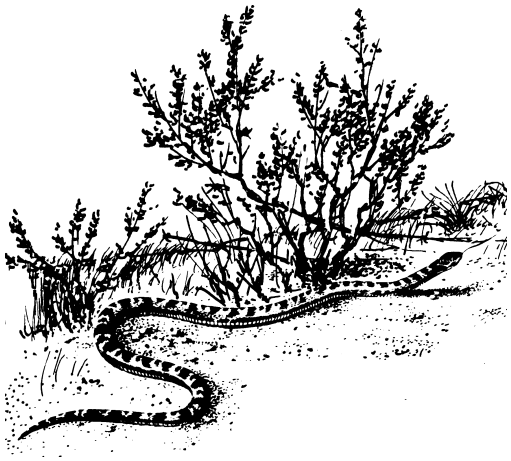
6.0 Biological Resources Inventory and Monitoring



6.0

Biological Resource Inventory and Monitoring

This chapter addresses inventory and monitoring of biological resources at Hanford. Both management actions are vital for DOE-RL to show its Hanford activities are not resulting in significant adverse cumulative impacts to the Site's biological resources in the context of the Columbia Basin Ecoregion. Additionally, biological resource inventory and monitoring provide the technical basis for resource management. The ecosystem integrity monitoring strategy outlined in this chapter helps fulfill one of the main purposes identified for BRMaP in Section 1.1: implementation of an ecosystem management approach for biological resources on the Hanford Site.

6.1 Purpose and Benefits

Inventory and monitoring of biological resources provides (1) baseline information on the presence and distribution of biological resources across the Hanford Site, and (2) biological information necessary to implement adaptive management.

Resource management can be ineffective, or even misdirected, if basic information about resource presence or distribution is lacking. Thus, baseline inventory information is a necessary first step in any monitoring strategy. Because species and habitats and the ecological and human-altered processes that affect them are dynamic, monitoring is necessary to track changes. Adaptive management is not possible without monitoring. Monitoring provides feedback that permits past management practices to be evaluated (i.e., are management objectives met?) and, when necessary, modified.

An accurate assessment of the degree of impact of Hanford activities, especially cumulatively, necessitates that the current status and trend over time of resource viability be known beyond the immediate borders of the area impacted. As described in Section 5.1, Hanford's compliance projects assess impacts at specific locations where individually identified activities occur. The relative importance of these impacts depends on an understanding of resource conditions outside of the impact zones (i.e., generally, the industrial areas of Hanford).

The monitoring strategy outlined in this section is intended to provide the relevant context for accurate cumulative impact assessment. This includes monitoring necessary to ensure federally protected species are not subject to adverse cumulative impacts.

When combined with data from the remainder of the Columbia Basin Ecoregion, Hanford Site inventory and monitoring data provide biological resource status information that will enable ecosystem management to be implemented regionally. Hanford Site data will be available for integration with similar data acquired from state and federal resource agencies and other organizations. Sharing methods and data will enable DOE-RL and resource agencies such as the U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, and Washington Department of Natural Resources to fulfill their trust responsibilities for the public's resources and help DOE-RL to remain an effective steward of Hanford's biological resources of concern.

Effective, cost-efficient, and compliant mitigation depend on monitoring the results of mitigation actions. Similarly, achieving successful restoration also depends on monitoring. Such monitoring, when based on specific performance measures, determines when corrective actions are needed. Mitigation/restoration monitoring also is the tool for providing documentation, and thus credit, to Hanford projects for habitat improvement actions

they have completed or started. As the understanding of what it takes to have successful mitigation improves through monitoring, the need for conservative and expensive mitigation ratios may diminish, and projects can more effectively budget for costs of mitigation.

Monitoring contaminant levels in biological resources enables: (1) an evaluation of the potential for exposure and accumulation; (2) detection of the possible effects of exposure to contaminants by fish, wildlife, and plants; and (3) determination of possible management options or mitigation that may be used should there be adverse effects on an exposed resource. Information on contaminant levels in the biota also can be used to support ecological risk assessments.

6.2 Legal and Policy Basis

A number of federal acts, regulations, and Executive Orders have specific provisions concerning monitoring. These include the:

- National Environmental Policy Act
- Endangered Species Act
- Federal Land Policy and Management Act
- Executive Order 11514 - Protection and Enhancement of Environmental Quality[1]
- Executive Order 11988 - Floodplain Management
- Executive Order 11990 - Protection of Wetlands.

Executive Order 11514, in furtherance of the purpose and policy of NEPA, directs federal agencies to monitor, evaluate, and control on a continuing basis their activities to protect and enhance the quality of the environment. The inventory and monitoring actions described in this section provide the requisite Hanford Site monitoring functions to meet the intent of Executive Order 11514.

The Comprehensive Environmental Response, Compensation, and Liability Act makes those parties responsible for a release of hazardous substances liable for cleanup costs and injuries to natural resources resulting directly or indirectly from the release of a hazardous substance. Natural resources include all biological resources of concern identified in BRMaP. Although CERCLA provides no specific provisions on monitoring, the monitoring strategy identified in this section can provide reference biological resource data that, when used in concert with additional specific biological resource injury data, will enable DOE-RL to evaluate the extent of potential injuries arising from CERCLA-related activities.

Monitoring for federally threatened and/or endangered species and their habitats, as provided by BRMaP, will provide much of the required data for biological assessment required by USFWS under the Endangered Species Act and by DOE's NEPA implementing regulations (10 CFR 1021) for any actions that might jeopardize the continued existence of any listed species or adversely modify its habitat. Specific actions for bald eagle protection on the Hanford Site, which require monitoring for implementation, have been written into the *Hanford Site Bald Eagle Management Plan* (Fitzner and Weiss 1994).

Certain parcels within the Hanford Site are Bureau of Land Management-withdrawn lands. Although withdrawn specifically for DOE-RL use, the Bureau retains an interest in these parcels. The monitoring strategy will provide the technical data needed to identify and protect as appropriate, when not overridden by other considerations such as mission requirements, the quality of the ecological resource values on withdrawn parcels. The inventory and monitoring portion of BRMaP also will enable DOE-RL to both identify and characterize "areas of critical environmental concern," which are required to be given priority designation and protection by the Bureau of Land Management under the Federal Land Policy and Management Act.

Monitoring with respect to mitigation actions is specifically addressed under the NEPA regulations [40 CFR 1505.2(c)], as well as Executive Orders 11988 and 11990. In regard to specifically biological resource mitigation, the U.S. Fish and Wildlife Service Mitigation Policy (46 FR 7644) encourages monitoring to determine the effectiveness of mitigation measures in achieving the mitigation planning goal.

The DOE recently became a signatory to a Memorandum of Understanding to foster the ecosystem

[1] As amended by Executive Order 11911, "Relating to Protection and Enhancement of Environmental Quality."

approach. A provision of that Memorandum of Understanding indicated that "each signatory agency shall examine the specific recommendations made in the report of the Interagency Ecosystem Management Task Force [IEMTF 1995]...and identify recommendations that may apply to its programs." Based on its review, an agency could then undertake appropriate actions. One specific task force recommendation related to monitoring says:

> **Monitoring of all ecosystem efforts.** Agencies should require a monitoring component as an integral part of all ecosystem efforts. Monitoring provides the essential information to agencies about how closely actual conditions approach the desired ecosystem conditions. This information is a crucial element in adaptive management. Agencies should develop consensus regarding selection and interpretation of factors (commonly known as "indicators") that indicate progress or deviation from an expected or preferred path. Each ecosystem monitoring program should include: a description of the desired outcomes of the policy or management change; identification of indicators used to track progress toward these outcomes; and a description of monitoring strategies that will be employed to determine progress. Initially, monitoring could increase information costs; in the long run, it would allow more rapid and flexible response to changing conditions.

The monitoring strategy outlined in Section 6.4 uses the task force recommendations as part of its technical basis.

6.3 Management Goals and Objectives

The following goals apply to the Hanford Site biological resource inventory and monitoring strategy. Objectives are highlighted in the box.

- continue to gather biological resource inventory data to enable a sound technical basis for planning land-use and conducting site activities while preserving biological resources of concern and the integrity of the Hanford ecosystem
- gather biological resource inventory data that furthers an understanding of Hanford's biodiversity within a bioregional context
- implement a Hanford Site biological resource monitoring strategy that will focus on the patterns of biodiversity; track long-term trends or

Management Objectives

The following objectives are based on inventory and monitoring goals. They provide a strategy by which an effective inventory and monitoring program can be implemented.

1. As part of the Ecosystem Monitoring Project, coordinate with other biological resource agencies, Tribes, and stakeholders to ensure a comprehensive and regionally consistent set of biodiversity indicator variables are identified. Monitoring these will enable evaluation of changes in the integrity of the Hanford ecosystem within its bioregional context.

   Within 1 year of issuance of BRMaP as a final document, devise a Hanford monitoring strategy in cooperation with USFWS, WDFW, WDNR, and other appropriate landowner/administrators that contributes to a long-term, regionally based monitoring program for the Columbia Basin Ecoregion.

2. Within 1 year of issuance of BRMaP as a final document, develop, through joint participation of appropriate Hanford contractor and DOE-RL program and Office of Site Services staff, consistent monitoring procedures for tracking the success and effectiveness of mitigation/restoration actions and for determining when corrective actions are necessary. The monitoring guidance and requirements outlined in the BRMiS (DOE-RL 1996) provide an initial starting point.

3. Within 1 year of issuance of BRMaP as a final document, develop, through joint participation of contractor contaminant-monitoring projects at Hanford, an evaluation of the need for and extent of monitoring plant, fish, and wildlife exposure to and uptake of chemical and radiological contaminants. The evaluation should consider existing exposure pathways and their trends over time, the results of the Columbia River Comprehensive Impact Assessment, the current biotic monitoring activities that are conducted in support of human and environmental exposure assessment, and the potential for future Site activities creating new exposure pathways.

abrupt changes in the relative amount, distribution (fragmentation), and condition of habitat/plant communities of concern on the Hanford Site; and provide resource status data to detect major changes in species of concern and ensure the public that cumulative impacts of Hanford Site activities are not adversely affecting them

- based on the results of appropriate monitoring data, conduct annual site-wide ecological risk characterization and analysis
- seek opportunities to form partnerships with resource agencies and other organizations to share inventory and monitoring data and develop and implement long-term, consistent, cost-efficient, and effective monitoring protocols that can be used throughout the Columbia Basin Ecoregion.

6.4 Implementation

Inventory—Information on the identity, location, population size, or community distribution of a resource is obtained initially by field inventory and frequently displayed as resource maps. Much of the inventory work on Hanford's biological resources has been completed. Preliminary resource mapping of plant communities and distributions for some plant and animal species that have particular resource value have been accomplished.

Hanford Site resource management projects have provided population-level inventory and monitoring data for selected species identified either as species of concern or as resources having high value in the eyes of the public. Bald eagle census and nest surveys have been conducted as well as breeding surveys of nesting Canada geese on the Columbia River and counts of fall chinook salmon redds in the Hanford Reach.

Much work, to date, has been directed at identifying trends in populations to determine impacts from Hanford Site activities, or monitoring the status of species of concern to meet legally mandated requirements. Areas in the vicinity of planned Site activities have been thoroughly surveyed for species of concern as part of the CERCLA and NEPA environmental compliance processes. Limited inventory work also has been conducted to locate and map species of concern, such as pygmy rabbits and Columbia yellowcress, within suitable habitats over the broader Hanford Site.

The Nature Conservancy recently conducted work on the Hanford Site principally on the ALE Unit, Umtanum Ridge, North Slope, and along the Hanford Reach (see TNC 1995, 1996, 1998, and 1999) to identify and map native plant communities and populations of individual plant species of concern; census neotropical migratory bird species and small mammals using the Site; and identify many invertebrates that may be unique to the area. Plant communities and land cover classes have been mapped by both Pacific Northwest National Laboratory and The Nature Conservancy.

Monitoring—Monitoring is the repetitive survey process that tracks the status and condition of a resource. Monitoring often occurs at the population (individual or multiple species) or ecosystem (individual or multiple habitats/plant communities) levels to facilitate tracking trends in resource size or distribution.

Monitoring also may be conducted to obtain information on the condition of the resource and include tracking characteristics such as contaminant concentrations, health of individuals, population vigor, and habitat quality. Also, monitoring can occur at regional scales that enables tracking changes in land use and fragmentation patterns. Finally, monitoring is an important component of mitigation and restoration activities. Any monitoring strategy should include the following considerations: (1) baseline (i.e., inventory) information must be collected or available, (2) monitoring objectives must be established, (3) monitoring actions must be repeated over time using consistent, standardized procedures, and (4) monitoring results must be interpreted relative to the baseline information and the monitoring management objectives (PNINAC 1991). Population status monitoring and contaminant monitoring are currently being conducted through activities conducted at both Pacific Northwest National Laboratory and Fluor Daniel.

Special Case Monitoring—The presence of waste management and cleanup (i.e., environmental restoration) activities at the Hanford Site may result in the exposure to and possible accumulation of radiological or chemical contaminants in plants, fish, or wildlife. Contaminant levels in biological resources are a concern because they may (1) affect adversely the health and viability of the resource, and (2) provide a route of transport and exposure to other resources in the food web or to humans. Most fish, wildlife, and vegetation monitoring

conducted to date on Hanford has focused on either potential routes of exposure to humans or on indicators of intrusion into controlled areas. Past monitoring of contaminants has not emphasized ecological effects because levels of chemicals or radioactive materials are often well below levels thought to adversely affect organisms.

The strategy outlined in the sections to follow establishes additional Hanford Site monitoring activities to include mitigation area monitoring and ecosystem-level habitat monitoring.

6.4.1 Inventory

Biological resource GIS-based data maps of existing Hanford Site inventories are provided in Appendix D.

Many of the Hanford Site's biological resources were inventoried in 1994, 1995, and 1997 under work conducted by The Nature Conservancy (TNC 1995, 1996, 1998, and 1999). The TNC completed plant community mapping for most of the uplands (ALE Unit, the North Slope, and Central Hanford) except for areas inside facility boundaries. Much of the area within facility boundaries has been surveyed during the environmental compliance review process (see Figures D.3 through D.11 in Appendix D).

The TNC also surveyed about 19,500 ha for rare plants and identified bird species on the ALE Unit, the North Slope, and a portion of central Hanford. Mammals, amphibians, and reptiles were identified at limited locations across the Site. Invertebrate sampling also was limited to relatively few habitats that were believed to be among the more diverse.

Other biological resource inventory data are available for the Hanford Site based on ecological studies conducted over the last 40 years, more or less, and from Hanford Site projects (i.e., Ecosystem Monitoring Project, Environmental Compliance Project, Integrated Pest Management Project, and others).

The Ecosystem Monitoring Project, conducted by Pacific Northwest National Laboratory, has primary responsibility for integrating the biological diversity (inventory) data for the Site. Inventory results provide the basis for biological resource monitoring.

6.4.2 Monitoring: Single Species Status

In the past, most biological resource monitoring at Hanford focused on individual species. This type of monitoring will be continued; however, it will focus on specific species of concern, such as bald eagles and fall chinook salmon. All Level IV species will be individually monitored (i.e., to the extent possible, each area of occurrence will be monitored). Available budget and resources will determine the extent to which additional species will be individually tracked with priority given to Level III species (with state-listed species given first preference) and species for which there already are long-term monitoring data sets (e.g., Canada goose nesting). The status of the bulk of the individual species of concern will be tracked as part of the biodiversity and habitat/plant community status monitoring program.

6.4.3 Monitoring: Hanford Ecosystem Integrity

The integrity of the Hanford ecosystem relies on both the presence of (e.g., species, species assemblages, habitats) and the occurrence of the ecological processes, at the appropriate rates, that generate and maintain the elements. The combination of biotic elements and ecological processes commonly has been referred to as biodiversity (or biological diversity). Some authors, however, find it useful to distinguish elements from processes; thus Angermeier and Karr (1994) use the term biological integrity to refer to the combination of elements and processes and reserve biodiversity to refer to just the elements. Within BRMaP, the term biodiversity is used broadly to refer to both elements and the underlying ecological processes that sustain them; because if both are present the end result is a natural habitat or community (Angermeier 1994; Angermeier and Karr 1994). The key point is that if the management goal is to monitor the integrity of the Hanford ecosystem, and by so doing detect adverse trends that enable an appropriate management response, then monitoring must address the selection of indicators that capture both the biodiversity elements and the important ecological processes. Moreover, such monitoring must be accomplished in a cost-effective manner that can be sustained over the long term.

Not all biotic elements and processes can or should be monitored. Those elements and/or processes selected to be monitored must be those that have

a strong connection with assessing ecosystem integrity. To design an effective monitoring strategy that addresses the correct benchmark for comparisons, a few clarifications regarding biological diversity are necessary. First, monitoring should not focus on only one level of the biodiversity hierarchy. Diversity at one level is not necessarily a function of diversity at other levels (Angermeier 1994). Thus, for example, monitoring must include species composition (assemblage) diversity and habitat/plant community diversity (i.e., landscape patterns) components.

Second, biological diversity does not include artificial diversity (Angermeier 1994).[2] Artificial (i.e., human-generated) diversity does not refer to simply the introduction of non-native species to an ecosystem. Artificial diversity can occur at any level of the biodiversity hierarchy; for example, at the landscape level it can include human-induced fragmentation of habitats. Increases in artificial diversity often reduce native diversity through extirpation and covergence (e.g., make different native habitats more similar) (Angermeier 1994).

Finally, the relationship between biodiversity elements, ecological processes, and ecosystem integrity or function is complex. The best strategy is to monitor just a few key processes that structure the ecosystem at intermediate scales of space and time (Risser 1995). For Hanford, such processes could include the patterns of disturbance (human-induced and natural), alternating patterns of rainfall and drought, the dam-regulated flood cycle of the Columbia River, and the presence of invasive non-native plants.

To help structure the implementation of a biodiversity monitoring strategy, Noss (1990) suggests 10 steps. A modification of these steps is provided by the CEQ (1993). Table 6.1 provides an overview of how a Hanford Site biodiversity monitoring strategy will be developed and implemented. It describes the 10 steps and their applicability to the Hanford Site monitoring strategy. The final monitoring strategy will incorporate those findings obtained as a result of Objective No. 2 in Section 6.3.

Implementation of the Hanford Site monitoring strategy began during FY96. Through a cooperative effort with the Washington Department of Fish and Wildlife, an initial total of 30, generally 20 ha monitoring plots were established in different types of shrub-steppe habitat. Most of these plots were surveyed for both bird diversity and vegetation characteristics. Additionally, some of these plots were surveyed for small mammal diversity. Other taxa and plots are planned to be added in subsequent years. Figure 6.1 shows the distribution of monitoring plots established during FY96 across the Hanford Site within the context of the Hanford land cover map.

6.4.4 Monitoring: Mitigation and Restoration Actions

Mitigation and restoration actions must be monitored to determine if the mitigation/restoration commitments have been met. Performance measures, especially if habitat improvement is involved, should be based on the specific mitigation/restoration goals and physical/biotic characteristics of the mitigation area. Performance monitoring should occur at least annually until the mitigation/restoration goals have been met.[3] If monitoring indicates that mitigation goals are not being met, then corrective actions must be taken.

The *Biological Resources Mitigation Strategy* (DOE-RL 1996) identifies possible performance measures for a habitat improvement area. The specific procedures for monitoring mitigation/restoration actions and determining the need for corrective actions will be based on the recommendations of the working group identified in Section 6.3 (Objective No. 3). Recommendations should be implemented as soon as they are available.

6.4.5 Monitoring: Plant, Fish, and Wildlife Exposure to and Uptake of Chemical and Radiological Contaminants

Although the likelihood that Hanford's biological resources are exposed to chemical and radiological

[2] Artificial diversity still will be recorded as a part of any monitoring protocol; however, in assessing its effect on ecosystem integrity, its presence will be considered negatively. Separate from the issue of monitoring ecosystem integrity, the status of non-native species considered priority species by WDFW because of their commercial and/or recreational importance also are considered appropriate to be monitored.

[3] The annual monitoring will enable projects that are conducting mitigation under a Mitigation Action Plan to meet the annual reporting requirements of DOE O 451.1, National Environmental Policy Act Compliance Program.

Table 6.1 Ten Steps for Implementing a Biodiversity Monitoring Strategy

Noss (1990) Step	Description	BRMaP Implementation
1. What and why?	Establish goals and objectives and the biodiversity endpoints that an agency wishes to assess and maintain.	The broad resource management goals for the Hanford Site are identified in Section 2.2.2. Specific biodiversity endpoints might include the maintenance of both alpha (species richness within a habitat) and beta (turnover in species across space) species diversity, (2) the maintenance of high proportions of native species versus non-native species within habitats/ plant communities, and (3) the minimization of human-induced fragmentation across the landscape.
2. Gather and integrate existing data.	Make use of existing biodiversity-related data and analyze in a GIS-based format.	The GIS-based resource maps in Appendix D make use of the best available data for depicting what is known about the geographic distribution of Hanford's biological resources of concern. Comparable data for the ecoregion as a whole is lacking, but some GIS depictions of a reduced area of coverage or less resolution are available.
3. Establish "baseline" conditions.	Determine the extent, distribution, and condition of existing vegetation types, the probable distribution of species of concern, and the distribution (and intensity) of stressors (e.g., habitat fragmentation).	For Hanford, much of this information is available from historic ecologic studies and recent TNC biodiversity surveys; however, some significant baseline data gaps remain. Ecoregion-wide GIS information is just now in the state of development. Species distribution information is spotty. A Hanford inventory strategy is outlined separately in this section. Establishing baseline conditions for the overall ecoregion will require the integration of monitoring programs and data sharing among landholders and resource agencies within the ecoregion.
4. Identify "hot spots" and ecosystems at high risk.	Delineate areas of high species richness and endemism, as well as areas and ecosystems at high risk of impoverishment because of their particular susceptibility to human-induced stressors. The preceding areas warrant more intensive monitoring.	Habitats and plant communities at Hanford have not been evaluated for their overall species diversity. As part of its implementation, the Hanford monitoring strategy will fill these data gaps. Across the ecoregion, it is likely that the patterns of diversity will change. Some areas, such as Hanford, may be important for preserving certain species assemblages and habitat/plant community types; whereas, other locations, such as the Yakima Training Center, may contain other assemblages, habitats, and plant communities. The Hanford Reach, because it is the last free-flowing stretch of the Columbia River, may have no parallel in regard to its potential for maintaining aquatic biodiversity. The Columbia River Plain (which encompasses the central core of Hanford) is the driest and generally one of the hottest areas of sagebrush-steppe in the western United States. The presence of non-native annual plants has added to its susceptibility to human alteration.

Table 6.1 Ten Steps for Implementing a Biodiversity Monitoring Strategy (continued)

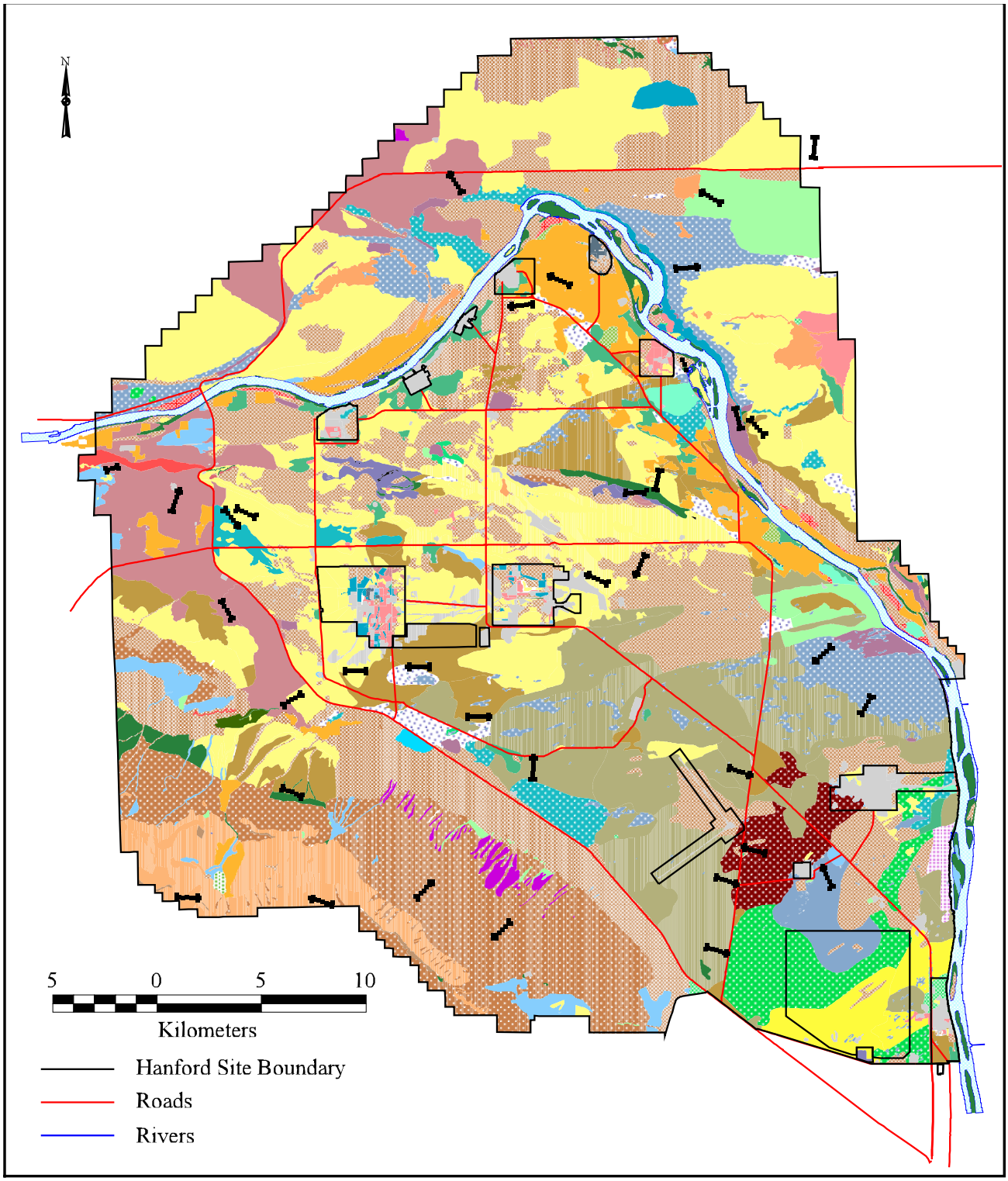
Noss (1990) Step	Description	BRMaP Implementation
5. Formulate specific questions to be answered by monitoring.	The questions to be answered will depend on the goals, objectives, and biodiversity endpoints identified in Step 1. Thresholds for the biodiversity endpoints should be specified that will trigger the need for changes in management practices.	The types of questions that are appropriately formulated to be answered by a Hanford monitoring strategy include: (1) Are populations of species of concern declining, stable, or increasing? At Hanford? Within the ecoregion? (2) What are the patterns of species diversity across habitats and plant communities? (3) Are these patterns affected by the presence of artificial diversity? (4) Is artificial diversity, at its different levels of organization, declining, stable, or increasing? (5) How are the size, distribution, and condition of native habitats and plant communities changing? (6) How does biodiversity differ between natural and artificial ecotones (i.e., transitional areas between ecosystems or plant community types)?
6. Select indicators.	Identify indicators of structural, functional, and compositional biodiversity at several levels of the hierarchy that correspond to the end points (Step 1) and questions (Step 5) (see Table 1 in Noss 1990 for a listing of indicator variables; the table also includes a listing of inventory and monitoring tools for each biodiversity level).	The levels of the hierarchy that will be used to select indicators will generally be limited to Noss's (1990) community-ecosystem (i.e., within habitat) and regional landscape levels. Noss's population-species level monitoring is addressed in Section 6.4.2 for specific species of concern; however, some species considered to be ecological indicators (see Appendix D) will be included as part of the biodiversity monitoring strategy. Additionally, population-level information on species of concern will be obtained as a byproduct of the community-ecosystem level monitoring. The genetic level of monitoring, except in special case situations, is not envisioned to be a part of the current monitoring strategy. When using species assemblages as indicators, it is important that different functional groups of species be monitored. The ecological requirements of one group of organisms may be different than other groups. The selection of indicators will account for structure, function, and composition variables and abiotic as well as biotic indicators. The final selection of indicator variables will depend on the results of the cooperative effort to develop a regionally consistent monitoring strategy described in Section 6.3 (see Objective No. 2).
7. Identify control areas and treatments.	For each major class of habitat (which may contain different plant communities), identify control areas (i.e., generally free from human-induced impacts) and areas subject to more intensive management or environmental stress.	The ALE Unit will serve as a control site as needed. In general, however, because this monitoring strategy applies to the areas of Hanford outside the industrial areas, control areas refer to areas of native habitat/plant communities, and stressed/managed areas refer to areas that have been disturbed by humans in the past and/or have a high proportional component of artificial diversity. Although in its initial stages, the monitoring strategy will focus on the upland ecosystem, the intent in the future is to add riparian/wetland communities on the ALE Unit, North Slope, and along the Hanford Reach (depending on future ownership of these areas).

Table 6.1 Ten Steps for Implementing a Biodiversity Monitoring Strategy (continued)

Noss (1990) Step	Description	BRMaP Implementation
8. Design and implement a sampling scheme.	With due consideration for the principles of experimental design, select monitoring sites for identified questions and objectives.	Monitoring sites are intended to consist of both permanent sites (visited one or more times each year) and non-permanent sites. The permanent sites will be stratified across the different kinds of habitat/plant communities, replicated for each habitat/plant community monitored, and reflective of the different grades of habitat quality or condition. For FY96, in coordination with WDFW's shrub-steppe habitat fragmentation project, vegetation and bird community attributes were the focal point of initial monitoring. Additional sites and taxa, as well as physical features, will be added in subsequent years (see Step 6). Landscape-level monitoring at the ecoregion level is dependent on acquiring the appropriate GIS-based vegetation maps.
9. Validate relationships between indicators and (sub-) end points.	Continually evaluate how well the selected indicators correspond to the biodiversity endpoints of concern.	The monitoring strategy will continually evaluate the relevance of its biodiversity endpoints, the questions asked, the indicator variables selected for monitoring, and their relationships. Changes to the monitoring strategy and its in-the-field protocols will be made as necessary.
10. Analyze trends and recommend management actions.	The results of monitoring must be analyzable in a statistically rigorous manner. Also, the results must be capable of synthesis into an assessment that is relevant to policymakers and that can be used to make positive changes in management direction.	The results of the biodiversity monitoring effort will be used as an important component of adaptive management. If monitoring indicates an adverse change in the resources (either at Hanford or elsewhere within the ecoregion), then the monitoring results will be used to formulate appropriate changes in management actions.

contaminants has decreased significantly from Hanford's defense-oriented mission days, some pathways still exist through which the biota potentially are exposed (e.g., groundwater flow to the Columbia River). Moreover, the need to conduct additional monitoring of potential contaminant uptake in plant, fish, and wildlife resources is, in part, determined by the present and future occurrence of environmental restoration and waste management activities in areas that are known or suspected of containing radiological or chemical contamination. Actions in these areas potentially can cause contaminants, previously contained and isolated from the biota, to become biologically available. These locations, as well as possible existing exposure pathways, can be defined based on historic monitoring and process knowledge. Activities taking place outside of these designated areas do not require a review of potential exposure of biological resources.

Contaminant monitoring decisions for specific project areas require that contaminants of concern for each area are identified and that the dose responses of resident biota are known. Existing data, including monitoring and process knowledge, will be reviewed to determine the potential for contamination and whether there is a reasonable likelihood that biota are or will be contaminated by project



Monitoring Plots

Data Collected: 1994, 1997/The Nature Conservancy
1991, 1999 Pacific Northwest National Laboratory
Plots Established: 1996
Map Created: September 1999/Pacific Northwest National Laboratory

Figure 6.1 Hanford Site Monitoring Plot Locations (Map)

LEGEND

- Abandoned Old Agricultural Fields
- Alkali Saltgrass - Cheatgrass
- Big Sagebrush - Bitterbrush / Bunchgrass
- Big Sagebrush - Bitterbrush / Needle-and-Thread Grass
- Big Sagebrush - Bitterbrush / Sandberg's Bluegrass
- Big Sagebrush - Rigid Sagebrush / Bunchgrass
- Big Sagebrush - Rock Buckwheat / Bunchgrass
- Big Sagebrush - Spiny Hopsage / Bunchgrass
- Big Sagebrush - Spiny Hopsage / Sandberg's Bluegrass - Cheatgrass
- Big Sagebrush / Bluebunch Wheatgrass
- Big Sagebrush / Bunchgrass
- Big Sagebrush / Needle-and-Thread Grass
- Big Sagebrush / Sand Dropseed
- Big Sagebrush / Sandberg's Bluegrass - Cheatgrass
- Bitterbrush / Bunchgrass
- Bitterbrush / Indian Ricegrass
- Bitterbrush / Needle-and-Thread Grass
- Black Greasewood / Alkali Saltgrass
- Bluebunch Wheatgrass - Needle-and-Thread Grass
- Bluebunch Wheatgrass - Sandberg's Bluegrass
- Bunchgrass - Cheatgrass
- Crested Wheatgrass
- Disturbed
- Gray Rabbitbrush - Snow Buckwheat / Bunchgrass
- Gray Rabbitbrush / Bunchgrass
- Gray Rabbitbrush / Cheatgrass
- Gray Rabbitbrush / Needle-and-Thread Grass
- Gray Rabbitbrush / Sand Dropseed
- Gray Rabbitbrush / Sandberg's Bluegrass - Cheatgrass
- Needle-and-Thread Grass - Indian Ricegrass
- Needle-and-Thread Grass -Sandberg's Bluegrass
- Non-Riverine Wetlands and Associated Deepwater Habitats
- Rabbitbrush / Bunchgrass
- Rigid Sagebrush / Sandberg's Bluegrass
- Riparian
- Riverine Wetlands and Associated Deepwater Habitats
- Sand Dropseed - Sandberg's Bluegrass - Cheatgrass
- Sandberg's Bluegrass - Cheatgrass
- Snow Buckwheat - Bitterbrush / Bunchgrass
- Snow Buckwheat / Bunchgrass
- Snow Buckwheat / Sandberg's Bluegrass - Cheatgrass
- Spiny Hopsage / Sandberg's Bluegrass - Cheatgrass
- Talus
- Threetip Sagebrush / Bunchgrass
- Thymeleaf Buckwheat / Sandberg's Bluegrass
- Vernal Pool
- White Bluffs
- Winterfat / Bunchgrass

Figure 6.1 Hanford Site Monitoring Plot Locations (Legend)

activities. Although adequate data are available for screening contaminants of concern, information on the sensitivity of key resident species is most likely unavailable. Dose response relationships will have to be drawn from available data generated on species more routinely used for toxicological investigations and extrapolated to resident biota.

If necessary, sampling may be required to demonstrate that concentrations of contaminants have not reached detrimental levels. Potential population effects will be evaluated on a localized basis and a site-wide (cumulative) basis to determine the impacts to the biological resource. If Hanford populations are impacted, then the impacts also should be evaluated as to their regional significance.

A final contaminant monitoring strategy that addresses the need for and extent of monitoring with respect to biological resources will be implemented in a timely manner (subject to the extent that budget and other considerations allow) based on the recommendations of the evaluation identified in Section 6.3 (Objective No. 4). Besides providing public assurance that populations of species are not adversely impacted, monitoring data also can be used to support site-wide ecological risk assessments.

6.5 Roles and Responsibilities

Biological resource inventory and monitoring for the Hanford Site is under the direction of DOE-RL's Office of Site Services. To this point in time, biological resource inventory and monitoring work has been conducted principally by the Ecosystem Monitoring Project. Monitoring contaminants in plants, fish, and wildlife is conducted by the Surface Environmental Surveillance Project and by the Operational Environmental Monitoring Project. Additionally, the Surface Environmental Surveillance Project is expanding its ecological exposure assessment and risk analysis capabilities to provide site-wide ecological risk assessment as part of its annual report findings.

Although the monitoring and evaluation of contaminant effects on biota share similarities to location-specific, ecological risk assessment, each approach may serve to address different purposes. A primary difference between a traditional, location-specific risk assessment (such as that conducted at Hanford by the Environmental Restoration Contractor for terrestrial ecosystems and Pacific Northwest National Laboratory for aquatic ecosystems) and environmental monitoring (such as that conducted by the Surface Environmental Surveillance Project) is that of scale: both spatial and temporal. For example, location-specific risk assessments at Hanford are focused primarily at individual operable units, whereas, monitoring activities address the effects of all operable units collectively to evaluate impacts at a site-wide level (or to ecologically defined regions). Thus, site-wide monitoring can be used to support site-wide ecological risk assessments. Additionally, location-specific risk assessments typically are limited in temporal scale (i.e., they evaluate one point in time). Conversely, environmental monitoring activities typically assess long-term temporal trends in and cumulative effects from contaminant concentrations, biological processes, or other environmental factors.

Specific monitoring responsibilities are assigned with respect to accomplishing four objectives identified in Section 6.3. For each objective, a particular contractor project will take the lead role for ensuring that the objective is met as follows:

- Objective No. 1: Ecosystem Monitoring Project
- Objective No. 2: Ecosystem Monitoring Project
- Objective No. 3: Hanford Biological Resources Laboratory
- Objective No. 4: Surface Environmental Surveillance Project.

6.6 Tribes and Stakeholders

Several local Tribes and stakeholders have concerns for and interests in the status of Hanford Site biological resources. Biological resource inventory and monitoring data are used by multiple entities for planning resource usage and preservation schemes, evaluating DOE-RL's performance in biological resource stewardship, assessing DOE-RL's compliance to various laws and regulations, and for other purposes. These entities include, but are not limited to, the Yakama Nation, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Indian Nation, USFWS, Washington State Department of Ecology, WDFW, WDNR, Benton County Planning Department, TNC, the Lower Columbia Basin Audubon Society, and members of the public at large.