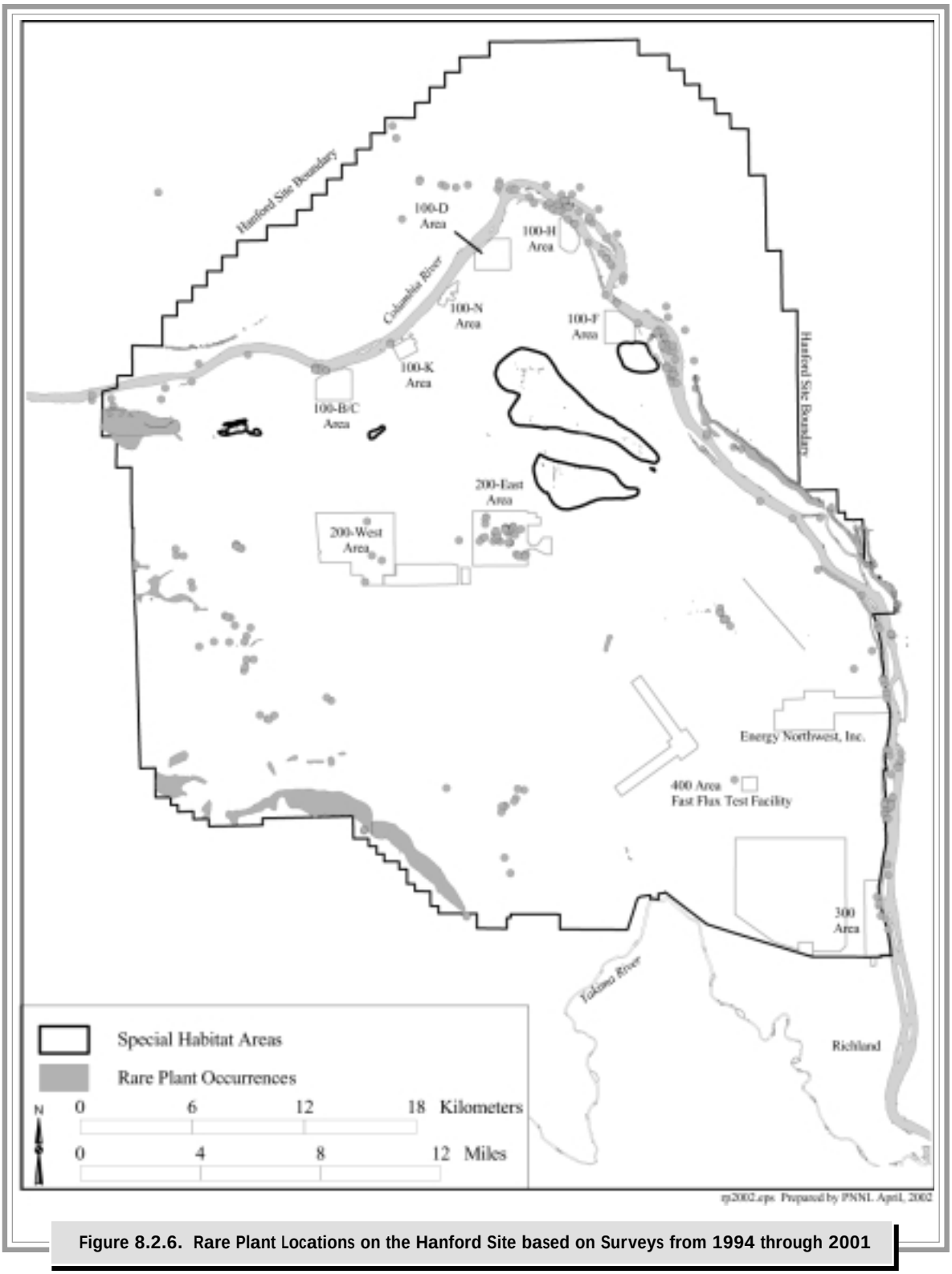

Figure 8.2.6. Rare Plant Locations on the Hanford Site based on Surveys from 1994 through 2001

Table 8.2.1. Numbers of *Rorippa columbiae*[a] Stems Counted along the Hanford Reach of the Columbia River, 1994, 1998, 1999, 2000, and 2001

Survey Location	1994 Counts	1998 Counts	1999 Counts	2000 Counts	2001 Counts
100-F beach	>15,000	70	94	196	17
Locke Island	>10,000	117	Not surveyed[b]	1,038	1,793
Island 18[c]	>10,000	0	Not surveyed	19	0

(a) Persistent sepal yellowcress.
(b) High water levels prevented access to populations.
(c) Located in the Columbia River at the 300 Area.

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 mortality, root rot, soil salinity, anaerobiosis, and vascular shoot wilt induced by fungal pathogens (Nelson et al. 1989; Weber et al. 1989). To date, no evidence exists suggesting any relationship between Hanford Site operations and the distribution and extent of the die-off of sagebrush. Big sagebrush is the only vascular plant species that has declined in the areas monitored. Other shrubs, such as hopsage (*Grayia spinosa*) and bitterbrush (*Purshia tridentata*), with similar deep root systems appear unaffected. In the monitored areas, herbaceous plant species, such as native bunchgrasses, also appear to remain relatively healthy and vigorous.

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). The resulting report indicated that a total area of 1,776 hectares (4,388 acres) showed evidence of sagebrush decline, with a central portion of 280 hectares (692 acres) where shrub death was estimated to be ~80% or greater. 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 areas.

Annual surveys from 1997 through 2001 of shrubs within the die-off areas indicated significant declines in sagebrush during 1997 through 1999. Shrubs along transects were classified by amount of live canopy in the following manner: dead, less than 50% live canopy, 50% to 90% live canopy, and more than 90% live canopy. These measurements indicated that though few shrubs actually died along each measured transect, 10% to 35% of shrubs measured declined by at least one category between 1997 and 2001. Surveys in 2001 indicated continued decline in sagebrush vigor on transect 6 outside the main die-off area. Two transects were burned in a small wildfire that occurred near the 100 Areas Fire Station and shrubs could no longer be measured (Table 8.2.2). However, the data also indicate a lack of establishment of new shrub seedlings that would be necessary for recovery of the population.

Table 8.2.2. Decline of Sagebrush Conditions Measured along Six Transects within and along the Boundaries of the Sagebrush Die-Off Area on the Hanford Site

Transect	% Dead 1997	% Dead 1999	% Dead 2000	% Dead 2001	% >90% Live Canopy 1997	% >90% Live Canopy 1999	% >90% Live Canopy 2000	%>90% Live Canopy 2001
1 (n=27)	95	95	95	[a]	5	5	5	[a]
2 (n=34)	18	18	18	[a]	41	35	22	[a]
3 (n=31)	81	84	84	88	10	0	0	0
4 (n=50)	48	48	48	50	14	4	6	2
5 (n=61)	15	16	20	22	43	15	24	0
6 (n=51)	18	18	18	18	54	27	27	4

n = Number of shrubs.
(a) Destroyed by fire.

8.2.6. Ecological Compliance

Policies of the DOE Richland Operations Office require that all projects having the potential to adversely affect biological resources have an ecological compliance review performed prior to initiation of the project. This review assures that the DOE is in compliance with the *Endangered Species Act* and the *Migratory Bird Treaty Act*. It also assures that other significant resources such as Washington State listed species of concern, wetlands, and native shrub steppe habitats are adequately considered during the project planning process. Where effects are identified, mitigation action is prescribed. Mitigation actions can include avoidance, minimization, rectification, or compensation.

Since many projects occur during periods of the year when the plants are not growing and plants are difficult to identify or evaluate, each of the operational areas (200-East and 200-West, all of the 100 Areas, and the 300 Area) are surveyed each spring. These baseline surveys provide information about the habitat types, and species inventories and abundance, which can then be used throughout the rest of the year to assess potential project impacts. Examples of the baseline survey maps are available at http://www.pnl.gov/ecology/ecosystem/Compliance/comp.html.

A total of 109 ecological compliance reviews were performed during 2001 in support of general Hanford Site activities. An additional 60 reviews were performed in support of environmental restoration activities. The total number of reviews prepared in 2001 (169) was similar to the number performed in 2000 (Table 8.2.3).

Table 8.2.3. Ecological Reviews Performed, 1997 through 2001

Calendar Year	100 Areas	200 Areas	300 Area	Other[a]	Total
1997	8	79	44	33	164
1998	42	91	28	47	208
1999	36	72	36	52	196
2000	36	52	27	47	161
2001	26	64	27	52	169
Totals	147	358	162	231	898

(a) Includes the 400, 600, 700, Richland North, and former 1100 Areas.