DOE/RL 96-32
Revision 0
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Hanford Site Biological Resources Management Plan

October 2000

United States
Department of Energy
Richland, Washington

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Executive Summary

S.1 Introduction

As a federal land manager, the U.S. Department of Energy (DOE) is responsible through its Richland Operations Office (DOE-RL) for conserving fish, wildlife, and plant populations and their habitats on the Hanford Site. The DOE-RL currently manages impacts to threatened and endangered species through a number of separate initiatives, but no previous management strategy has considered the overall health of the entire Hanford ecosystem. To fill this management void, a comprehensive plan was needed that viewed Hanford's biological resources and their management from both site- and program-wide perspectives.

The *Hanford Site Biological Resources Management Plan* (BRMaP) was developed to meet this need. The plan provides DOE-RL and its contractors with a consistent approach to protect biological resources and monitor, assess, and mitigate impacts to them from site development and environmental cleanup and restoration activities. Approaches to better manage total resources also are provided in the plan. The BRMaP's primary purposes are to support DOE-RL's environmental cleanup and other Hanford missions; provide a mechanism for ensuring compliance with laws that relate to the management of potential impacts to biological resources; provide a framework for ensuring appropriate biological resource goals, objectives, and tools are in place to make DOE-RL an effective steward of Hanford's biological resources; and implement an ecosystem management approach for biological resources on the Site.

As a comprehensive plan, BRMaP provides a framework to enable Hanford Site resource professionals to effectively fulfill their responsibilities and address Tribal, resource agency, and other stakeholder concerns about the Site's biological resources. The plan strongly emphasizes the benefits of good up-front planning for mitigation and restoration at Hanford.

Figure S.1 identifies essential aspects of Hanford biological resource management, which include resource monitoring, impact assessment, mitigation,

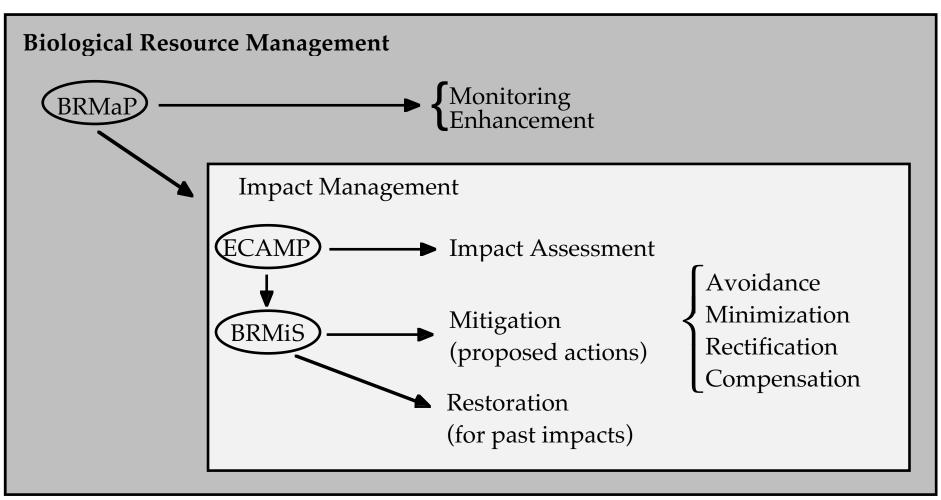


Figure S.1 Relationship of Biological Resource Management Actions to Appropriate DOE-RL Guidance Documents and restoration. The figure shows management actions and their relationship to the appropriate DOE-RL guidance documents, including the BRMaP, *Ecological Compliance Assessment Management Plan* (ECAMP) (DOE-RL 1995), and *Biological Resources Mitigation Strategy* (BRMiS) (DOE-RL 1996). The general relationship of BRMaP to these two subtier documents is that of a strategy and guidance document to an implementation document. BRMaP provides general but comprehensive direction that specifies DOE-RL's biological resource management policies, goals, and objectives and prescribes how they will be met. The subtier documents outline specific management actions necessary to meet various policies, goals, and objectives. The BRMaP also shares an important relationship with the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS),* (DOE 1999). The land-use plan integrates appropriate biological resource data and biological resources management strategies from BRMaP with other components dealing with environmental, cultural, economic, and sociopolitical elements to implement an ecosystem management approach to land-use planning at the Hanford Site.

S.2 Biological Resource Management at Hanford

The policies and guidelines described in BRMaP were developed based on legal requirements and policy initiatives that direct an ecosystem management approach toward resource management.

Development of BRMaP is consistent with Secretary of Energy policy, which promotes an ecosystem management approach to resource stewardship, and with resource management plans developed at other DOE sites. In support of the Secretary's policy, DOE-RL developed the following broad biological resources protection policy:

> It is the policy of the Department of Energy Richland Operations Office to be responsible stewards of the natural environment on the Hanford Site. The Richland Operations Office will work with its contractors, resource agencies, stakeholders, and the Indian Tribes to preserve or enhance the biological resources under its stewardship in a manner that is consistent with the principles of ecosystem management and sustainable development.

The box outlines DOE-RL's specific policies for biological resources management at Hanford.

DOE-RL Biological Resources Management Policies

DOE-RL will:

- act to preserve and enhance the biological resources under its stewardship as valuable national resources
- ensure biological resource values are considered by all programs in all actions conducted on DOE-RL's behalf consistent with applicable treaties, laws, regulations, and obligations as a natural resource trustee
- endeavor to enhance throughout the Hanford complex an awareness of and appreciation for biological resource values and their preservation, restoration, and enhancement
- integrate biological resource management goals and administrative procedures into relevant program- and project-level activities to ensure potential adverse impacts to biological resources are avoided or minimized
- integrate biological resource information into land and facility use plans to ensure broad-scale land use planning and specific site selection decisions consider biological resource values, apply ecosystem management principles, and minimize cumulative impacts to biological resources
- incorporate ecosystem management principles and tools into the program (project) planning process to facilitate meeting biological resource management goals and objectives while minimizing impacts to program (project) budgets and schedules
- adopt recommendations of the Council on Environmental Quality to incorporate biodiversity considerations into environmental impact analysis under NEPA (CEQ 1993)
- mitigate, as necessary, adverse impacts to biological resources that may result from current and future Hanford activities in a manner commensurate with the value of the resource and the severity of the impact
- as the Lead Response Agency at Hanford under the National Contingency Plan, conduct response activities (i.e., removal or remedial actions) cost effectively that avoid or minimize adverse impacts to biological resources
- cooperate with federal, Tribal, and state resource agencies to ensure a cost-effective yet adequate information baseline on resource status is maintained for Hanford's biological resources within a bioregional context
- coordinate with other governmental agencies and stakeholders, as applicable, on biological resource management issues in an open and cooperative manner.

S.3 Roles and Responsibilities

Figure S.2 shows overall roles and responsibilities for implementing BRMaP. Although ultimate decisions for managing Hanford's biological resources are vested with the manager, Richland Operations Office, the Office of Site Services plays a key role in developing such policy and in overseeing the plan's implementation across the Site. A Natural Resources Working Group provides implementation assistance.

The BRMaP applies to DOE-RL, its Hanford Site contractors, and permit and lease holders. Plan requirements and/or guidance apply to all DOE-RL programs at all locations within its administrative control. The requirements in BRMaP will be applied to Hanford Site contractors as necessary. Contractors are expected to consider BRMaP's guidance and to incorporate biological resource values and management strategies into the early phases of their project planning as requirements are incorporated into their contracts. Existing permits and leases may be modified, as necessary, to meet DOE-RL's biological resource management responsibilities and objectives.

The BRMaP will be reviewed at least every 2 years to ensure it meets DOE-RL's biological resource management needs. The plan will be updated, as needed, when the status of particular resources change or management prescriptions are modified in response to new findings.

S.4 Hanford's Biological Resources: Management by Level of Concern

The Hanford Site is located within the Columbia Basin Ecoregion. In the last hundred years, the steppe and shrub-steppe communities of this ecoregion have undergone substantial loss or degradation attributed primarily to human development (Dobler 1992, Noss et al. 1995). However, because of Hanford's initial use as a production site for defense nuclear materials, much of the Site has been protected from intensive industrial and agricultural development. As a result, the Site retains the largest remaining blocks of relatively undisturbed shrub-steppe in the Columbia Basin Ecoregion (Smith 1994) and a corresponding diversity of plant and animal communities (TNC 1995, 1996). In addition to shrub-steppe, the Site contains significant riparian, wetland, and aquatic habitats associated with the Hanford Reach.

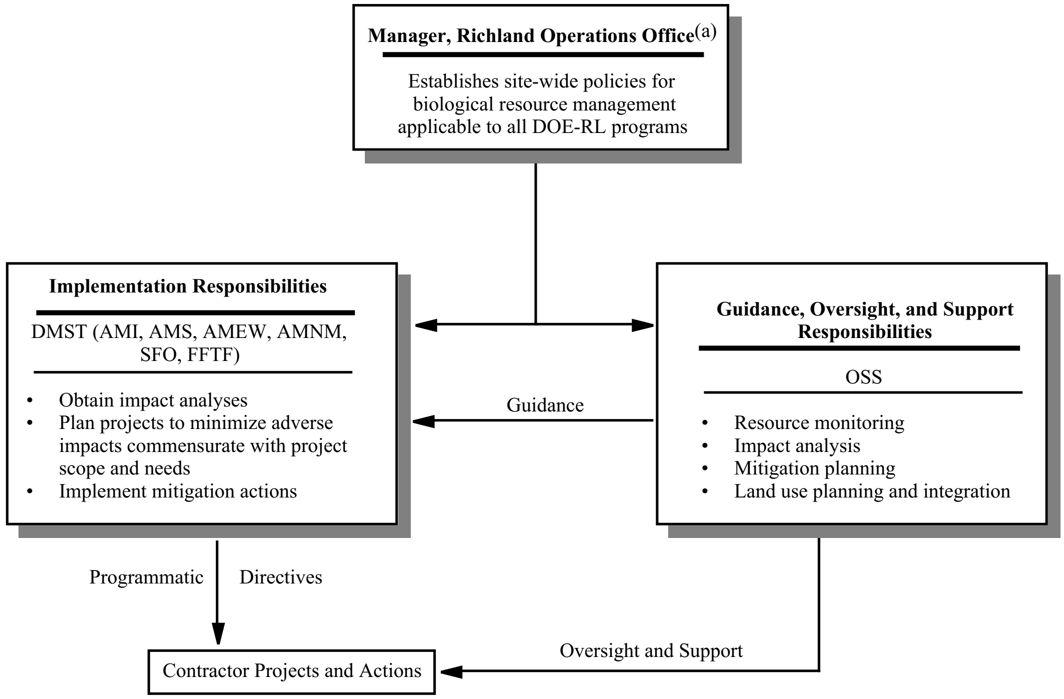
Recently, The Nature Conservancy (TNC) of Washington, in cooperation with DOE-RL, implemented a detailed inventory of Hanford's rare species and ecosystems on the Site to assist DOE-RL in making more informed decisions about future land uses. The TNC (1996) concluded that:

> From a conservation standpoint, the Hanford Site is a vital—and perhaps the single most important—link in preserving and sustaining the biodiversity of the Columbia Basin's shrub-steppe region.

To manage the biological resources described above, DOE-RL has developed an approach that associates different management actions—monitoring, impact assessment, mitigation, and restoration—with particular sets of biological resources. This approach accounts for differences in resource "value"(i.e., that some resources require greater management attention than others.) For example, a native sagebrush/bunchgrass community that is rare in the ecoregion would warrant greater management attention than would a disturbed area dominated by non-native plants such as cheatgrass.

To address these differences in "value" DOE-RL classifies Hanford Site biological resources by four levels of management concern (I-IV). Level I represents the lowest level of management concern and Level IV the highest. Each level has a specific set of associated management actions and requirements. As Table S.1 shows, biological resources categorized at Level I require monitoring, but no other management actions such as impact assessment or impact mitigation are required. At higher levels of concern (Levels III and IV), however, the number of management actions increases, and the actions become more restrictive.

Biological resources on the Site are defined by species category or by either landscape-level attributes such as plant communities or habitats—the latter as defined by their usage by plants, fish, or wildlife—or by administrative designation. Level I resources include species such as the Great Basin pocket mouse and Rocky Mountain elk. Level II resources include 115 species of plants, fish, and wildlife—86 of which are birds—and wildlife habitat areas in an early stage of vegetation change as a



AMI = Office of Assistant Manager for Planning & Integration
AMS = Office of Assistant Manager for Engineering and Standards
AMEW = Office of Assistant Manager for Environmental Restoration & Waste Management
AMNM = Office of Assistant Manager for Nuclear Materials and Facility Stabilization
DMST = Deputy Manager for Site Transition
FFTF = Fast Flux Test Facility Project office
OSS = Office of Site Services
SFO = Office of Spent Nuclear Fuels

(a) Office of River Protection has parallel responsibilities.

Figure S.2 Roles and Responsibilities

Table S.1 Classes of Management Actions and the Biological Resource Levels of Concern at Which They Apply

Class of Management Actions	Resource Level of Concern at Which the Management Action is Applicable			
	I	II	III	IV
Status monitoring	Yes	Yes	Yes	Yes
Impact assessment	No	Yes	Yes	Yes
Mitigation via avoidance/ minimization	No	Yes	Yes	Yes
Mitigation via rectification/ compensation	No	No	Yes	Yes[a]
Minimum NEPA analysis required	CX	CX	EA	EA

[a] Rectification is probably not possible nor an appropriate means of mitigation at this level; compensation can be used but only when it is achieved by acquisition and/or protection of in-kind resources (cf. USFWS Mitigation Policy at 46 FR 7644). CX = categorical exclusion; EA = environmental assessment.

result of recent fires. Examples of Level III resources on Hanford include the sage sparrow and the Columbia yellowcress, the largest population of which in Washington State occurs along the Hanford Reach. Level III habitat areas include wetlands, the Hanford Reach 100-year floodplain, and mature stands of shrub-steppe. As a federally designated Research Natural Area, the Fitzner/Eberhardt Arid Lands Ecology (ALE) Unit also is considered a Level III resource. Level IV, the highest and most restrictive level of management concern, applies only to rare pristine plant communities and habitats and to five species (two species of fish and three bird species), only two of which, the bald eagle and fall chinook salmon, are common.

Figure S.3 shows the extent and distribution of Level II, Level III, and Level IV resources across the Hanford Site (species-based information is included only for Level IV resources). This composite map was developed from individual map layers developed using concise Geographic Information System (GIS)-based summaries of the biological data at a landscape scale. These data layers can be used to make land-use and environmental cleanup decisions that are intended to avoid significant impacts to biological resources.

S.5 Management of Biological Resource Impacts: Impact Assessment, Mitigation, and Restoration

Shaded boxes in the following sections highlight specific commitments for managing biological resources at Hanford; the DOE-RL, contractor project, or lease or permit holder responsible for implementing the management action; and the timetable for completion of the action.

Although DOE-RL recognizes that impacts to biological resources cannot always be eliminated, potential impacts must be assessed during early phases of project development and their consequences incorporated in decision making. This is initiated through an ecological compliance review. Through the review process, impact assessments are conducted for projects that potentially could impact the biological environment. The process complements other environmental reviews such as facility pre-operational baseline studies.

If an ecological compliance review determines adverse impacts to biological resources—such as habitat alterations or disturbances that could affect the reproductive success of species of concern—specific mitigation actions are identified. Mitigation is a series of prioritized actions that, taken together, reduce or eliminate significant adverse project impacts to biological resources. Table S.2 shows the hierarchy of mitigation actions.

Impact Assessment

Commitment: To determine whether a proposed action requires an ecological compliance review, submit a request for review to the Hanford Biological Resources Laboratory (at PNNL) (if non-CERCLA) or to the Environmental Restoration Contractor (if CERCLA related). Follow up on report review recommendations. Include report findings in project documentation.

Implementation Responsibility: All programs/projects responsible for impact assessment; Office of Site Services (Hanford Biological Resources Laboratory)

Timeframe: Early stages of project planning

Mitigation of significant adverse impacts to biological resources via rectification and/or compensation is intended to ensure, to the extent practicable, no net loss of Level III or Level IV biological resources of concern on the Hanford Site. Avoidance and then minimization of adverse impacts are always the preferred mitigation actions. Some projects, however, may be of such a scale and/or have specific siting criteria that make complete avoidance and minimization impossible. In these cases, mitigation through on-site rectification and/or compensation away from the project site would be required.

While mitigation addresses impacts to existing biological resources that will occur as a result of a proposed action, restoration addresses human-caused impacts that may have occurred in the past. The purpose of restoration is to create some amount of habitat value at a site (e.g., past-practice waste site, industrial area, road) where at the time of remediation, decommissioning, or end of use little or no value exists. The specific restoration goal depends, in part, on the site's future use. In cases where the land-use goal is not to create habitat value at a particular site, the site simply may be stabilized, or it may be converted to other uses.

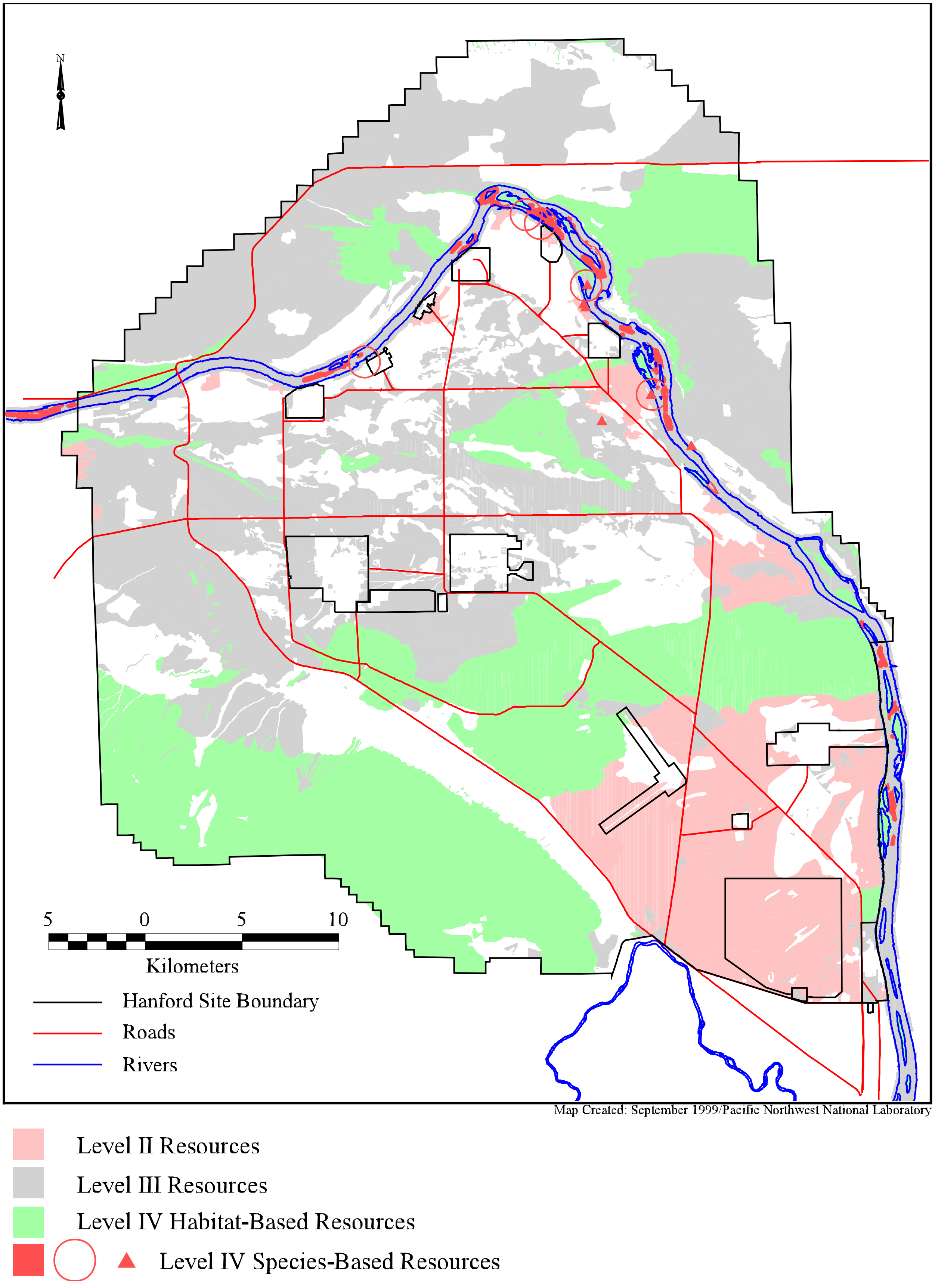


Figure S.3 Composite Map of Level II, Level III, and Level IV Biological Resources (Level I resources are not depicted because they are ubiquitous and require no mitigation.)

Table S.2 Hierarchy of Mitigation Actions for Biological Resource Impacts

Mitigation	Utilization Preference	Description of Mitigation Means
Avoid impact	1st	Alter proposed project (timing, location, or implementation) to avoid injury to biological resources of concern
Minimize impact	2nd	Alter proposed project to minimize injury to biological resources of concern
Rectify the impact	3rd	Replace onsite the biological resources to be disturbed
Compensate for the impact	4th	Replace or protect offsite the biological resources to be disturbed

Mitigation

Commitment: Determine if mitigation is required for the proposed action in accordance with the guidance provided in BRMaP. If so, implement mitigation requirements using the mitigation hierarchy. Implement any needed mitigation via rectification and/or compensation as described in *the Biological Resources Mitigation Strategy*

Implementation Responsibility: All programs/projects responsible for mitigation; Office of Site Services (Hanford Biological Resources Laboratory)

Timeframe: Use of the mitigation hierarchy is most useful if incorporated during the early stages of project planning. Implementation of any necessary mitigation via rectification and/or compensation should commence as soon as the impact is identified or at least soon after the impact occurs.

S.6 Biological Resource Inventory and Monitoring

Inventory and monitoring of biological resources at Hanford are vital management actions for DOE-RL to show that its actions are not resulting in significant adverse cumulative impacts to Hanford's biological resources. Biological resource inventory and monitoring also provide the technical basis for resource management via an ecosystem management approach.

Information on the identity, location, population size, or community distribution of a resource is obtained initially by a field inventory and frequently displayed as resource maps. Inventory work on Hanford's biological resources has been an on-going process. Some plant communities and habitats have been mapped in detail. Information on occurrence and relative abundance also has been collected for some plant and animal species of concern. Additional inventory work needs to be completed for selected locations, habitat classes, and biological components.

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) level to facilitate

Restoration

Commitment: Restore or stabilize human-impacted areas as necessary or when made a requirement under a record of decision or mitigation action plan.

Implementation Responsibility: Relevant program/project

Timeframe: Determine need during the early stages of project planning for remediation, decommissioning, or end of use. Implement restoration or stabilization actions as soon after the completion of remediation or decommissioning as is reasonably possible.

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 at Hanford, coordinate with other biological resource agencies, Tribes, and stakeholders to ensure a comprehensive and regionally consistent set of biodiversity indicator variables is 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 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 Environment, Safety, and Health 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, evaluate, through joint participation of contractor contaminant-monitoring projects at Hanford, 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.

tracking trends in resource size or distribution. Monitoring at Hanford, to date, has been directed at identifying trends in specific species populations to determine impacts from Hanford Site activities or monitoring the status of species of concern to meet legally mandated protection requirements for those species. Besides these traditional monitoring activities, BRMaP outlines strategies for monitoring Hanford's overall ecosystem integrity and for monitoring designated mitigation/restoration areas.

S.7 Landscape Management

Although DOE-RL does not have the authority to directly manage species, it does manage actions and processes that affect multiple species, habitats, and ecosystems. Landscape management activities considered in BRMaP include fire management; habitat fragmentation; landscape-level human activities such as road construction and agriculture; revegetation practices; and administrative control of land areas.

Fire management policy for Hanford's habitats of concern is to minimize the potential for human-caused fires and to aggressively fight fires.

Revegetation on the Hanford Site is an important component of many Site activities, including waste site restoration or interim stabilization and mitigation actions.

Fire Management

Commitments: Create a Hanford fire management policy that relates fire-fighting with biological resource values. The policy will include strategies for protecting biological resources of concern from fire and minimizing the impacts to these resources from fire-fighting techniques.

Implementation Responsibility: Assistant Manager for Engineering and Standards (Hanford Site Fire Department); Office of Site Services (Ecosystem Monitoring Project)

Timeframe: Within 1 year of BRMaP issuance as a final document

The five major types of revegetation actions are: (1) short-term interim stabilization, (2) long-term interim stabilization, (3) habitat improvement via habitat amendment, (4) habitat improvement via reclamation or habitat creation, and (5) landscaping.

Specific goals for managing landscape-level attributes are to maintain all native terrestrial and aquatic resident species at viable population levels, maintain viable representatives of all native plant and animal communities and the functionality of both biotic and abiotic ecosystem processes, and have no adverse impacts on populations of migratory species. Management of landscape attributes

Revegetation Practices

Commitment: Follow protocols for revegetation actions included in BRMaP.

Implementation Responsibility: All programs/projects; Office of Site Services; (Hanford Biological Resources Laboratory); permit holders as applicable

Timeframe: Ongoing

will focus on three classes of management actions: evaluation and management of DOE-RL impacts, status monitoring, and preservation actions. These management actions are implemented in a graded approach that reflects the level of concern for each landscape-level attribute.

Some areas of Hanford have administrative designations with a biological resource protection element. For example, Hanford is one of seven DOE sites established as a National Environmental Research Park that provide a protected area for research demonstrations and education in ecology (DOE 1994). Also, the ALE Unit was designated a Research Natural Area as a result of an interagency federal cooperative agreement (PNL 1993) to serve scientific and educational purposes and act as a baseline for comparison with similar, but intensely managed, areas.

Landscape-Level Attributes

Commitment: Avoid or otherwise minimize fragmentation of Level II, III, and IV habitats/plant communities of concern. Use the graded approach to manage landscape-level attributes.

Implementation Responsibility: Office of Site Services (Hanford Biological Resources Laboratory and Ecosystem Monitoring Project); Assistant Manager for Engineering and Standards

Timeframe: Ongoing

Other administrative designations related to resource protection areas include (1) areas containing rare plant communities (element occurrences), (2) mitigation/restoration areas, (3) collection/propagation areas for native plant materials, (4) lands used under permit and leased properties, and (5) species of concern administrative control areas, which include bald eagle buffer zones, fall chinook salmon spawn locations, ferruginous hawk buffer zones, and plant species of concern (Level III and IV) population locations.

Administrative Designations

Commitments: On the ALE Unit, access is restricted to activities related to research, education, Native American cultural practices, or facility/infrastructure maintenance. Agriculture and domestic livestock grazing are prohibited, except for experimental purposes. Access for mineral and energy resource exploitation is prohibited except for two borrow sites along Route 240. Vehicular traffic off of established roads is expressly prohibited.

Compensatory mitigation areas and their associated habitat improvement areas will be managed as Level IV resources. Onsite rectification and restoration areas will be managed as Level III resources. Mitigation and restoration actions at Hanford specifically intended to replace habitat value will require plant material that is locally derived.

DOE-RL will manage its actions to avoid significant impacts to species of concern within designated administrative control areas

Implementation Responsibility: Office of Site Services (Ecosystem Monitoring Project and Hanford Biological Resources Laboratory); all programs/projects

Timeframe: Ongoing

The portions of the Hanford Site DOE-RL makes available to the U.S. Fish and Wildlife Service under permit are the Wahluke Unit, the Saddle Mountain Unit, and the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit (ALE Unit), which form the Hanford Reach National Monument/Saddle Mountain National Wildlife Refuge. These lands are managed principally to protect their biological resource values. The DOE-RL also leases portions of the Hanford Site for a variety of purposes not related to biological resources management.

Domestic livestock grazing is prohibited on all Hanford lands. Although limited grazing occurred in the past, a recent presidential proclamation

Agriculture

Commitment: DOE-RL will monitor animal populations that are potential agents for damage to nearby agricultural interests and share that information with the USFWS.

Implementation Responsibility: Office of Site Services (Ecosystem Monitoring Project)

Timeframe: Ongoing

(7319, June 9, 2000) established the Hanford Reach National Monument and restricted grazing and off-road vehicle use.

The only current use of the Hanford Site for agriculture occurs on the Wahluke Unit. Agriculture use beyond 2000 will be determined by the USFWS based on management planning for the national monument, which is in progress. The remainder of the Hanford Site is not currently farmed. Permit agreements may place restrictions on additional agricultural practices.

Road/Railroad/Utility Corridor Construction

Commitment: When new roads/railroads/utility corridors are unavoidable, they should be built, as much as possible, through already disturbed areas. No roads/railroads/ utility corridors shall be built through Level IV resource areas. No recreational use of motor-powered off-road vehicles is permitted on the Site. A Hanford Site policy that generally prohibits all off-road driving will be advertised in appropriate Hanford Site publications accessible to Site employees. This policy also will be made available to permit and lease holders.

Implementation Responsibility: Office of Site Services (Hanford Biological Resources Laboratory); Assistant Manager for Engineering and Standards

Timeframe: Ongoing

Because it leads to habitat fragmentation, new road/railroad/utility corridor construction should be avoided. When new roads/railroads/utility corridors are unavoidable, they should be built, as much as possible, through already disturbed areas. No vehicles are permitted off established roads on the Hanford Site unless specifically approved by DOE-RL's Office of Site Services for conducting work activities or if required by an emergency situation.

S.8 Species Management

Species management actions DOE-RL can include integrated pest management, control of species introductions, and some management actions associated with state or federally listed species or recreationally and/or commercially important species. Generally, DOE-RL assists fish and wildlife agencies in species management by providing monitoring data on selected species, conducting impact assessments for individual species of concern, protecting and/or manipulating habitat, and otherwise cooperating with the agencies on fish and wildlife issues of mutual interest.

Management of Some Recreationally and/or Commercially Important Species

Commitment: Continue to monitor the Hanford elk herd to determine effects on habitat and whether dispersal is occurring into other areas of the Site.

Implementation Responsibility: Office of Site Services (Ecosystem Monitoring Project)

Timeframe: Ongoing

The DOE-RL has adopted the use of integrated pest management strategies and methods to control pests at Hanford facilities. Professional pest managers will use information in BRMaP to identify species and habitats of concern that could be impacted by pest control practices and modify their actions accordingly. The control of noxious weeds and other undesirable plants is an important component of integrated pest management and biological resource management in general. The use of appropriate control strategies when plant populations are small and localized is the most cost-effective means of minimizing the impacts of noxious weeds and other undesirable plants to biological resources of concern.

Integrated Pest Management

Commitment: Consult the *Hanford Site Integrated Pest Management Plan* for specific implementation procedures for pest control. Consider the control of noxious weeds and other non-desirable plants, especially when their presence may impact Level IV resource areas.

Implementation Responsibility: Office of Site Services (Hanford Biological Resources Laboratory)

Timeframe: Ongoing

Much of the reduction in Hanford's biodiversity can be attributed to the introduction (mostly unintentional) of non-native species. The continued introduction of non-native species to Hanford could do irreparable harm to both the abundance and diversity of the native flora and fauna.

Specific exceptions to a general prohibition against non-native species introductions are allowed in regard to revegetation practices. Also, in limited circumstances it may be necessary to introduce non-native species for use as biological control agents as part of an integrated pest management strategy.

Species Introduction

Commitment: No non-native plant or animal species will be introduced to the Hanford Site without appropriate authorization.

Implementation Responsibility: Office of Site Services (Hanford Biological Resources Laboratory)

Timeframe: Ongoing

Species requiring special management include all species identified as Level II, III, and IV. Management of these species will focus on three classes of management action: evaluation and management of DOE-RL impacts, species/habitat tracking, and focused enhancement. These management actions

are implemented in a graded approach that reflects the level of concern for each species group. Although Level I species require monitoring, they do not qualify for any additional management attention.

Management of some recreationally and/or commercially important species at Hanford includes fish rearing; deer and elk management; and hunting, fishing, and trapping. Plant and animal species are protected on the ALE Unit, and no hunting or trapping is permitted.

Listed or Otherwise Protected Species Requiring Special Management

Commitment: Use the graded approach to manage Level II, III, and IV species.

Implementation Responsibility: Office of Site Services (Hanford Biological Resources Laboratory and Ecosystem Monitoring Project)

Timeframe: Ongoing

S.9 Biological Resource Data Management

To facilitate biological resource management, procedures are necessary to define how Site floral and faunal survey data are maintained. A primary data base will be maintained that contains up-to-date data on plant, fish, and wildlife species of concern associated with the Hanford Site.

This data base will be maintained by the Hanford Biological Resources Laboratory and will be DOE-RL's official reference source for documenting the occurrence of a particular species on the Hanford Site, its federal and state listing status, and its level of management concern as assigned in BRMaP.

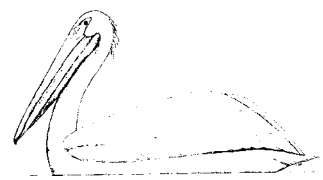
Geographic Information System-based resource maps will be maintained and updated as needed by the Laboratory (industrial areas) and the Ecosystem Monitoring Project (all other resource layers).

Biological Resource Data Management

Commitment: Establish data transfer procedures that will address the appropriate handling of sensitive biological resource data.

Implementation Responsibility: Office of Site Services (Ecosystem Monitoring Project); Assistant Manager for Environmental Restoration and Waste Management (Environmental Restoration Contractor Team data base management staff)

Timeframe: Within 1 year of BRMaP issuance as a final document



Contents

Figures

Tables

1.0

Introduction

The 1450 km^2 (560 mi^2) Hanford Site is part of the Columbia Basin Ecoregion (Daubenmire 1970; Franklin and Dyrness 1973). The ecoregion includes approximately 6 million ha of steppe and shrub-steppe vegetation covering most of central and southeastern Washington State, as well as a portion of northcentral Oregon. A free-flowing stretch of the Columbia River, known as the Hanford Reach, runs through the northern part of the Site and forms part of its eastern boundary (Figure 1.1).

Plant communities found on the Hanford Site are remnants of the original shrub-steppe vegetation. Until 200 years ago, shrubs and native grasses dominated the vegetation of the entire shrub-steppe. As a result of European settlement and extensive land conversion, however, much of the native vegetation has either been altered or eliminated. Because Hanford lands have been protected from human intrusion, they provide much of the remaining sizable acreage of relatively undisturbed shrub-steppe in the state. This undeveloped land provides habitat for native wildlife populations, many of which are diminishing elsewhere in eastern Washington.

As a federal land manager, the U.S. Department of Energy (DOE) is responsible through its Richland Operations Office (DOE-RL) for conserving the biological resources (fish, wildlife, and plant populations and their habitats) of the Hanford Site. The DOE-RL currently manages impacts to threatened and endangered species through a number of separate initiatives, but no previous management strategy considered the overall health of the entire Hanford ecosystem (which includes all aquatic, riparian, and upland habitats and their associated species assemblages). To fill this management void, a comprehensive plan was needed that viewed Hanford's biological resources and their management from both a site- and program-wide perspective.

1.1 Purpose and Scope

The *Hanford Site Biological Resources Management Plan* (BRMaP) was developed to provide DOE-RL and its contractors with a consistent approach to protect biological resources and to monitor, assess, and mitigate impacts to biological resources from Site development and environmental cleanup and restoration activities, as well as approaches to better manage total resources. As a comprehensive plan, BRMaP provides a framework to enable Hanford Site resource professionals to effectively fulfill their responsibilities and to address Tribal, resource agency and other stakeholder concerns about Hanford's biological resources.

The primary purposes of BRMaP are to (1) support DOE-RL's environmental cleanup and other Hanford Site missions; (2) provide DOE-RL with a mechanism for ensuring compliance with those laws that relate to the management of potential impacts to biological resources; (3) provide a framework for ensuring appropriate biological resource management goals, objectives, and strategies are in place to facilitate DOE-RL stewardship of Hanford's biological resources; and (4) implement an ecosystem management approach for biological resources on the Hanford Site.

The BRMaP applies to DOE-RL, its Hanford Site contractors, and permit and lease holders, as appropriate. Plan requirements and/or guidance apply to all DOE-RL programs at all locations within DOE-RL's administrative control. Existing permits and leases may be modified as necessary to meet the management objectives of the plan.

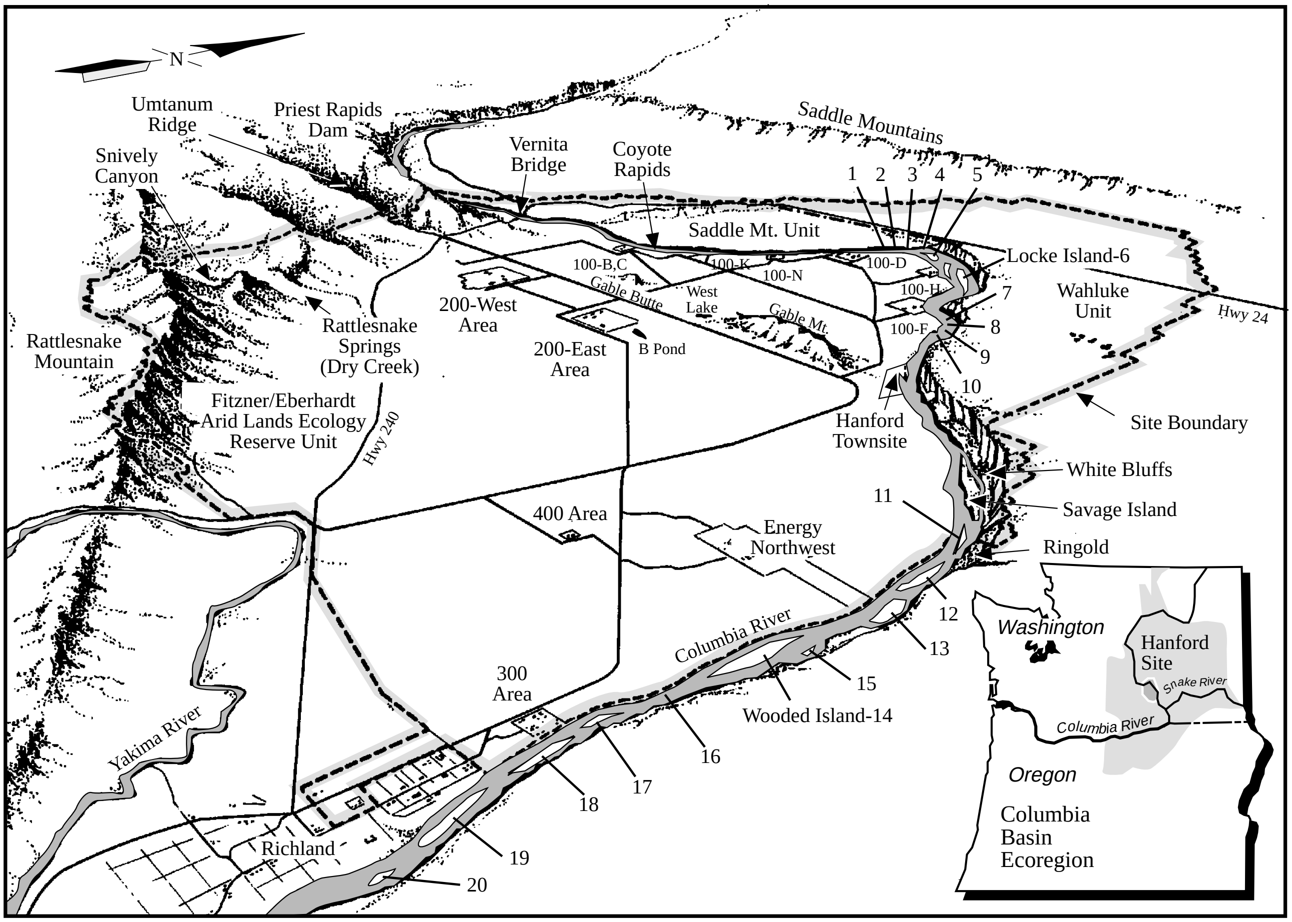


Figure 1.1 Location and Major Features of the Hanford Site Within the Columbia Basin Ecoregion

Because it is more efficient to manage habitats to maintain natural populations than to restore threatened and endangered species, BRMaP focuses on management prescriptions that help ensure threats to habitat—such as direct loss and fragmentation—are addressed in addition to single species concerns. Additionally, BRMaP places a strong emphasis on the benefits of good up-front planning for mitigation and restoration of impacts to Hanford's biological resources. The resource data and management framework that BRMaP provides also can be used to help support a smooth transition to future site uses. As a living document, BRMaP can accommodate changes in the status of the resource base and in DOE-RL missions.

Development of a Hanford Site biological resource management plan is consistent with Secretary of Energy policy (see Chapter 2.0) and with resource management plans developed at other DOE sites. For example, a multi-volume plan was developed to manage habitat and wildlife, among other resources, at the Oak Ridge Reservation. Descriptions of this and other DOE site resource management plans are included in Appendix A.

Scope of BRMaP

The BRMaP:

- describes how biological resources will be managed on the Hanford Site within the greater context of the Columbia Basin Ecoregion.
- identifies resources that require status monitoring, impact assessment, and appropriate mitigation.
- prescribes management levels (e.g., mitigation thresholds) for these resources.

The BRMaP will be reviewed for its ability to meet DOE-RL's biological resource management needs at least every two years and will be updated as needed (e.g., when the status of a particular resource changes, or management prescriptions are modified in response to new findings).

1.2 Relationship to Other Planning Documents

Figure 1.2 shows the relationship of BRMaP to two primary Hanford Site planning documents, the Hanford Mission Plan (issued periodically) and the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)* (DOE 1999), and to other biological resource management documents such as the *Ecological Compliance Assessment Management Plan* (DOE-RL 1995), *Biological Resources Mitigation Strategy* (DOE-RL 1996), and *Integrated Pest Management Plan* (Giddings 1996). As part of total resource management at Hanford, BRMaP also must integrate its management actions with other primary resource management documents, including the *Hanford Cultural Resources Management Plan* (Chatters 1989) and Hanford Groundwater Protection Management Plan.

The BRMaP is intended to provide general, but comprehensive, direction that specifies DOE-RL policies, goals, and objectives relative to different biological resource management concerns and prescribes how such policies, goals, and objectives will be met. Subtier documents, such as the *Ecological Compliance Assessment Management* (DOE-RL 1995) and *Biological Resources Mitigation Strategy* (DOE-RL 1996), outline specific management actions necessary to meet various policies, goals, and objectives (The working relationship of these two subtier documents to BRMaP and to each other is further elucidated in Chapter 5.0.).

The DOE-RL will define its biological resource management policies through BRMaP (see Section 2.2.1). Although the policies provide some general direction as to appropriate uses of Hanford lands and their resources, DOE-RL will use the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)* (DOE 1999) ecosystem-based strategy to manage and control development of Hanford lands and facilities. The Land Use Plan strategy will integrate appropriate biological resource data and biological resource management policies, goals, and objectives from BRMaP with other components dealing with environmental, cultural, economic, and sociopolitical elements. Because preparation of the Land Use Plan includes extensive public participation and stakeholder involvement, it will reflect the final approval process for overall ecosystem management and sustainable development at Hanford.

Although BRMaP addresses specifically only the biological resource management aspects of the Hanford Site's natural and cultural resources for local Tribes, biological resources also may be considered cultural resources. Thus, BRMaP and the *Hanford Cultural Resources Management Plan* (Chatters 1989) need to be fully integrated. The cultural resources plan currently is being revised to be more holistic in its coverage of cultural resources. The revised plan could result in increased Tribal involvement in managing cultural resources at Hanford. This could affect biological resource management under BRMaP.

1.3 Plan Organization and Use

The BRMaP is designed to assist those Hanford Site program and project managers and resource professionals, local Tribes, resource agencies, and other stakeholders who have an interest or a role in the management of Hanford's biological resources. Table 1.1 provides a matrix that can be used to quickly surmise which sections of BRMaP may be of interest to the reader.

Chapter 2.0 provides a brief description of the primary legal drivers for biological resource management, outlines the Site's ecosystem management approach, and identifies DOE-RL's biological resource management policies. Chapter 3.0 describes the roles and responsibilities of DOE-RL and its contractors associated with biological resource management. Chapter 4.0, briefly describes the Columbia Basin Ecoregion, the Hanford Site and its land uses, and the regional and national significance of Hanford's biological resources. How Hanford's biological resources will be managed by associating particular resources with specific levels of management concern also is described.

Chapters 5.0 and 6.0 address particular classes of management actions. Chapter 5.0 outlines impact assessment, mitigation, and restoration. Included in this chapter is a description of the ecological compliance review process. It also describes the mitigation hierarchy and how its efficient and consistent implementation can both protect biological

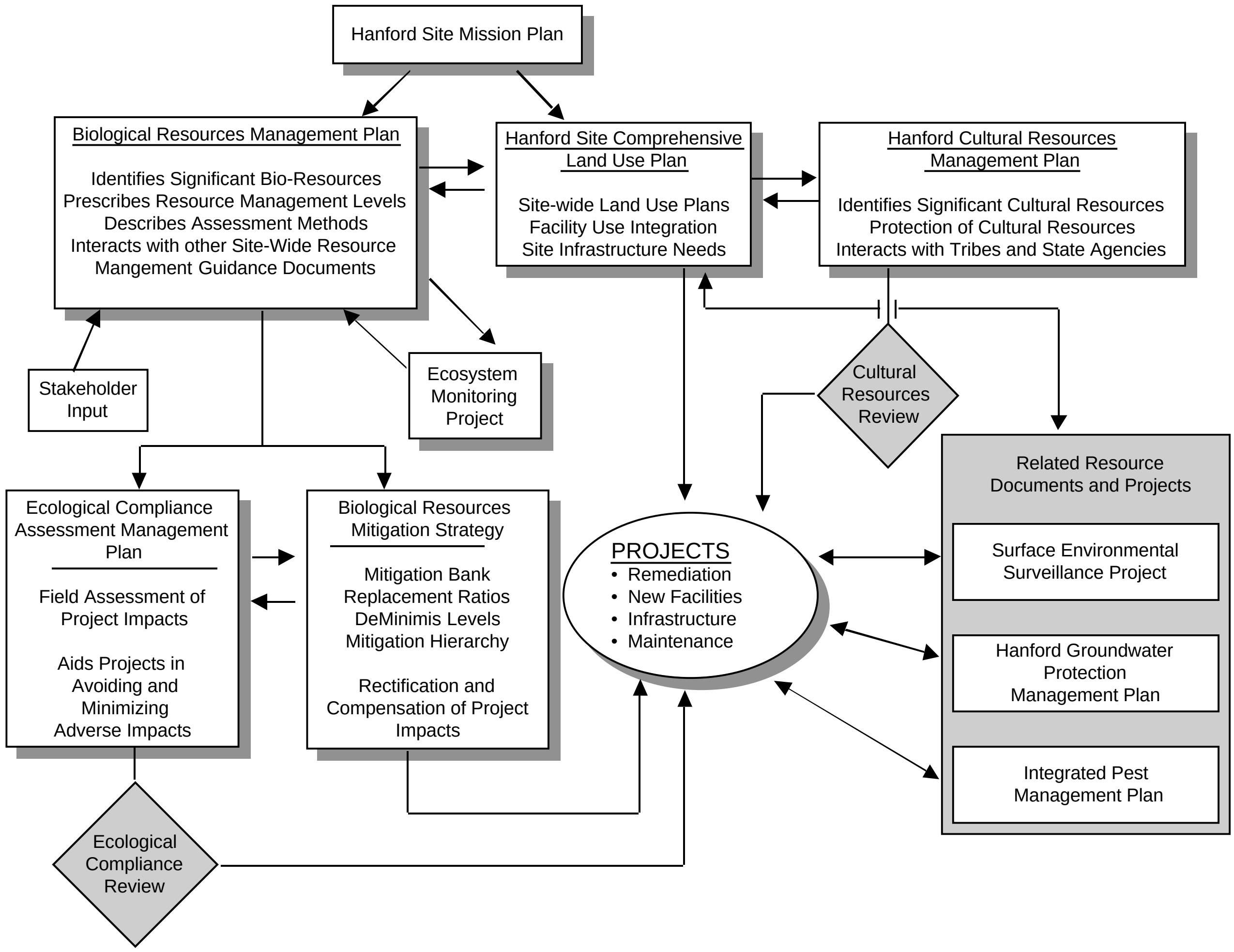


Figure 1.2 Relationship of BRMaP to Other Hanford Site Planning and Resource Management Documents

resource values and minimize long-term mitigation costs. The chapter concludes with a section on restoration.

Monitoring and inventory are discussed in Chapter 6.0. Inventory of biological resources is an ongoing process. Some areas of the Site and certain taxa have been studied intensively, but for other biological resources significant data gaps remain. Monitoring is a repetitive survey process that tracks the status and condition of the resource.

Chapters 7.0 and 8.0 outline management prescriptions for two different levels of the biodiversity hierarchy, landscape management and species management. Landscape management addresses actions and processes that affect multiple species, habitats, and ecosystems. Chapter 7.0 addresses such topics as fire management, revegetation practices, and administrative control areas. Chapter 8.0 focuses on management actions that generally involve single species or class of species concerns, including integrated pest management, listed or otherwise protected species management, and recreationally and/or commercially important species management.

Chapter 9.0 describes biological resource data management, including the types of biological resource data that need to be maintained and procedures for transfer of data to onsite and offsite users. References are included in Chapter 10.0 and a glossary of technical terms in Chapter 11.0.

Most detailed technical information is included in Appendices A-E. Appendix A provides an in-depth review of ecosystem management policy, principles, and implementation as they apply to the Hanford Site and DOE-RL. It also reviews natural resource management activities at other DOE sites. A review of the laws, regulations, Executive Orders, and policies that potentially affect the management of Hanford's biological resources is included in Appendix B. Readers who want to know about the regional context of Hanford's biological

Table 1.1 Matrix of BRMaP Sections and User Categories[a]

BRMaP Section	DOE-RL/Contractor Program and Project Managers	DOE-RL Natural Resource Team and Contractor Resource Professionals	Tribes and Resource Agencies	Other Stakeholders
Executive Summary	X	X	X	X
1.0	X	X	X	X
2.0	X	X	X	X
3.0	X	X		
4.0	4.3	X	X	X
5.0	X	X	X	
6.0	6.4.4	X	X	X
7.0	7.2, 7.4, & 7.7	X	X	X
8.0	8.1	X	X	X
9.0		X		
10.0		X	X	X
11.0	X	X	X	X
Appendix A	A.1 & A.4	X	X	
Appendix B	X	X	X	
Appendix C		X	X	
Appendix D		X	X	X
Appendix E		X	X	

[a] X = entire section may be useful to the reader; specific section referenced = only the specifically identified section is anticipated to be useful to the reader.

resources and their significance can find this information in Appendix C. Most GIS-based resource maps provided in BRMaP and their technical basis are included in Appendix D. Appendix D also includes data tables and background information on species of concern. Appendix E identifies information needs required for more effective implementation of ecosystem management at Hanford.

2.0

Biological Resource Management at Hanford

This chapter provides an overview of the primary legal requirements that affect biological resource management decisions at Hanford, as well as the concept and policy implications of ecosystem management. Within the context of Executive Branch, Department, and Richland Operations Office ecosystem management policy directives, it also defines DOE-RL's specific biological resource management policies and goals at Hanford. The policies have been developed based on the goals, principles, and tools of ecosystem management and legal requirements. Further discussion of ecosystem management and the laws, regulations, Executive Orders, and policies that potentially affect how biological resources are managed at Hanford is included in Appendices A and B, respectively.

2.1 Legal Requirements

Several substantive and procedural legal requirements have a major effect in determining how biological resources should be managed at Hanford. The following four federal Acts provide a strong impetus for a comprehensive approach to biological resource management at Hanford:

- **National Environmental Policy Act (NEPA)** states it is the policy of the federal government to create and maintain conditions under which people and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. The Act says the federal government is responsible for using all practicable means to: (1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations, (2) attain the widest range of beneficial uses of the environment without degradation, and (3) preserve important natural aspects of the nation's heritage.
- **Endangered Species Act (ESA)** provides for designation and protection of wildlife, fish, and plant species in danger of becoming extinct because of natural or human-made factors and for the conservation of the ecosystems on which these species depend. The Act makes it illegal to kill, collect, remove, harass, import, export, or conduct interstate or international commerce in an endangered or threatened species without a permit from the Secretary of the Interior. The Act requires all federal agencies to use their authorities to carry out programs that conserve endangered or threatened species.
- **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)** provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment as well as the remediation of inactive hazardous waste disposal sites.
- **Migratory Bird Treaty Act (MBTA)** prohibits hunting, taking, killing, capturing, or possessing migratory birds (or any part, nest, or egg of such a bird) except as authorized by regulation or in accordance with a permit. The U.S. Fish and Wildlife Service designates those species that qualify as migratory birds under the Act and administers the permit system.
- **Presidential Proclamation 7319 of June 19, 2000,** established the Hanford Reach National Monument. The proclamation specifies several environmental protection-related management requirements. Section 2 of the American Antiquities Act of June 8, 1906 (34 Stat. 225, 16 U.S.C. 431), authorized the president, in his discretion, to declare by public proclamation historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest that

are situated upon the lands owned or controlled by the government of the United States to be national monuments, and to reserve as part thereof parcels of land, the limits of which in all cases shall be confined to the smallest area compatible with the proper care and management of the objects to be protected.

2.2 Ecosystem Management

Ecosystem management (or an ecosystem approach) can be defined as a process that "... integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term" (Grumbine 1994).

It is the Department's policy to strengthen the stewardship of DOE lands. To facilitate accomplishing this policy initiative, the Department has embraced the ecosystem management approach. The Land and Facility Use Policy issued by the Secretary states:

> It is Department of Energy policy to manage all of its land and facilities as valuable national resources. Our stewardship will be based on the *principles of ecosystem management* (emphasis added) and sustainable development. We will integrate mission, economic, ecological, social and cultural factors in a comprehensive plan for each site that will guide land and facility use decisions. Each comprehensive plan will consider the site's larger regional context and be developed with stakeholder participation. This policy will result in land and facility uses which support the Department's critical missions, stimulate the economy, and protect the environment.[1]

The DOE also has indicated its support for a more holistic approach to natural resource management by becoming a signatory to a Memorandum of Understanding, along with 13 other federal agencies, that fosters an ecosystem [management] approach.[2] The policy portion of the Memorandum of Understanding states:

> The federal government should provide leadership in and cooperate with activities that foster the ecosystem approach to natural resource management, protection, and assistance. Federal agencies should ensure that they utilize their authorities in a way that facilitates, and does not pose barriers to, the ecosystem approach. Consistent with their assigned missions, federal agencies should administer their programs in a manner that is sensitive to the needs and rights of landowners, local communities, and the public, and should work with them to achieve common goals.

The DOE-RL approach to ecosystem management, related to biological resources management at Hanford, involves the following elements (these are described more fully in Appendix A):

- defining the goal of ecosystem management
- identifying principles that guide how the goal is attained
- formulating management tools that will enable successful implementation of ecosystem management at Hanford.

To provide a policy basis for the ecosystem management approach at Hanford, DOE-RL has established a broad biological resources protection policy. This policy states:

> It is the policy of the Department of Energy Richland Operations Office to be responsible stewards of the natural environment on the Hanford Site. The Richland Operations Office will work with its contractors, resource agencies, stakeholders, and the Indian Tribes to preserve or enhance the biological resources under its stewardship in a manner that is consistent with the principles of ecosystem management and sustainable development.

2.2.1 Hanford's Biological Resources Management Policies

Based on legal requirements, the ecosystem management approach, and its own broad biological resources protection policy directive, DOE-RL also has developed a more specific set of policies for biological resource management at Hanford as shown in the box on the next page.

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1 Memorandum from H. R. O'Leary, Secretary of Energy, to Secretarial Officers and Operations Office Managers, December 21, 1994, Land and Facility Use Policy.

2 Memorandum of Understanding to Foster the Ecosystem Approach, dated December 15, 1995. See Appendix A for the list of signatories.

DOE-RL Biological Resources Management Policies

DOE-RL will:

- act to preserve and enhance the biological resources under its stewardship as valuable national resources
- ensure biological resource values are considered by all programs in all actions conducted on DOE-RL's behalf consistent with applicable treaties, laws, regulations, and obligations as a natural resource trustee
- endeavor to enhance throughout the Hanford complex an awareness of and appreciation for biological resource values and their preservation, restoration, and enhancement
- integrate biological resource management goals and administrative procedures into relevant program- and project-level activities to ensure potential adverse impacts to biological resources are avoided or minimized
- integrate biological resource information into land and facility use plans to ensure broad-scale land use planning and specific site-selection decisions consider biological resource values, apply ecosystem management principles, and minimize cumulative impacts to biological resources
- incorporate ecosystem management principles and tools into the program (project) planning process to facilitate meeting biological resource management goals and objectives while minimizing impacts to program (project) budgets and schedules
- adopt recommendations of the Council on Environmental Quality to incorporate biodiversity considerations into environmental impact analysis under NEPA (CEQ 1993)
- mitigate, as necessary, adverse impacts to biological resources that may result from current and future Hanford activities in a manner commensurate with the value of the resource and the severity of the impact
- as the Lead Response Agency at Hanford under the National Contingency Plan, conduct response activities (i.e., removal or remedial actions) cost effectively that avoid or minimize adverse impacts to biological resources
- cooperate with federal and state resource agencies to ensure a cost-effective yet adequate information baseline on resource status is maintained for Hanford's biological resources within a bioregional context
- coordinate with other governmental agencies and stakeholders, as applicable, on biological resource management issues in an open and cooperative manner.

2.2.2 Hanford's Biological Resources Management Goals

Biological resources management goals can be used to formulate specific resource management objectives that relate to measurable outcomes for managed resources. To accomplish each objective, specific actions to be taken and monitoring necessary to evaluate success need to be clearly defined. The following are DOE-RL's biological resource management goals:

1. Continue on an as-needed basis the process of inventorying the biological resources of the Hanford Site and relate their occurrence, abundance, and distribution to their status within the Columbia Basin Ecoregion. Maintain an up-to-date data base of inventory results.
2. Preserve Hanford's *native* biological diversity (terrestrial and aquatic) and the ecological processes that sustain it within a bioregional context. At the same time, support human needs, including the DOE-RL mission. Secondary goals [from Grumbine (1994)] include maintaining viable populations of all native species and representatives of all native ecosystem types across their natural range of variation.
3. Establish consistent and effective requirements, guidelines, and procedures for the program- and site-wide management of biological resources at Hanford.
4. Identify Hanford's biological resources of concern that require status monitoring, impact assessment, and appropriate mitigation.
5. Expand the focus of biological resource management from threatened and endangered species and their critical habitat needs to recognize that a broader array of fish, wildlife, plants, and habitats are of value. Focus increased management attention on the overall integrity of the Hanford ecosystem and its connection to the surrounding landscape versus managing single species or small areas.
6. Preserve and enhance ecosystem integrity by managing biological resources at a scale commensurate with the scale of the natural processes that sustain them; protecting communities, ecosystems, and landscapes to ensure protection for a large number of species and their interrelationships; managing to maintain evolutionary and ecological processes; minimizing

fragmentation by promoting the natural pattern and connectivity of habitats; restoring degraded resources to enhance ecosystem integrity; avoiding introduction of non-native species and minimizing further expansion of currently present non-native species into native communities; protecting rare and ecologically important species and unique or sensitive environments; maintaining or mimicing naturally occurring structural diversity; monitoring ecosystem integrity; and acknowledging uncertainty [derived in part from CEQ (1993) and Grumbine (1994)].

7. Establish focused objectives for biological resource information needs to support both resource management and the Hanford mission.

3.0

Roles and Responsibilities

Effective implementation of the BRMaP requires that the roles and responsibilities be well defined within DOE-RL, as well as within each of its contractors. General roles and responsibilities for each of these organizations or groups are described in the following sections. Figure 3.1 depicts the broad overall relationships.

3.1 Department of Energy—Richland Operations Office

The DOE-RL has numerous responsibilities concerning biological resource management. As Figure 3.1 indicates, ultimate decisions on Department policy regarding management of Hanford's biological resources is vested with the manager, Richland Operations Office. The Office of Site Services, however, plays a key role in developing such policy and in overseeing its implementation across the Site. Ownership of the BRMaP lies with this office.

Cross-programmatic responsibilities include adhering to the biological resource policy statements outlined in Section 2.2.1. In addition to these broad DOE-RL responsibilities, each program manager is responsible for applying the provisions of these policies to each site, facility, or project under their responsibility and for coordinating with their respective contractors to ensure that project planning and funding will support, as appropriate, DOE-RL's policy objectives. This will ensure that biological resource protection measures are applied consistently site-wide.

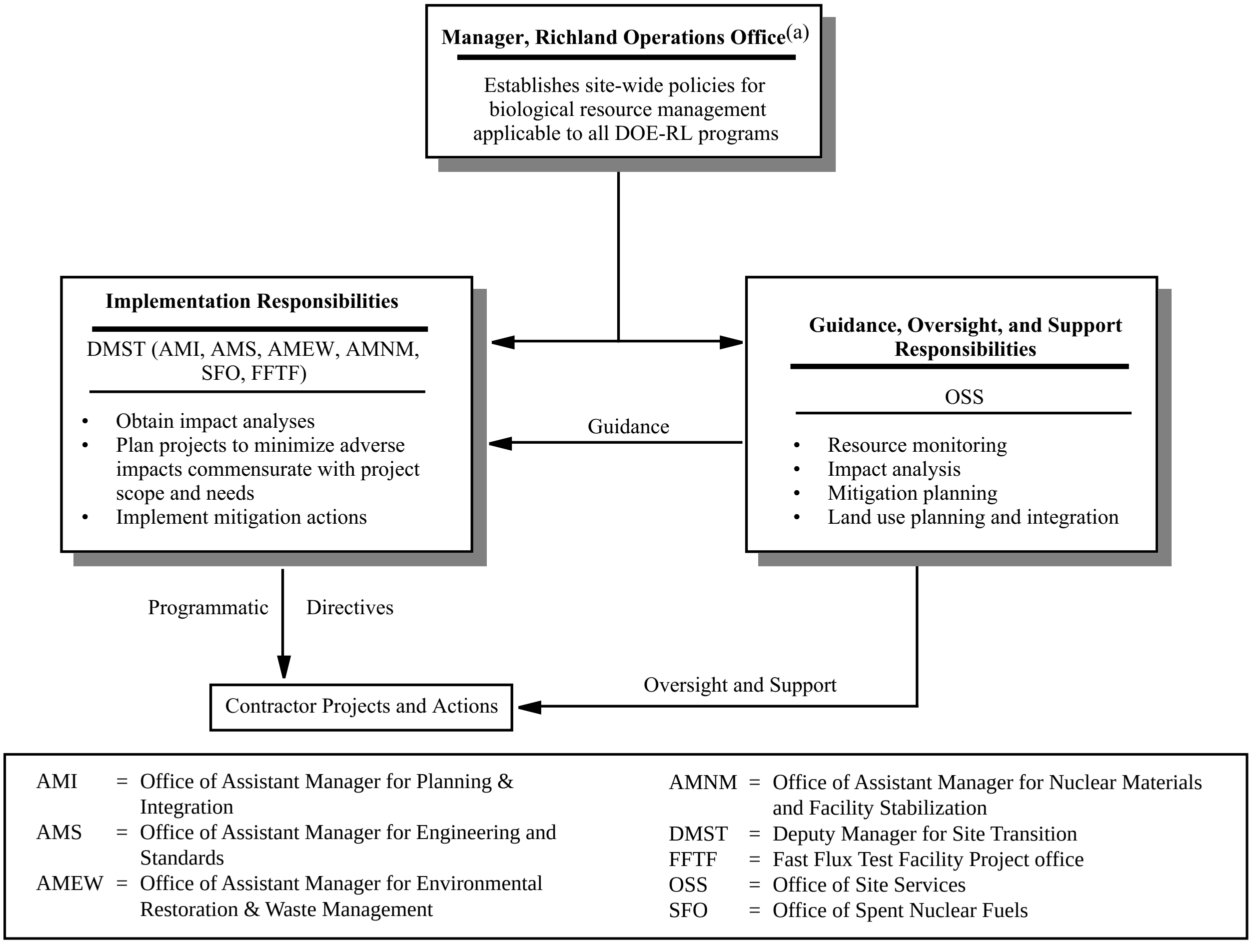
Specific roles assigned to various offices and programs within DOE-RL are outlined in the following sections.

3.1.1 Office of Site Services

As part of its biological resources management activities, the DOE-RL's Office of Site Services[1] will:

- take the lead in defining Hanford's ecosystem management approach to biological resource management
- work with the Site Management Board to continually update DOE-RL's biological resource policies, as appropriate
- provide assistance and oversight to the DOE-RL programs/contractors on interpreting the requirements and guidance found in BRMaP (see Section 3.1.4)
- track the performance of contractor projects that implement monitoring and impact assessment activities
- provide guidance on mitigation threshold determinations and track the results of mitigation actions as they affect Hanford's biological resources
- track annual reporting on mitigation action plans
- track through its Office of Performance Evaluation the overall implementation effectiveness of BRMaP, especially as it relates to the consistent

[1] Point-of-contact responsibilities will be handled by staff of the Resource Protection and Analytical Services Team.



(a) Office of River Protection has parallel responsibilities.

Figure 3.1 Roles and Responsibilities

application of BRMaP's guidance by DOE-RL programs and Hanford contractors

- review BRMaP's ability to meet DOE-RL's biological resource management needs at least every two years and determine when updates to the BRMaP are necessary to reflect new information or changes in management methods
- act as DOE-RL's point-of-contact for forming ecosystem management partnerships with outside organizations.
- coordinate to use the biological resource information present in the BRMaP to identify to the programs those resource areas where resource protection is the prime consideration and development is not allowed (Level IV resources) and those resource areas where development is permissible, but residual adverse impacts to biological resources will require appropriate mitigation (Level III resources)
- consider and incorporate biological resource values and management strategies in all site project and construction planning to ensure appropriate mitigation actions are taken when biological resources of concern (Levels II-IV) may be adversely impacted
- early in the project planning process, identify any potential adverse impacts to resources of concern that may result from site development activities
- coordinate with the U.S. Fish and Wildlife Service (USFWS) to ensure USFWS management of DOE-owned property is consistent with biological resource management policies.

3.1.2 Deputy Manager for Site Transition

The Office of the Deputy Manager for Site Transition, as part of its responsibilities for biological resources management on the Hanford Site, will:

- consider and incorporate biological resource values and management strategies into the early phases of both remedial actions and new facility projects to ensure appropriate mitigation actions are taken when biological resources of concern (Levels II-IV) may be adversely impacted
- early in the project planning process under NEPA or CERCLA, identify to the Office of Site Services any potential adverse impacts to resources of concern that may result from program activities.

3.1.3 Natural Resources Working Group

To assist the Office of Site Services Resource Protection and Analytical Services Team in providing assistance and oversight support to DOE-RL programs/contractors, resolving technical issues associated with BRMaP implementation, and determining when updates to BRMaP are necessary, a DOE-RL/contractor Natural Resources Working Group is established. The working group will be composed of staff representatives from the Natural Resources Trustee Council and resource professionals from the Hanford Site contractors. The working group will meet at least quarterly to address any significant problems of BRMaP implementation and new resource management issues. Each of the DOE-RL programs and their contractor representatives will be invited to send representatives to these meetings, as needed, to voice their concerns or to seek additional guidance.

3.2 Contractors

The requirements in BRMaP will be applied to Hanford Site contractors as necessary. Contractors will be expected to consider the guidance that is present within BRMaP relative to biological resource management. Also, as a general principle, Hanford contractors will be expected to incorporate biological resource values and management strategies into the early phases of their project planning as requirements are incorporated into their contracts. Existing contracts may be modified as necessary to meet DOE-RL's biological resource management responsibilities and objectives.

3.3 Permit and Lease Holders

Several entities use land on Hanford under permit or lease with DOE-RL. Existing permits and leases may be modified as necessary to meet DOE-RL's biological resource management responsibilities and objectives.

4.0

Hanford's Biological Resources: Management by Level of Concern

This chapter provides a brief overview of Hanford's biological resources within a regional context, summarizes land uses at Hanford, and outlines DOE-RL's approach to biological resource management. For a more detailed description of Hanford's biological resources and their significance, refer to Appendices C and D.

4.1 Biological Resources

The Hanford Site is located within the Columbia Basin Ecoregion, an area that historically included over 6 million ha (14.8 million acres) of steppe and shrub-steppe vegetation across most of central and southeastern Washington State (Franklin and Dyrness 1973) as well as portions of northcentral Oregon. The current Hanford Site occupies about 1450 km^2 (about 560 m^2) at the approximate center of the ecoregion (see Figure 1.1). Besides shrub-steppe, Hanford also encompasses significant aquatic resources. A free-flowing stretch of the Columbia River, the Hanford Reach, bisects the Site.

The steppe and shrub-steppe communities of the Columbia Basin Ecoregion have undergone substantial loss or degradation in the post-European era that can be attributed primarily to human-induced change (Dobler 1992; Noss et al. 1995). Within Washington alone, approximately 60% of what was historically present has been lost (Dobler 1992), primarily to agriculture. Much of what remains is either already degraded and fragmented or is threatened by development and agricultural expansion; thus, Noss et al. (1995) recently concluded that:

- native shrub- and grassland-steppe [steppe in which the shrubs are not the most conspicuous part of the flora] within Washington and Oregon is an endangered ecosystem, in that it has experienced between an 85% to 98% decline since European settlement.
- ungrazed sagebrush-steppe in the Intermountain West is a critically endangered ecosystem, in that it has experienced greater than a 98% decline since European settlement.

Use of Hanford for the production of defense nuclear materials has protected much of the Site from industrial development, agriculture, and livestock grazing (Gray and Becker 1993; Gray and Rickard 1989). Because of this, the Hanford Site retains the largest remaining blocks of relatively undisturbed shrub-steppe in the Columbia Basin Ecoregion (Smith 1994). Additionally, the Site's diversity of physical features has led to a corresponding diversity of plant communities and associated fauna (TNC 1995, 1996, and 1998). Although the Hanford Site's biological resources are characteristic of the Columbia Basin Ecoregion, Hanford retains some of its own uniqueness. It is located within the driest and hottest portion of the ecoregion (Franklin and Dyrness 1973). Although this may result in unique species assemblages relative to the rest of the ecoregion, these extreme conditions also make the Hanford shrub-steppe a fragile ecosystem that is easily disturbed and not readily restored. Finally, because of its location, Hanford also provides opportunities for creating connectivity with other portions of the ecoregion, such as with the Yakima Training Center.

The rarity and decline in quality of shrub-steppe affects individual species. A number of these species depend on shrub-steppe habitats for at least a portion of their life cycle. Many, such as the sage grouse (*Centrocercus urophasianus*) and pygmy rabbit (*Brachylagus idahoensis*), have experienced population declines in Washington. Additionally, several shrub-steppe species that may occur on Hanford are already listed species or are candidates for state protection such as the ferruginous hawk (*Buteo regalis*), loggerhead shrike (*Lanius ludovicianus*), sage sparrow (*Amphispiza belli*), striped whipsnake (*Masticophis taeniatus*), and Columbia milk-vetch (*Astragalus columbianus*).

In addition to shrub-steppe habitat, the Hanford Site contains significant riparian, wetland, and aquatic habitats associated with the Hanford Reach of the Columbia River. The Reach represents the last free-flowing stretch of the Columbia in the United States. As such, it contains native riparian habitat, free-flowing riffles, gravel bars, oxbow ponds, and backwater sloughs that are otherwise limited in occurrence on the Columbia River (USFWS 1980; NPS 1994). In 1980, the U.S. Fish and Wildlife Service (USFWS) inventoried exceptional fish and wildlife habitats within the state of Washington. Based on USFWS criteria of nationally significant and unique ecosystems, the Hanford Reach of the Columbia River ranked second in the state (USFWS 1980). Also, the ecological importance of the Hanford Reach and the land north and east of the Columbia River (Wahluke or North Slope) has contributed, in large measure, to a recent determination that these areas should be permanently protected (65 FR 37253).

The destruction of other spawning grounds by dams in the Columbia River and its tributaries also has increased the relative importance of the Hanford Reach for spawning by such species as fall chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*O. mykiss*). The Hanford Reach also supplies significant breeding habitat for several resident fish and wildlife species of concern such as the white sturgeon (*Acipenser transmontanus*) and Columbia pebblesnail (*Fluminicola columbiana*). Many of the Washington State populations of the state endangered Columbia yellowcress (*Rorippa columbiae*) occur in scattered locations along the wet shoreline of the Reach (Downs et al. 1993). The federal and state threatened bald eagle (*Haliaeetus leucocephalus*) rests and forages along the Reach during its overwinter stay. Finally, several species of recreational importance such as the Canada goose (*Branta canadensis*), and other waterfowl, also use this stretch of the river, its islands, and riparian corridor for portions of their life cycle.

Other riparian and wetland areas not directly associated with the Hanford Reach are scattered across the Hanford Site. These areas include a mix of small, naturally occurring cold-desert springs and streams, artificial wetlands created by irrigation runoff (north of the Columbia River), and a variety of temporary water bodies attributed to waste-water discharges (Neitzel 1999; Downs et al. 1993). The springs and streams and their associated vegetation are especially important for providing water, forage, cover, and breeding sites within the dry-land portions of the Hanford Site (Downs et al. 1993). The presence of riparian and wetland areas also is important because of the increased habitat diversity they provide.

The Hanford Site also contains a diversity of other rare terrestrial habitats such as riverine islands, bluffs/cliffs, basalt outcrops, and sand dunes (Downs et al. 1993). Sand dunes, especially, have received little investigation, and could contain several faunal and floral species of concern.

In 1994, The Nature Conservancy (TNC) of Washington, in cooperation with DOE-RL, implemented a detailed inventory of Hanford's biodiversity on the ALE Unit and the North Slope. The goal of the inventory was to identify and map occurrences of native plant communities, rare plant populations, and certain animal taxa over large areas of the Hanford Site. The need for such a study was described by TNC as follows (TNC 1995):

> The DOE needs an accurate account of the rare species and ecosystems present on the Hanford Site in order to make informed decisions about future land uses....Biological studies undertaken in the past at Hanford have been primarily project- or species-specific. These studies have contributed enormously to the body of knowledge on Hanford, but have not included a large-scale, detailed inventory of the rare species and ecosystems present on the Site.

TNC conducted biological inventories of the Site in 1994, 1995, and 1997. Results of these inventories are informative as to the nature of Hanford's biodiversity (TNC 1995, 1996, 1998, 1999). Highlights include: (1) documentation of 48 plant community element occurrences of 17 terrestrial elements (community types); (2) 6 element occurrences of wetland/aquatic communities; (3) 112 populations of 28 rare plant taxa, 2 species

The Nature Conservancy

The Nature Conservancy (TNC) is an international, private non-profit conservation organization with more than 800,000 members nationwide and almost 34,000 in Washington State alone. The Conservancy uses the best science available and works in a non-confrontational, market-oriented fashion. In 1992, DOE and TNC entered into a Memorandum of Understanding that called for a cooperative and coordinated inventory of plants, animals, and ecologically significant areas on the Hanford Site. In 1994, DOE awarded TNC a grant, and the Conservancy raised private funds to support the inventory effort. A team of approximately 20 TNC scientists collected inventory data on the Site from 1994 to 1997. Previous biological studies conducted on the Site have been primarily project- or species-specific and did not include a comprehensive detailed inventory of rare species and ecosystems occurring on Hanford. Therefore, the primary objective of the TNC/DOE Hanford Biodiversity Inventory was to fill critical gaps in knowledge of the biology of the Site and to provide this information to decision-makers.

and 1 variety new to science; (4) 1121 taxa of invertebrates, 40 species and 2 subspecies new to science; (5) 368 butterfly and moth taxa; (6) 3 species of amphibians; (7) 9 species of reptiles; (8) approximately 200 species of birds; and (9) 16 mammal species.

Because the inventories focused on specific taxa and geographic areas, these results provide only a partial picture of Hanford's potential biodiversity (TNC 1995, 1996, and 1998). In assessing the relevance of their findings TNC concluded (TNC 1998):

> From a conservation standpoint, the Hanford Site is a vital—and perhaps the single most important—link in preserving and sustaining the biodiversity of the Columbia Basin's shrub-steppe region.

As a result of the importance of Hanford's biological resources outlined in the preceding paragraphs, the Site's biological resources (fish, wildlife, and plant populations and their habitats) have state, regional, and national significance. This recognition is not new. For example, the entire Site is designated a National Environmental Research Park by DOE (DOE 1994). This designation reflects Hanford's importance in providing a "protected area for research demonstrations and education in ecology" (PNL 1977). Also, the ALE Unit is designated a Research Natural Area. This federal designation is based on the ALE Unit's ability to provide opportunities for researchers, students, and educators to study and observe a relatively large and undisturbed ecosystem in which natural processes are retained (PNL 1993). The Research Natural Area designation also supports the state of Washington's Natural Heritage Plan (e.g., by providing a protected area for rare plant communities) (WDNR 1995).

4.2 Hanford Site Land Uses

Before 1943, the recent land-use history of the Hanford Site related principally to livestock ranching, farm homesteads, and small supply and grain shipment towns (Gerber 1992). The consequences of some of these land uses are still apparent today as, for example, the abandoned town sites and old fields along the Columbia River. These areas today are composed mostly of non-native plant species that will probably not recover to a native composition without manipulation. Other areas that were grazed either retain a mix of native and non-native plant species or, if not intensively grazed, still closely resemble the original native plant communities. Even the ALE Unit experienced historic land uses (i.e., 1880-1940), such as homesteading, winter/spring sheep grazing, gas wells, and road building (Hinds and Rogers 1991). These historical non-DOE land uses also must be considered in understanding the ecological context of the Hanford Site.

The Hanford Site was created in 1943 in response to the nation's defense needs during World War II. Over its 50 years of operation Hanford's mission has been a combination of energy-related research and military-related material production, the apportionment of which depended on the nation's changing defense needs (Becker 1990).

Hanford's initial mission was to produce plutonium for use in fabricating nuclear weapons. Plutonium production involved construction and operation of eight single-pass nuclear reactors, one dual-purpose nuclear reactor, and associated ancillary facilities along the Columbia River (100 Areas); fuel reprocessing and waste management facilities in the central plateau region of the Site (200 Areas); fuel fabrication and research facilities north of the city of Richland and along the Columbia River (300 Area); and support facilities north of the city of Richland but inland (1100 Area) (Figure 4.1). Throughout much of their early operating history, the 100 and 300 Areas also were used for waste management activities. All combined, the 100, 200, and 300 Areas occupy about 28.5 km^2 (11 mi^2) (Neitzel 1999). A concise and informative summary of Hanford's history is provided by Gray and Becker (1993). Gerber (1992) provides a more detailed overview.

The Site also contains within its boundaries several other facilities and land areas mostly unrelated to Hanford's defense mission. The Fast Flux Test Facility (currently deactivated) is located in the 400 Area to the northwest of the 300 Area. The 600 Area includes all other land areas not previously described. These lands are mostly undeveloped; however, they do include an active commercial nuclear reactor that is operated by Energy Northwest, formerly the Washington Public Power Supply System [along with two unfinished commercial reactor complexes this site occupies about 4.4 km^2 (1.7 mi^2) of land], a commercial, low-level radioactive-waste burial facility operated by US Ecology on 0.4 km^2 (0.15 mi^2) of state of Washington leased land south of the 200 Areas, and the Laser Interferometer Gravitational-Wave Observatory west of Route 10. The state also owns 2.6 km^2 (1.0 mi^2) of land just north of state Highway 240 and southeast of the 200 Areas that was acquired as a potential site for disposal of nonradioactive hazardous waste. (Above area estimates are from Neitzel 1999.) A few hazardous and mixed waste burial sites are scattered throughout the 600 Area. A network of roads, railroads, and electrical transmission lines connect the various building complexes on Hanford.

Three land areas within the 600 Area are managed by the USFWS principally for their ecological values: The ALE Unit—a 310 km^2 (120 mi^2) area of relatively undisturbed shrub-steppe habitat southwest of state Highway 240—the 130 km^2 (50 mi^2) Saddle Mountain Unit, managed as a national monument/National Wildlife Refuge, and the 225 km^2 (87 mi^2) Wahluke Unit.

Two other wildlife areas abut the Hanford Site: the Rattlesnake Slope Wildlife Area (managed by the WDFW) and the McNary National Wildlife Refuge (managed by the USFWS), which includes some of the islands of the Columbia River north of Richland (Neitzel 1999). Other than these small resource management areas, much of the land surrounding Hanford is used for agriculture.

Scattered parcels throughout much of the Hanford Site are Bureau of Land Management withdrawn lands that have been transferred to the control of DOE-RL. Additionally, there are Bureau of Reclamation parcels on the North Slope that DOE-RL uses under a Memorandum of Agreement with Reclamation.[1] Reclamation retains the right to construct, operate, and maintain the irrigation infrastructure on these parcels.

In summary, much of Hanford remains undeveloped though portions of it have been affected by historic and ongoing land use. In contrast, much of the land surrounding Hanford has been converted to human use. Biological resource management strategies need to account for the intensity, areal extent, and distribution of land-use practices at Hanford and within the surrounding region.

4.3 Levels of Concern

The DOE-RL's approach to biological resource management is management by level of concern. This approach associates different management actions (i.e., monitoring, impact assessment, mitigation, and preservation) with particular sets of biological resources. Specific management requirements, however, do not apply equally to all species and habitats present on the Hanford Site. For example, disturbed areas with high proportions of non-native plant species do not warrant the same management consideration as certain native plant communities that are rare throughout the remainder of the ecoregion.

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[1] Memorandum of Agreement between the Bureau of Reclamation and the then-Atomic Energy Commission in regard to the transfer of rights for certain acquired and withdrawn lands on the Wahluke (North) Slope, dated February 27, 1957.

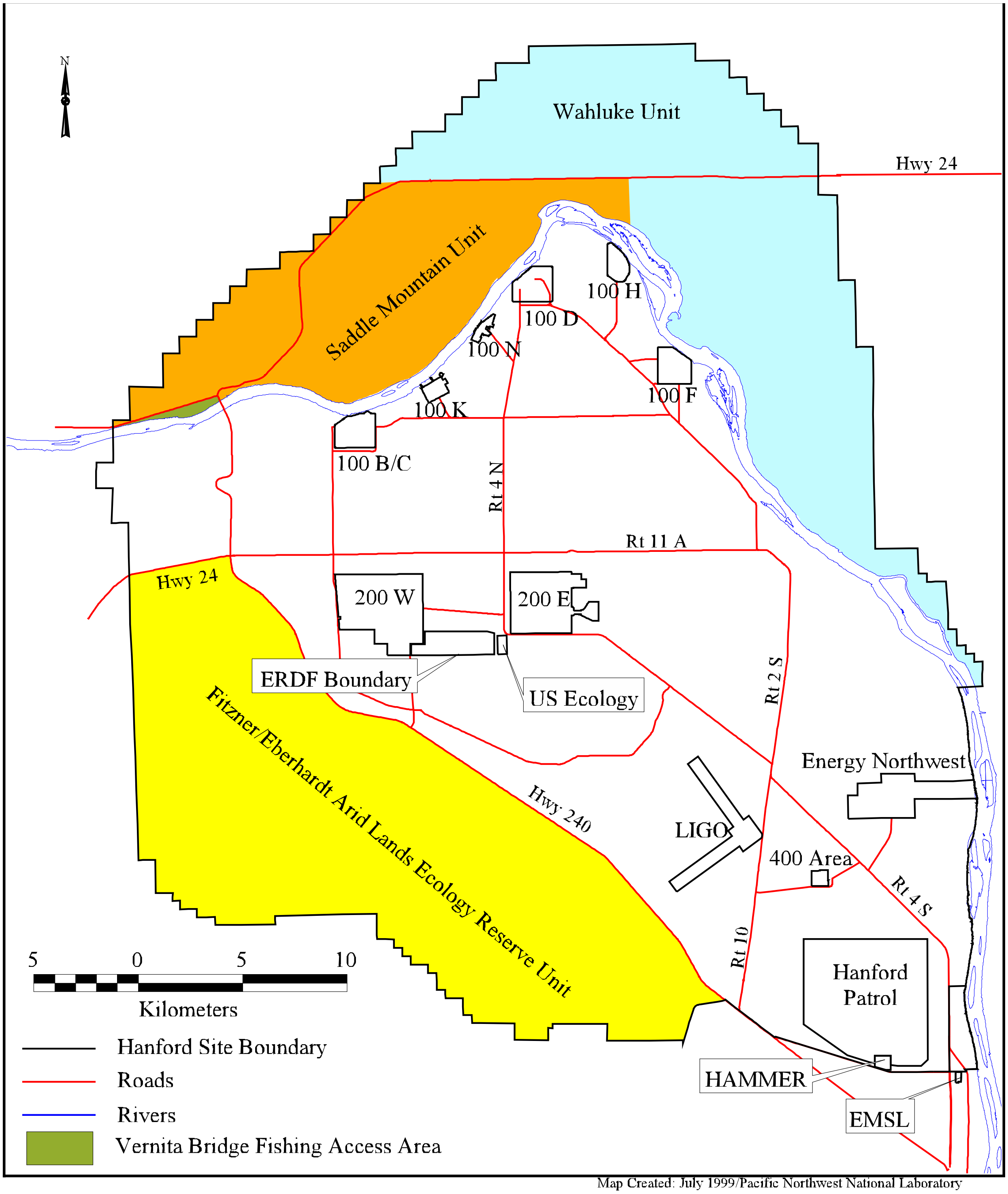


Figure 4.1 Major Land-Use Features of the Hanford Site (ERDF = Environmental Restoration Disposal Facility, LIGO = Laser Interferometer Gravitational-Wave Observatory, HAMMER = Hazardous Materials Management and Emergency Response Training Center, EMSL = Environmental Molecular Sciences Laboratory)

To address these differences in resource "value," DOE-RL's management approach classifies Hanford biological resources into four levels of management concern (Figure 4.2). These four levels define biological resources that are considered to have "value" and deserve some degree of management attention reflecting that value. Each level (I-IV) corresponds to a different set of management actions required to be taken in regard to the biological resources at that level. Table 4.1 summarizes management actions at each level. At higher levels of concern (e.g., Level IV), the associated biological resources are of higher value, and the number of applicable management actions are greater and more restrictive. A particular biological resource is associated with only one level of management concern.

4.3.1 Definition of Levels

The four levels described in the following subsections include only those biological resources considered to have "value." Resources not included within these levels of concern either do not qualify for focused management attention or represent undesirable biological resources (e.g., noxious weeds) that may negatively impact biological resources of concern. Section 4.4 addresses these latter kinds of biological resources.

Level I—Level I biological resources are those that—because of their recreational, commercial, or ecological role or previous protection status—require at a minimum some level of status monitoring at Hanford:

- recreational—includes resources of consumptive and nonconsumptive recreational value
- commercial—includes resources whose harvest and sale is legally permitted
- ecological—includes resources that serve as indicators of either human-induced environmental impacts or changes in ecosystem processes
- previously considered for protection—once considered a rare or vulnerable species/habitat/plant community but now considered more abundant and/or less vulnerable to adverse impacts than previously assumed.

The recreational/commercial and ecological resources defined at Level I generally do not include similar resources otherwise addressed at a higher level of concern.

Level II—Level II biological resources are those that—to show compliance with procedural and substantive laws such as NEPA, CERCLA, and the Migratory Bird Treaty Act—require consideration of potential adverse impacts from Hanford Site actions. For the most part mitigation of Level II resources is appropriately accomplished by avoidance and impact minimization. However, in some cases where Level II resources fall into the category

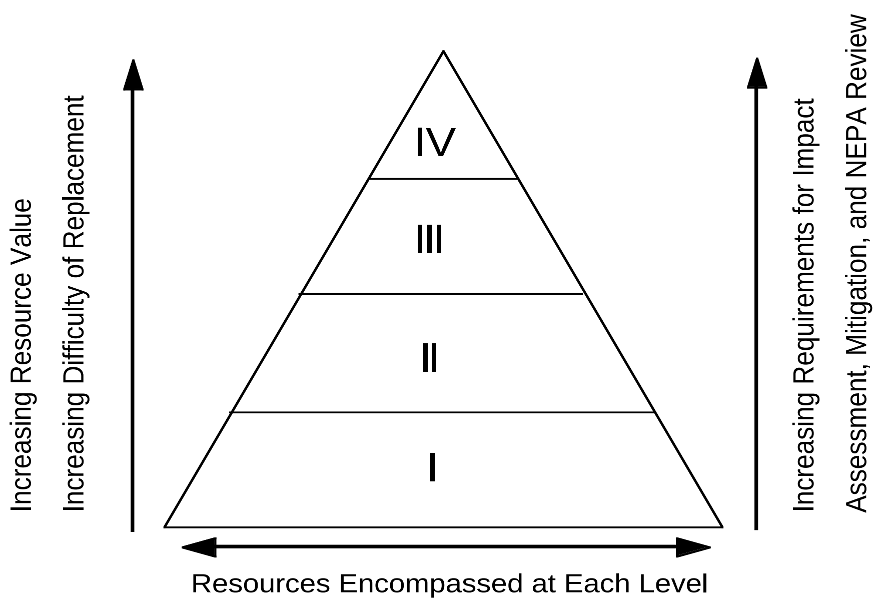


Figure 4.2 Classification of Biological Resources by Levels of Concern

Table 4.1 Classes of Management Actions and the Biological Resource Levels of Concern at Which They Apply

Class of Management Actions	Resource Level of Concern at Which the Management Action is Applicable			
	I	II	III	IV
Status monitoring	Yes	Yes	Yes	Yes
Impact assessment	No	Yes	Yes	Yes
Mitigation via avoidance/ minimization	No	Yes	Yes	Yes
Mitigation via rectification/ compensation	No	No	Yes	Yes[a]
Minimum NEPA analysis required	CX	CX	EA	EA

[a] Rectification is probably not possible nor an appropriate means of mitigation at this level; compensation can be used but only when it is achieved by acquisition and/or protection of in-kind resources (cf. USFWS Mitigation Policy at 46 FR 7644). CX = categorical exclusion; EA = environmental assessment.

of recovering shrub steppe habitat, and field surveys of the affected area confirm that sagebrush (the shrub component) recovery is well underway, then mitigation via rectification or compensation is recommended and the final decision should be made on a project by project basis. The basis for such action being that if site reviews indicate that the area is recovering such that a reclassification of the area to a Level III resource appears likely in the near future, then such areas have both actual and potential habitat value that exceeds what would normally be considered Level II, but has not yet achieved Level III status.

Level III—Level III biological resources—because of their state listing, potential for federal or state listing, unique or significant value for plant, fish or wildlife species, special administrative designation, or environmental sensitivity—require mitigation. Impacts to Level III resources should be avoided or minimized; however, when avoidance and minimization are not possible or their application still results in adverse residual impacts above a specified threshold value, mitigation by rectification and/or compensation is required. Maintenance of Level III resource values now may preclude possibly more restrictive and costly management prescriptions in the future.

Level IV—Level IV biological resources—because of their federally protected legal status or their regional and national significance—justify preservation as the primary management option. Typically, the plant communities and habitats that are defined to belong to this level are of such high quality (i.e., they show little or no indication of human impact or invasion by non-native species, or they have significant wildlife usage) and/or rarity they cannot be mitigated unless it is by compensatory mitigation via acquisition and protection of in-kind resources (in the few instances in which in-kind replacement resources off of Hanford may be available).

The legally protected species that are included in Level IV cannot be impacted without the concurrence of the U.S. Fish and Wildlife Service, in accordance with applicable regulations, that such impacts do not jeopardize the continued existence of the species.

For biological resources included at Level III or IV, any potential for adverse impacts from a planned Site action would preclude qualification for a categorical exclusion under DOE's NEPA Implementing Procedures and Guidance (10 CFR 1021, Appendix B to Subpart D) for that action. This analysis of an action's potential impact would then be either an environmental assessment, an environmental impact statement, or an equivalent CERCLA review incorporating NEPA values consistent with the Secretary of Energy's policy statement.[2]

Biological resources that also may be cultural resources of concern to local Native American are generally not separately identified (fall chinook salmon is an exception). Many biological resources of concern to Tribes already may be included in different levels of management concern based on other criteria. The DOE-RL will coordinate with the local Tribes to determine whether additional biological resources of concern to the Tribes need to be identified and whether particular resources deserve consideration at a different level of management concern.

Specific management actions that are part of the definition of a particular resource level generally apply to the higher value resource levels of concern. For example, although resources requiring status monitoring is part of the definition of Level I resources, Table 4.1 indicates that monitoring as a management action applies to all four resource levels.

Biological resources are defined by a (1) species category, or by (2) either a landscape-level attribute (e.g., plant communities or habitats as defined by their usage by plant, fish, or wildlife species) or administrative designation. The following subsections describe levels of concern by these categories.

4.3.2 Levels Defined by Species Categories

Table 4.2 shows the relationship between species categories and levels of concern. If a species can be classified at more than one level, the classification resulting in the highest level of concern is used to define the species. Table 4.2 does not address WDFW priority species as a separate category, but all these species occurring at Hanford have been accounted for in the table.

Not all species important from a resource management perspective are addressed under a narrowly defined concept of species of concern that considers only listing status. Thus, BRMaP includes—in addition to state and federal listed species and candidates for such listing—migratory birds, Washington State priority and monitor species, and ecologically important species as species of concern (i.e., deserving of some amount of management attention). As an example, resource Level of Concern I includes two species categories that are non-legal/administrative designations: recreationally/commercially important and ecologically important species. Thus, species important to society or ecologically as harbingers of environmental change are considered by DOE-RL to warrant management attention.

Appendix D provides a tentative list of these species and a rationale for their selection. Detailed information relative to resource level, listing status, and habitat associations also are provided by taxa in Appendix D for each applicable species.

Table 4.3 summarizes Level III and IV species categories. A proposed action that may result in an adverse impact to a species—or its habitat—that is identified as a Level III or IV resource cannot be accomplished under a categorical exclusion. Through the BRMaP, DOE-RL has added several species categories not currently included for such consideration under 10 CFR 1021. These are:

- Washington State candidate species
- Washington State sensitive species
- fall chinook salmon.

Overall, DOE-RL's NEPA policy addresses not only currently listed threatened or endangered species but extends agency concern to other species of concern in an attempt to minimize impacts to these additional species and, by this strategy, to preclude the need for their eventual listing. Section 5.1 identifies threshold criteria for when an impact can be considered adverse.

To assess the number of species potentially requiring some level of management attention, data were combined by taxa (Table 4.4). The numbers include, for taxa affected, those additional species identified as recreationally/commercially or ecologically important.

The numbers are conservative in that not all species included have been documented to currently exist

[2] Memorandum from H. R. O'Leary (Secretary of Energy) to secretarial officers and heads of field elements: "Secretarial Policy Statement on the National Environmental Policy Act," June 13, 1994.

Table 4.2 Relationship Between Species Categories and Resource Levels of Concern

Species Category	Resource Level of Concern at Which the Species Category is Included			
	I	II	III	IV
Recreationally/ commercially important	X			
Ecologically important	X			
WA state monitor	Watch list species	Plant review groups 1 and 2; fish and wildlife monitor species		
Migratory birds		X		
WA state candidate			X	
WA state sensitive			X	
WA state threatened			X	
WA state endangered			X	
Federal candidate[a]	Former candidate		Candidate	
Fall chinook salmon				X
Federal proposed				X
Federal threatened				X
Federal endangered				X

[a] On February 28, 1996, the USFWS redefined the candidate category (61 FR 7595). The new definition of candidate is equivalent to the previous candidate category 1 definition. The USFWS dropped candidate categories 2 and 3 and will rely on state resource agencies and Natural Heritage programs to track the status of the species previously contained therein. The BRMaP retains the identity of the former category 2 and 3 species applicable to Hanford, as well as Hanford area species recently removed from category 1 (i.e., candidate) status (61 FR 7457), by identifying them as "former candidates." See Appendix D for additional details.

Table 4.3 Species Categories for Which the Minimum NEPA Analysis of Potential Adverse Impacts is an Environmental Assessment (Level III and IV Species)

Federally Listed	State Listed	Other
Endangered	Endangered	Fall chinook salmon[a]
Threatened	Threatened	
Proposed	Sensitive[a]	
Candidate	Candidate[a]	

[a] These categories are in addition to those identified by 10 CFR 1021 (DOE NEPA Implementing Procedures and Guidelines).

Table 4.4 Summary of Numbers of Species Per Taxa Potentially Found on or Near the Hanford Site and Assigned Resource Level of Concern

Taxa	Resource Level of Concern			
	I	II	III	IV
Plants	10	4	19	0
Terrestrial invertebrates	1[a]	9	3	0
Aquatic invertebrates	6[a]	0	3	0
Fish	10	4	1	2
Amphibians	1	1	0	0
Reptiles	2	2	1	0
Birds	2	86	14	3
Mammals	6	9	4	0
Totals	38	115	45	5

[a] Some of these represent a higher taxonomic grouping of species and not necessarily individual species.

at Hanford. This conservatism has two bases. First, the numbers include some species that historically were present at Hanford and are now extirpated. Because suitable habitat may still be present on Hanford for these species, Hanford represents a possible reintroduction location for these species. Second, a number of species, though not currently known to exist at Hanford, have documented distributions near Hanford. Because the inventory of Hanford's biodiversity is incomplete, those species that have a reasonable expectation of occurring at Hanford are included.

The data in Table 4.4 are summarized from information provided for individual species in Appendix D. Data for species new to science or new to Washington State are not included as final determinations on listing status have yet to be made. Appendix D also includes information on the status of knowledge about a species' occurrence at Hanford.

4.3.3 Levels Defined by Landscape-Level Attribute or Administrative Designation

To foster an ecosystem management approach, it is necessary to move beyond single species concerns—to the landscape level—to identify biological resources that deserve management attention. To accomplish this requires, among other things, a consideration of rare plant communities, habitats that are important fish and wildlife usage areas, landscape-level processes, and areas administratively established to protect biological resource values.

This was done for the Hanford Site by developing map layers from data that represent each of these attributes using a Geographic Information System (GIS). Map layers were developed from existing information on the Columbia Basin Ecoregion. Although complete information does not yet exist, it is important to look at Hanford's biological resources in the context of the ecoregion and the status of the resources therein. Table 4.5 shows how each GIS-based map layer relates to the resource levels of concern. These layers are briefly described below for each resource level of concern. Appendix D provides a more detailed explanation of each map layer.

Habitat (Plant, Fish, or Wildlife Usage-Based) Map Layers—Habitat is the combination of abiotic and biotic components that provides the ecological support system for plant and animal populations. The map layers described in this section define habitats important to the viability of plant, fish, and wildlife species of concern.

Table 4.5 Landscape Attribute, Administrative Area, and Species-Based GIS Data Layers Versus Resource Level of Concern

Landscape Attribute or Species Category	Resource Level of Concern at Which the GIS-Based Data Layer is Included		
	II	III	IV
Habitat (plant, fish, or wetland wildlife usage based)	Habitats of concern: early-successional habitats	Habitats of concern: late-successional and riparian habitats Wetlands and associated deepwater habitats 100-year floodplain Late-successional sagebrush-steppe habitat	Rare habitats (includes terrestrial and aquatic ecosystem element occurrences)
Habitat (plant community-based)			Terrestrial element occurrences
Administrative area designation		Fitzner/Eberhardt Arid Lands Ecology Reserve Unit Wahluke Unit Saddle Mountain Unit Areas designated as onsite habitat restoration or rectification areas under a record of decision, mitigation action plan, or as part of a proposed NEPA action	Areas designated as compensatory mitigation/habitat improvement areas under a record of decision, mitigation action plan, or as part of a proposed NEPA action
Species-based		Plant species of concern population location Ferruginous hawk historic nest locations Bald eagle perch and secondary night roost locations	Bald eagle primary night roost and attempted nest locations Fall chinook salmon spawning areas

A map layer showing habitats of concern was derived from habitats identified as having high fish or wildlife usage value or as being important havens for populations of plant species of concern. Two additional data layers represent sensitive resource areas: wetlands and floodplains. Management attention to their importance arises in part from DOE policy and by the rarity and fragility of their associated resources within the Columbia Basin Ecoregion.

The wetlands and associated deepwater habitat data layer are based on National Wetlands Inventory data from the USFWS. The data complement data used to prepare the Hanford land cover map (see Appendix D).

The map layer depicting high-quality, late-successional sagebrush-steppe habitat is based on a model of habitat association for the sage sparrow, a state candidate and sagebrush-steppe obligate species. This map layer focuses on big sagebrush-steppe as one component of late-successional shrub-steppe. Late successional shrub-steppe has been emphasized in BRMaP because recent past fires have removed significant portions of similar habitat, and remaining habitat is at risk because of the potential for land conversion on the central plateau of Hanford (an area that contains extensive blocks of late-successional shrub-steppe, principally sagebrush-steppe).

Geographic Information System

A Geographic Information System (GIS) is used to analyze land features and create maps depicting spatial data. Geographic Information System is a generic term for software that enables researchers to construct and present multiple map layers. A map layer is a single class feature of an area such as roads, elevation contours, or soil types. Sources of information used to create these map layers include: (1) remotely sensed images, such as those acquired by satellite; (2) electronic versions of maps, such as those from the U.S. Geological Survey (USGS); or (3) data collected from field surveys using a Global Positioning System (GPS) to acquire geographical coordinates. Using GIS software, we can overlay individual map layers to create a visual representation of the area or analyze the intersection of the layers. For example, an overlay of an elevation and vegetation map could be used to show elevation preferences by certain vegetation classes. GIS maps can be either vector or raster based. A vector map is composed of lines that, when connected, form polygons. A raster map depicts an area like a checkerboard in which the grid size depends on the data source. Many raster map layers are from satellite or spectral data sources.

On the Hanford Site, map data are collected for many purposes, from delineating political boundaries to determining the extent of rare plant communities. Map layers for BRMaP came from existing map layers available from the Hanford GIS or the USGS, as well as from recent field surveys of the site conducted by PNNL and TNC. Several GIS software packages were used to produce maps for BRMaP, including GRASS (U.S. Army CERL), ERDAS (ERDAS, Inc.), and MapGrafix (ComGrafix, Inc.). These maps were then transferred to the Hanford GIS operated by Bechtel Hanford and are available in the ArcView (ERSI, Inc.) GIS.

With one exception, all the preceding map layers describe biological resources that qualify as at least Level III resources of concern (based on other criteria, some of these resources will qualify as Level IV); that is, resources that require mitigation by rectification and/or compensation when avoidance and minimization are not possible or significant impacts still remain after their application. The integrity of Level III resource values can be protected and costs reduced by avoiding impacts and minimizing mitigation, thereby eliminating the need for rectification and/or compensation.

The one exception, alluded to in the preceding paragraph, involves early-successional habitats that without further field verification are assumed to be intermediate in regard to habitat quality (i.e., they may contain areas that are dominated by non-native plant species). These early-successional habitats represent Level II resources: avoidance and/or minimization of potential impacts is appropriate but additional mitigation actions are not required.

One final map layer included in this category addresses rare habitats. Rare habitats are those habitats important for plant, fish, or wildlife species but that have low availability throughout the ecoregion. Six kinds of rare habitat occur at Hanford: basalt outcrops, cliffs (White Bluffs), desert streams, upland springs, Columbia River sloughs, and Columbia River islands. Other rare habitats may exist, such as riverine deepwater sites; however, data are not yet available to describe their occurrence and distribution. Rare habitats are considered a Level IV resource (i.e., resources that are essentially impossible to replace if lost). As such, management attention should focus on their protection as avoidance is generally the only feasible means of mitigation.

Habitat (Plant Community-Based) Map Layer—One way of assessing the condition of an ecosystem is by determining the extent to which its component plant communities retain their native species composition. Plant communities that have mostly native composition are indicative of healthy communities that are capable of sustaining associated native animal populations. In 1997, TNC surveyed the plant communities of the ALE Unit and the North Slope (TNC 1995). In 1997, TNC completed plant community surveys for central Hanford (TNC 1998). Each plant community [or element as defined by Washington Department of Natural Resources, Natural Heritage Program (WDNR 1995)] was evaluated by TNC as to its present condition, size, and proximity to disturbance vectors (e.g., livestock grazing). Natural Heritage Program reviewed The TNC's evaluation of plant communities that qualified as potential element occurrences (i.e., a high-quality representative of a native plant community type). Less than one percent in terms of the total acreage of potential element occurrences identified by TNC (TNC 1995) were determined by the Natural Heritage Program to not qualify as element occurrences.[3] All possible element occurrences on the Hanford Site are not included as the TNC surveys did not include the central core (i.e., that portion of the Hanford Site exclusive of the ALE Unit and the North Slope). Because they represent rare high-quality resources that generally lack protection, Hanford's element occurrences are considered Level IV resources. Element occurrences represent a subset of the habitats of concern map layer.

Administrative Area Designation Map Layer—The administrative areas included in this data layer are included under the assumption that their designations were meant to establish the perpetuation of biological resource values, among other values, as one of their top priorities. These areas are no impact zones or at least areas within which significant impacts to biological resources of concern (i.e., Levels III and IV) should be fully mitigated.[4] These areas include: the ALE Unit, Saddle Mountain Unit, and Wahluke Unit.

Species-Based Map Layers—Most species-level resource management concerns can be addressed by appropriate habitat-based management. Some species of concern, however, still require focused management attention. These include species that have specific legal protections (e.g., bald eagle); species that use a limited number of locations to carry out a portion of their life cycle, such as ferruginous hawks (restricted to a limited number of available nest platforms) or fall chinook salmon (restricted to a limited number of spawning sites within the Hanford Reach); and species that have a restricted distribution at Hanford, such as populations of different level III plant species of concern (that may occur only in specific locations).

Five species-based map layers were developed to address these species of concern (Individual map layers are provided in Appendix D.). The first two layers represent Level III resources. The first layer, the documented locations of populations of Level III plant species of concern, probably represents an incomplete data set as the entire Hanford Site has yet to be surveyed. The second layer shows the locations of ferruginous hawk historic nest locations, as well as bald eagle perch and secondary night roost locations.

The next two map layers represent Level IV resources. Bald eagle use areas are given formal protection in accordance with DOE's *Bald Eagle Site Management Plan* (Fitzner and Weiss 1994). The depicted areas include six primary night roost locations and an attempted eagle nesting area (A second attempted eagle nesting area, first occupied in 1996, overlaps one of the primary night roost locations.). The management plan was prepared via informal consultation with the U.S. Fish and Wildlife Service in accordance with the requirements of the Endangered Species Act. Fall chinook salmon are an important part of the Pacific Northwest and local Native American cultural as well as biological heritage. The Hanford Reach of the Columbia River represents the only significant mainstem spawning habitat remaining for upriver bright stocks of fall chinook salmon (Dauble and Watson 1990). The map layer shows the general locations of the major fall chinook salmon and steelhead spawning areas within the Hanford Reach.

Supporting Map Layers—A number of GIS-based map layers provide information to support and supplement the resource-level layers described above. These are:

- land cover map of the Columbia Basin Ecoregion
- land cover map of the Hanford Site and immediate surrounding areas

3 Element occurrences represent rare remnants of Washington's natural diversity. The priority the Natural Heritage Program assigns them for protection depend on the element's rarity, the degree of threat to which it is exposed, and the adequacy of protection by existing land management (WDNR 1995). Of the 32 elements that qualified as element occurrences on the ALE Unit and the North Slope, only two are considered adequately protected (WDNR 1995). Additional element occurrences were added along the Hanford Reach during 1995 by TNC surveys (TNC 1996), on the ALE Unit and the North Slope during 1996 by Natural Heritage Program surveys, and within central Hanford in 1997 (TNC 1998).

4 Administratively designated areas of Hanford represent special categories of environmentally sensitive resources [10 CFR 1021: Appendix B to Subpart D, Section B(4) and, as such, are areas within which mitigation for impacts to biological resources (beyond avoidance/minimization) may be appropriate.

- map of potential habitat improvement areas on the Hanford Site
- Hanford Biological Resources Laboratory (previously the Ecological Compliance Assessment Project) baseline survey maps.

The land cover map of the Columbia Basin Ecoregion provides the context for establishing the importance of Hanford's biological resources at the ecoregion level. The ecoregion map provided in Appendix C is based on data obtained from the Interior Columbia Basin Ecosystem Management Project. The Hanford land cover map is the base map for the Site. It provides the initial data layer for determining the areal extent and distribution of habitat and plant community based resources. The base map combines information on land cover from 1987 and 1991 aerial photography and TNC inventory data for the Hanford Site. As such, the land-cover class designations used are a compromise between different approaches to land cover class estimation that make the best use of the most recent available data and still provide a useful map.

The Hanford Biological Resources Laboratory baseline survey maps (updated annually) are a more refined land cover mapping of the industrial areas of the Hanford Site (i.e., 100, 200, 300, and 400 Areas). The same cover classes are defined as on the land cover base map. Thus, habitats or cover classes that are indicated as being of concern for the entire Site can be shown in greater detail in those areas where the need for impact management is greatest. For these maps, sighting information of individual species of concern also is included.

4.3.4 Composite Data Layers and Landscape Considerations

Composite data layer maps were developed from the individual data layers described in Section 4.3.3. These composites represent concise GIS-based summaries of biological data at a landscape scale. These data layers can be used to make land-use and environmental cleanup decisions that are intended to avoid adverse impacts to biological resources. Composite maps for Level III and IV biological resources are described in the following pages.

Figure 4.3 shows the Level II resources which include early successional sagebrush steppe habitats where sagebrush cover has been reduced or removed by fire. This designation also includes land cover types not dominated by sagebrush and not in good enough condition to be classed as Level III or IV.

Level II resources, though somewhat scattered across the Hanford Site, dominate the southeast portion of the Site.

Level III Biological Resources—Figure 4.4 shows habitat-based and species-based resources as a composite of the following individual map layers:

- habitats of concern map (minus the early-successional cover classes)
- 100-year floodplain map
- Level III plant species of concern approximate locations
- ferruginous hawk historic nest locations with 1 km buffer zones
- bald eagle perch and secondary night roost locations.

Individual map layers for these resources are included in Appendix D. The 100-year floodplain map was added to the habitats of concern map because it resulted in a wider corridor along the Hanford Reach that qualified as Level III resources than depicted by the habitats of concern map.[5] Because the habitats of concern map contains a more recent, though not as well-refined mapping

[5] The habitats of concern map uses two land cover classes to delineate the river corridor: (1) riparian, and (2) riverine wetlands and associated deepwater habitats. These cover classes were mapped at a river flow condition less than what occurs during the 100-yr dam-regulated flood. Thus, the 100-yr floodplain encompasses more area lateral to the ordinary high water mark than do the two cover classes used in the habitat of concern map. Unfortunately, the relevance of the 100-yr floodplain is somewhat arbitrary from a biological perspective. Executive Order 11988, "Floodplain Management," establishes the 100-yr floodplain as the regulatory floodplain of concern relative to restoring and preserving the natural values served by floodplains. Consequently, the 100-yr floodplain could be liberal or conservative in regard to protecting ecological processes that occur under high flow conditions on the Hanford Reach (e.g., flushing of sloughs). In the absence of specific information on the cause and effect relationship between river flow rates and ecological processes, the BRMaP relies on the regulatory floodplain of concern to protect biological resource values.

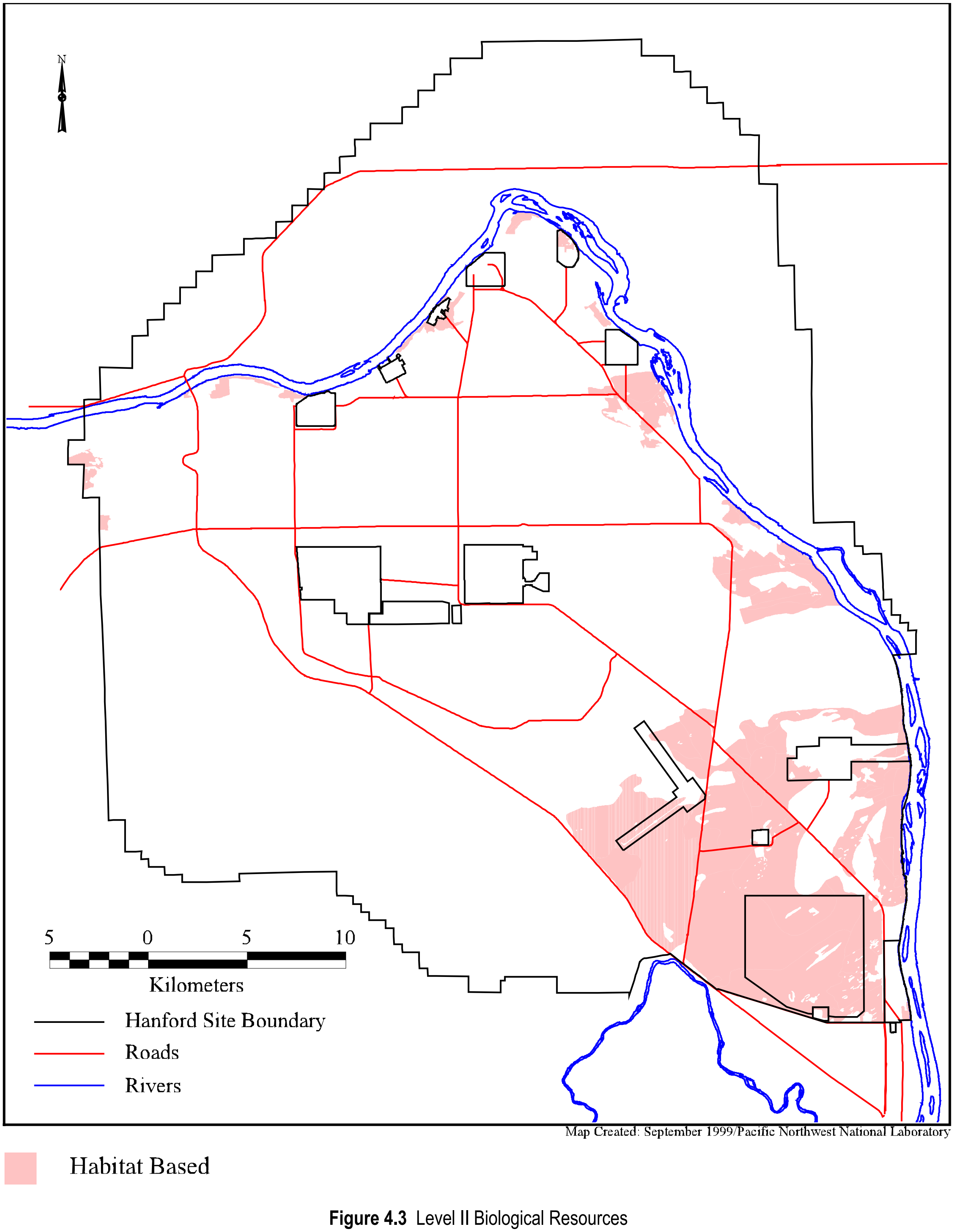


Figure 4.3 Level II Biological Resources

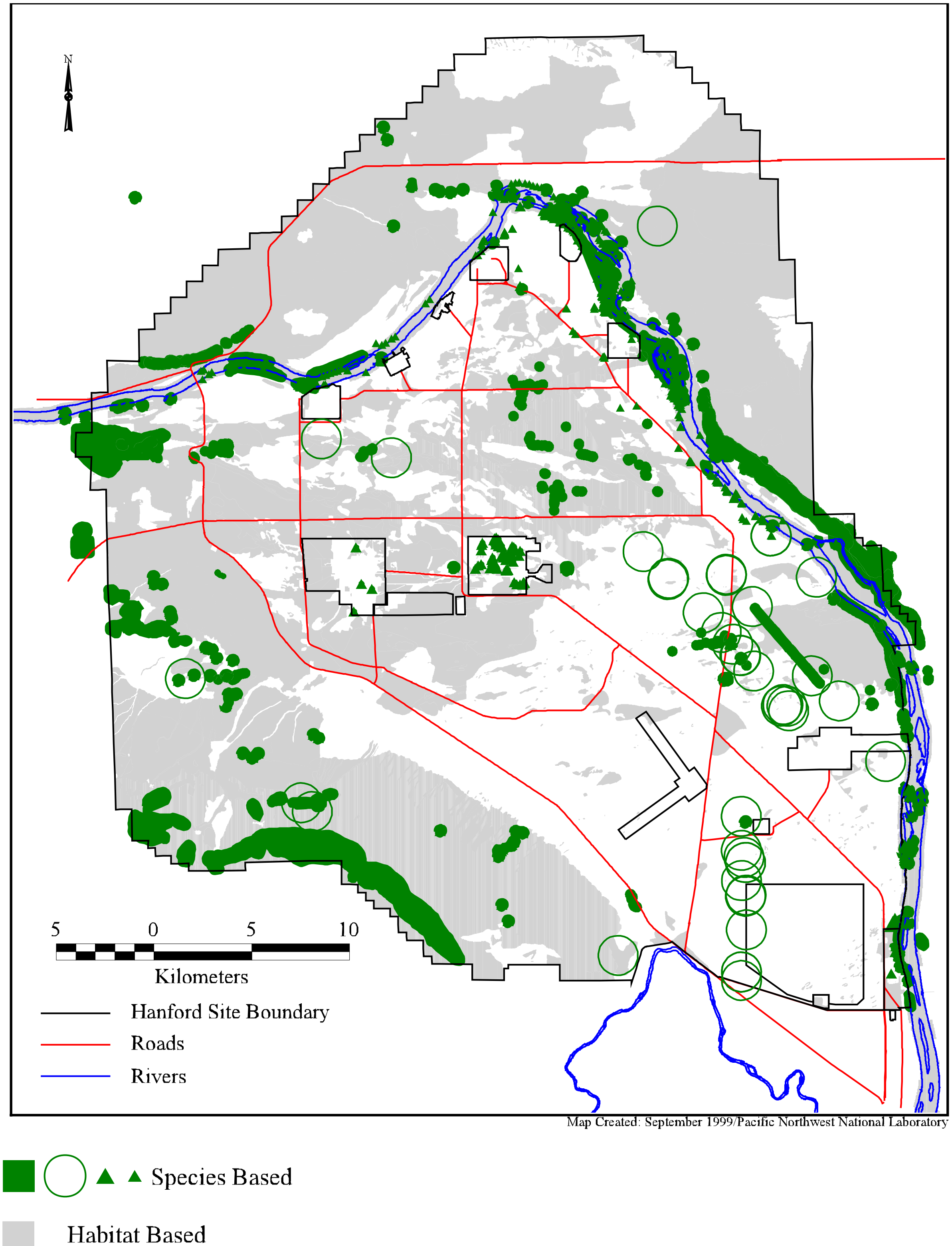


Figure 4.4 Level III Biological Resources

of wetlands and associated deepwater habitats, its wetland and deepwater habitat information was retained for the composite map in lieu of adding data from the National Wetlands Inventory.

As shown in Figure 4.4, with the exception of ferruginous hawk nest locations, most of the species-based occurrence data fall within the confines of the habitat-based data. This illustrates that protecting habitat will effectively accomplish protection of many of the individual species of concern. Although inventories of plant species of concern are incomplete, the Hanford Reach, ALE Unit, and Umtanum Ridge already can be identified as areas that contain numerous populations of plant species of concern.

In general, Level III resources are widely distributed across the Hanford Site. Although some fragmentation of Level III resource areas by low value habitat occurs, many large blocks of intact, high-value habitat still remain.

Figure 4.5 shows a different view of Level III resources. Late-successional sagebrush-steppe habitat (shown as potential sage sparrow habitat) is identified as a subset of the combined habitats of concern and floodplain data layers. This portrayal illustrates the portion of the Level III habitat-based resources that can be attributed to late-successional sagebrush-steppe habitat. Figure 4.5 also shows the outlines of the administrative areas, which are areas where biological resource value protection is a priority consideration.

Level IV Biological Resources—Figure 4.6 shows habitat-based and species-based resources based on a composite of the following individual data layers:

- rare habitats
- terrestrial (i.e., plant community) element occurrences
- bald eagle attempted nest and primary night roost locations with 800-m buffer zones
- fall chinook salmon spawning areas
- steelhead spawning areas.

These individual data layers are included in Appendix D. There are some overlaps in the data related to sand dunes and basalt outcrops and the plant communities associated with them. Unlike the pattern seen for Level III resources, the species-based resource areas generally fall outside areas identified by the Level IV habitat data. Thus, they are mostly additive in regard to the delineation of Level IV resource areas.

Level IV resources tend to be concentrated on the ALE Unit, along the Hanford Reach, south of the northern boundary formed by the east-west stretch of State Highway 24 on the North Slope, and across areas of the central core.

Combined Level II, Level III, and Level IV Biological Resources—Figure 4.7 combines the Level II, Level III, and Level IV resource data layers to produce a composite map. The following individual data layers were used to construct Figure 4.7:

- habitats of concern map (both Level II and III portions)
- 100-year floodplain map
- rare habitats
- terrestrial (i.e., plant community) element occurrences
- bald eagle potential nest and primary night roost locations with 800-m buffer zones
- fall chinook salmon spawning areas.

In this depiction, overlap between how the different resource levels depict a particular location's resource value is addressed by assigning the location the highest resource value (i.e., Level IV). Thus, Figure 4.7 shows Level IV resources embedded within Level III resources. Level II resource areas do not overlap the habitat-based resources of Levels III or IV.

Figure 4.7 shows that Level IV resources occur on the Hanford Site. They may also occur outside of the Hanford Site boundaries but were not evaluated there.

Landscape Considerations—Figure 4.7 also shows the extent and distribution of Level II, Level III, and Level IV resources across the Hanford Site at the landscape scale. Such a scale of view can be useful when trying to understand the spatial relationship of Hanford's resources in regard to such features as: (1) the degree of fragmentation by low-value resource areas, and (2) how the mosaic pattern created by different kinds of habitat contributes to a functional and diverse ecosystem. With an ecoregion perspective, this type of analysis can be extended to an even larger scale.

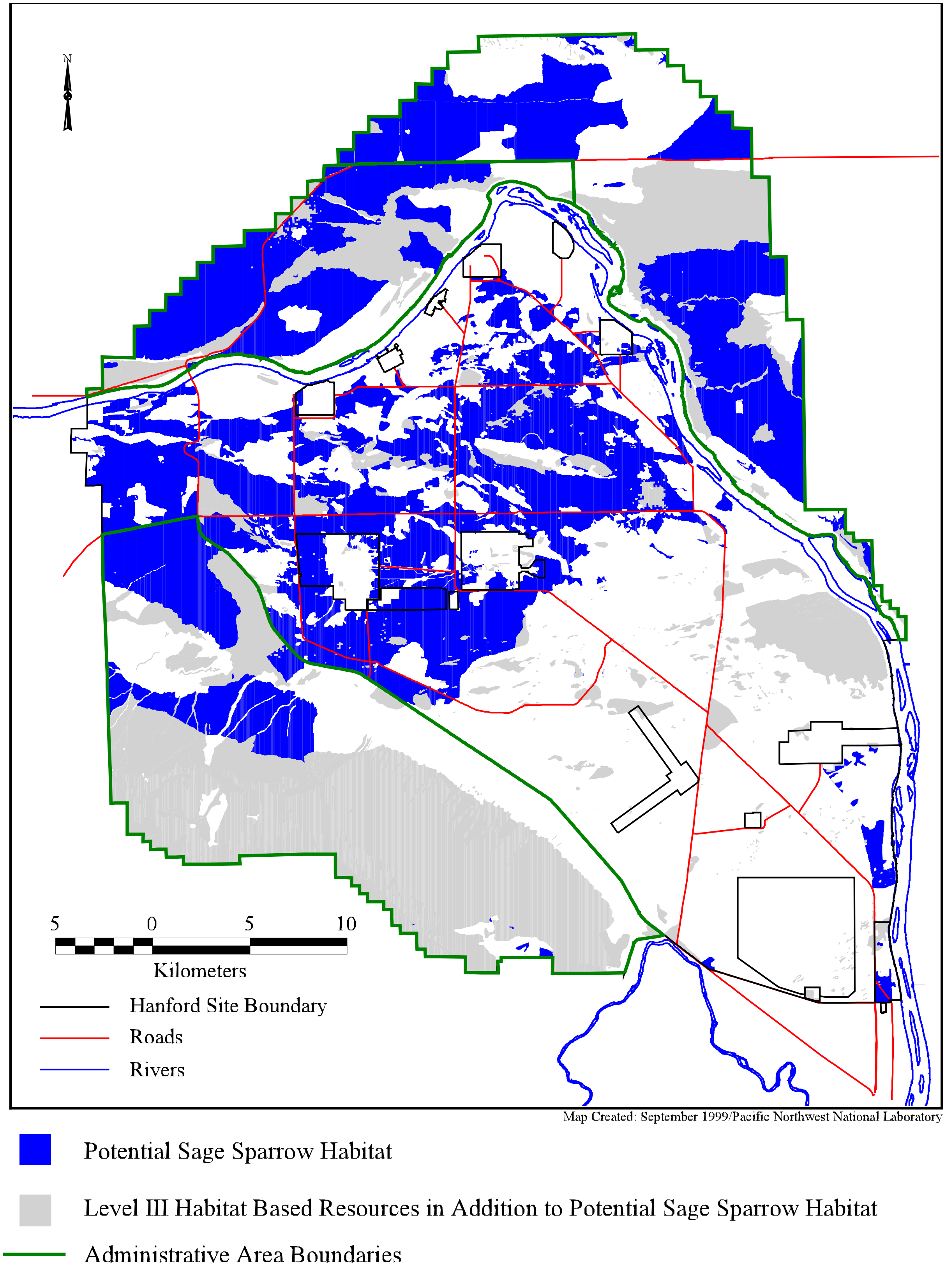


Figure 4.5 Level III Biological Resources with Potential Sage Sparrow Habitat and Administrative Area Boundary Overlays

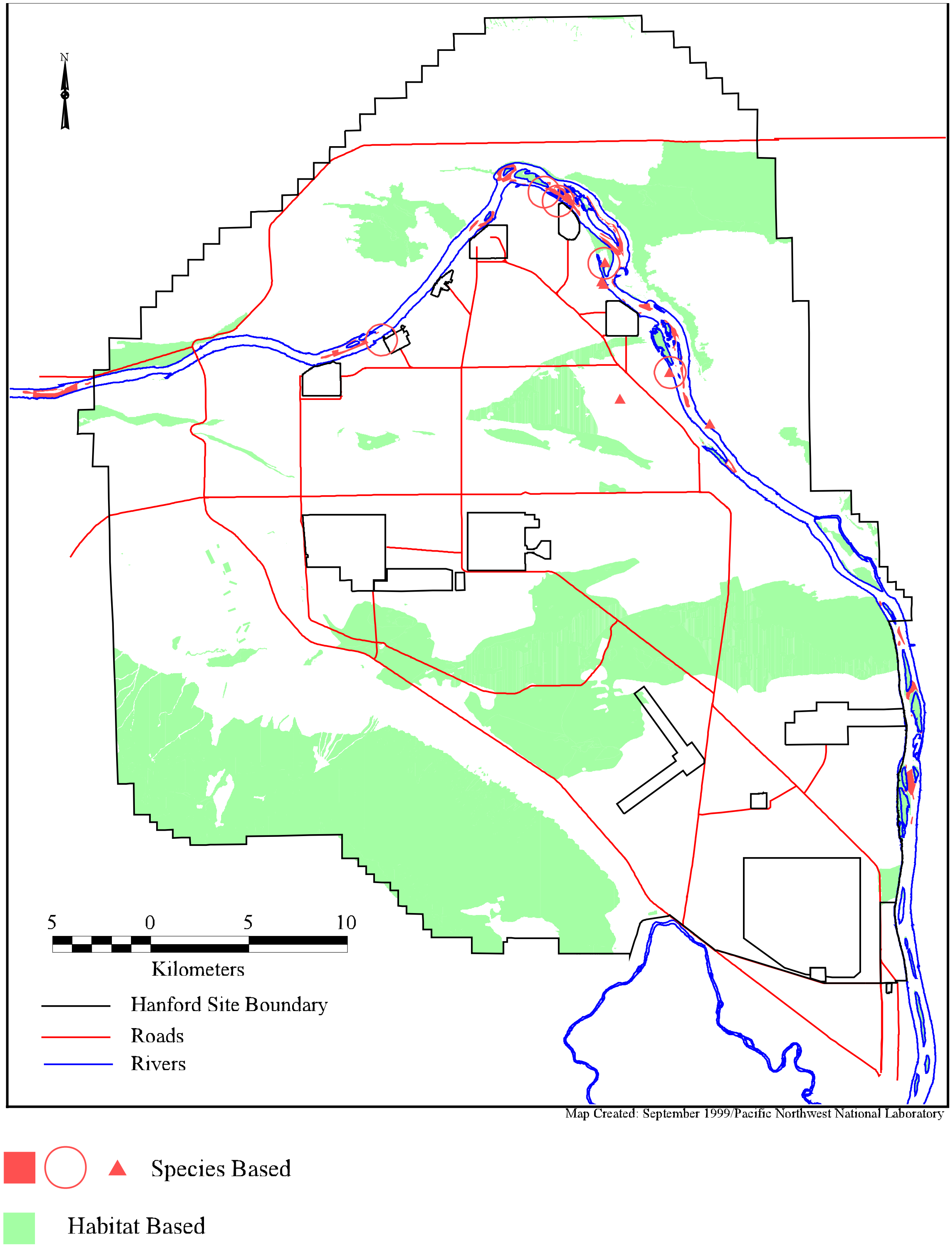


Figure 4.6 Level IV Biological Resources

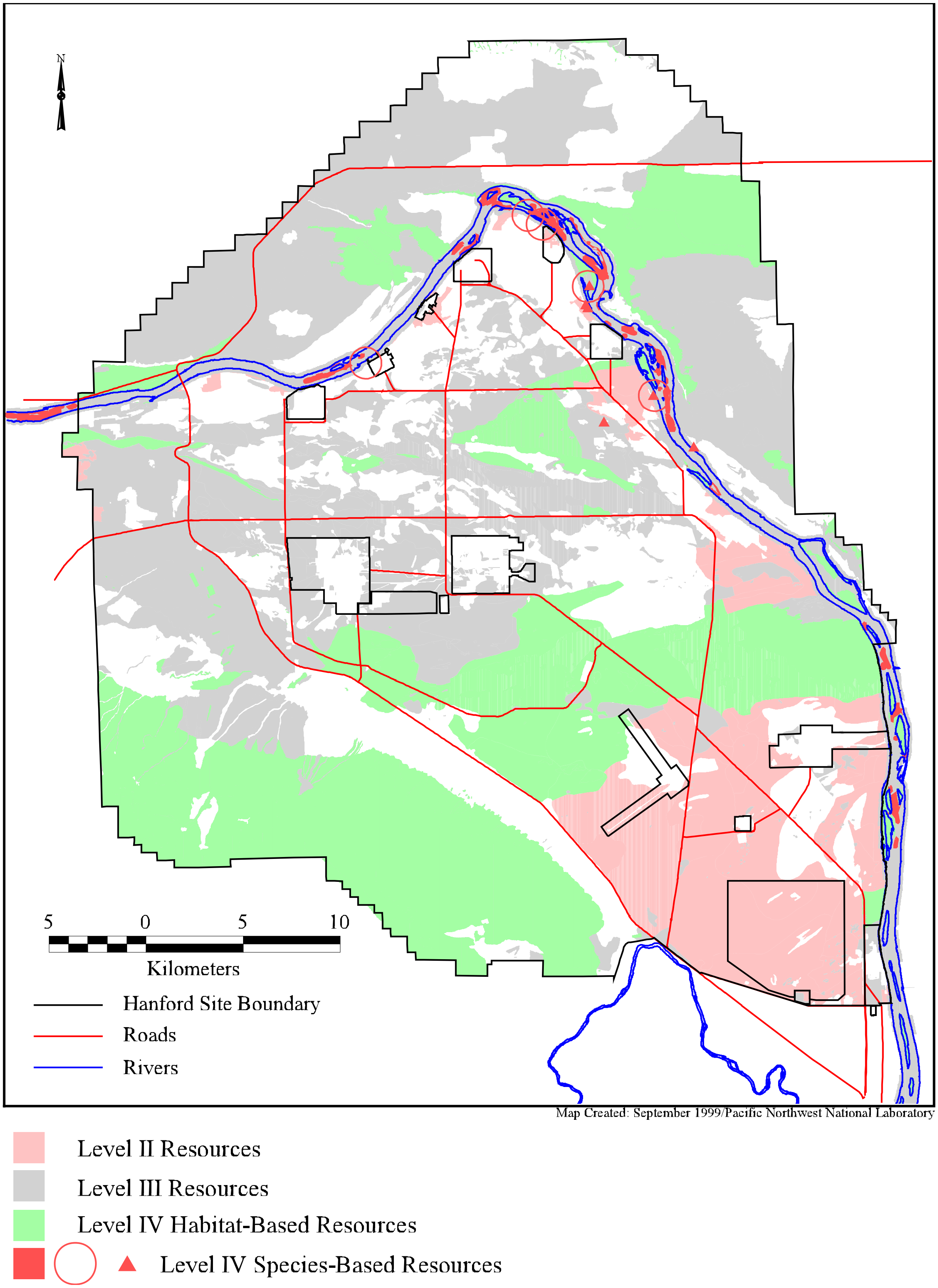


Figure 4.7 Composite Map of Level II, Level III, and Level IV Biological Resources

A landscape view also is necessary to understand that, though certain areas may not, in themselves, be depicted as high-value resources (i.e., Level III or Level IV), they may be important in providing movement corridors for certain wildlife species between high-value resource areas. At the level of the ecoregion (or at least outside of Hanford proper), these movement corridors may take on greater significance as they enable connectivity between adjacent portions of the ecoregion (e.g., between Hanford and the Yakima Training Center).

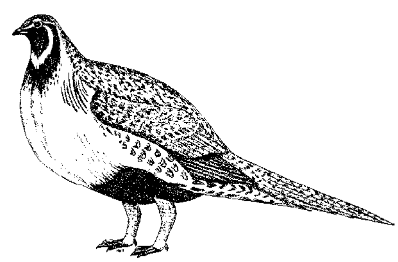
Thus, to fully use Figure 4.7, it is important that landscape considerations are accounted for. Site activities should be planned such that fragmentation is not exacerbated, wildlife movement corridors are maintained, and the full range of native habitat diversity in a functional relationship is maintained. Accounting for landscape factors also can help in the appropriate siting of mitigation areas such that habitat improvements can best meet their intended goal of replacing lost resource values.

4.4 Biological Resources that do not Qualify for Focused Management Attention or that Represent Undesirable Resources

In addition to the four levels of management concern discussed in Section 4.3, BRMaP addresses two other management levels. These levels are defined as follows:

- Level A—Biological resources that are either artificial habitats, such as abandoned old fields, or that are common, regionally abundant resources (but do not otherwise lend themselves for monitoring ecosystem integrity at Hanford) and therefore do not qualify for focused management attention
- Level B—Undesirable biological resources that may negatively impact biological resources of concern at Hanford (e.g., noxious weeds). Management is directed at control of Level B resources and not their conservation.

Further discussion of Level A resources in BRMaP is limited to a discussion in Appendix D of those cover classes that do not qualify as a habitat of concern on Hanford. Control of undesirable species (Level B) is discussed in Sections 8.1 and 8.2. Also, Section 7.2.2 provides additional guidance in regard to avoiding the introduction of undesirable plant species during revegetation actions.



5.0

Management of Biological Resource Impacts: Impact Assessment, Mitigation, and Restoration

This section describes the ecological compliance review process, addresses mitigation, especially as it relates to rectification and compensation, and provides an overview of ecological restoration as they apply at Hanford. Guidance and requirements provided fulfill two of BRMaP's main purposes to: (1) anticipate and incorporate biological resource needs in a timely manner to minimize impacts to project cost and schedule and to biological resources, and (2) describe a process whereby consistent and effective recommendations and requirements for mitigation can be identified early in project planning to ensure adequate funding is allocated for mitigation, if necessary.

Compliance with requirements outlined in this section also shows, in part, compliance with DOE-RL biological resource management initiatives described in Section 2.2.1.

5.1 Impact Assessment

Although DOE-RL recognizes that biological impacts cannot always be eliminated, potential impacts must be considered during early phases of project development and their consequences incorporated in decision making.

Assessment of biological resource impacts are the focus of the ecological compliance review process. Impact assessment involves analyzing the impacts to biological resources of concern (Levels II through IV) that may be expected if a proposed action is implemented. This analysis is conducted well before implementation to enable enough time for the responsible program or project to evaluate and implement alternatives that would avoid or minimize impacts as much as possible, to plan for additional mitigation actions that may be necessary, to determine the need for ecological permits, and to obtain such permits, if necessary.

Impact management is accomplished in part by mitigation. Mitigation is a series of prioritized actions that, taken together, reduce or eliminate adverse project impacts to biological resources. The ecological compliance review process, as described in the *Ecological Compliance Assessment Management Plan* (DOE-RL 1995), also will identify the need for such mitigation actions.

5.1.1 Purpose and Goals

The ecological compliance review process assists DOE-RL in managing impacts to species and habitats of concern. Assistance is provided through collection and dissemination of information on project-specific impacts to biological resources, guidance provided to Site project managers toward making planning decisions, identification of mitigation requirements, and annual compilation of cumulative impacts to biological resources as a result of Hanford Site activities. The process provides a sound basis for evaluating biological impacts using appropriate environmental baseline data before initiating a proposed action.[1]

[1] Baseline data are of two types. Data collected via Hanford's compliance projects track resource status within expected impact zones (e.g., 100 Areas, 200 Areas, etc.). A second type of baseline data is collected via the Ecosystem Monitoring Project. This latter set of data serve to track the status of a particular resource within a broader context (i.e., within the entire Hanford ecosystem or, when data outside of Hanford are available, within the Columbia Basin Ecoregion). These data provide the relevant context for assessing cumulative impacts to biological resources of concern that also accounts for changes in resource status not directly attributable to DOE-RL activities. Section 6.0 addresses this second type of baseline data collection.

Goals of the ecological compliance review process are to:

- assess the potential for proposed projects, including maintenance activities, to adversely impact biological resources of concern, including migratory birds, using methods that ensure such resources are detected in potentially affected areas
- document the assessment and basis for the assessment for the requester and DOE-RL
- provide recommendations that will avoid, minimize, or otherwise mitigate adverse impacts
- retain the documentation in a format that can be reviewed by DOE-RL and used to support decisions to be made through the NEPA or CERCLA processes.

5.1.2 Legal and Policy Basis

Federal laws as well as other relevant and appropriate regulations (e.g., Washington State Department of Fish and Wildlife regulations) apply to ecological compliance on the Hanford Site. Applicable requirements for evaluating ecological resource impacts include the following federal laws:

- National Environmental Policy Act (NEPA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Endangered Species Act
- Bald and Golden Eagle Protection Act[2]
- Migratory Bird Treaty Act[3]
- Clean Water Act
- Fish and Wildlife Coordination Act
- Presidential Proclamation 7319 (Establishment of the Hanford Reach National Monument).

Regulations that implement these laws include those promulgated by regulatory agencies responsible for enforcement and DOE guidelines that define DOE responsibilities under NEPA (10 CFR 1021; see also 10 CFR 1022 for DOE's specific responsibilities in regard to compliance with floodplain/wetlands environmental review requirements). Additional guidance and requirements are defined in federal Executive Orders and DOE Orders. Detailed explanations of these requirements are provided in DOE-RL (1999).

Species protected by federal regulations are regularly identified and updated in the *Federal Register* and other agency publications. Species listed under the Endangered Species Act as threatened or endangered, or candidates for such listing, are published in 50 CFR Part 17, "Endangered and Threatened Species." Endangered species lists are also published by the U.S. Fish and Wildlife Service on the World Wide Web (www.usfws.gov/r9erdspp/endspp.html). Species protected under the Migratory Bird Treaty Act are listed by the USFWS under 50 CFR Part 10.13. Wetlands delineation and permitting procedures under the Clean Water Act are published by the U.S. Army Corps of Engineers at 33 CFR Parts 320-330.

Definitions of species and habitats protected or prioritized for management attention by Washington State laws, regulations, or guidance are published by the Washington State Department of Fish and Wildlife and Washington Department of Natural Resources. For current information, see www.wa/gov/wdfw (WDFW) and www.wa/gov/dnr (WDNR) and for priority habitats and species, www.wa/gov/wdfw/hab/phspage.htm.

Protection of species of concern and their habitats on the Hanford Site is central to the compliance process. Therefore, an up-to-date database will be maintained on Level II through IV resources known to occur on or use the Hanford Site that will be kept current with regard to changes in federal and state species protection laws, regulations, and listings (see Section 9.1).

5.1.3 Implementation

The implementation of the ecological compliance review process involves a number of considerations. This section discusses the aspects of implementation: methods used to conduct an ecological review,

[2] Although there are no specific impact assessment provisions, there are enforcement provisions in regard to the taking of individuals, etc., that could result in criminal penalties. Thus, DOE-RL feels it is prudent to assess potential impacts to biological resources covered under the provisions of this act.

[3] Ibid.

types of reports that can be generated, and extent of mitigation recommendations that can result.

5.1.3.1 Ecological Compliance Review Process: Methods

Impact assessment reviews will be conducted for projects with the potential for impacting the biological environment. A decision methodology for determining the need for an ecological compliance review is defined in DOE-RL (1995). Impacts to be considered include habitat alterations, disturbances that could affect species-specific behaviors (e.g., nest desertion) with resultant potential impacts on reproduction and/or survival, and toxicological effects from routine releases of potentially hazardous materials beyond those currently permitted (see Table 5.1).

Ecological compliance reviews will rely on field data specific to the site where the proposed action is to occur. To be reliable, field data must be obtained at the biologically appropriate times of year (i.e., the time period when the species of concern can be expected to be present and in an identifiable condition). Because Hanford projects cannot always determine their need for a review early enough in the biological cycle to enable the necessary field data to be collected, the compliance review process will use baseline biological surveys for areas where the majority of activities are expected to occur. These baseline surveys will be conducted at the biologically appropriate time of year. The baseline survey approach thus minimizes the likelihood of project delays due to project scheduling conflicting with the appropriate seasonal period at which to conduct surveys.

A determination of adverse impact will be based on whether: (1) biological resources of concern are present or use the area where the proposed action is to occur, and if so, (2) the proposed action would result in any of the effects described in Table 5.1. Use of an area is determined on the basis of the field survey as well as an assessment of foraging use by species of concern with relatively large home ranges, such as Swainson's hawks or bald eagles. As a working basis, direct impacts are assessed at the level of the individual; impacts to habitat are assessed at the level that would eliminate a pair's nesting/den/spawning area and/or foraging habitat or a local plant population.

Information on the sensitivity of various species to disturbance will be used in the assessment, as well as references to exclusion areas and sensitive periods that are identified for federally listed birds on the Hanford Site.

5.1.3.2 Ecological Compliance Review Process: Reports

Ecological review reporting will include letter reports documenting the review process, findings, and recommendations with regard to mitigation or contact points for permitting, as warranted. Report content will reflect the level of impact to the resources. Reviews for proposed actions that will

Table 5.1 Evaluation of Impacts to Biological Resources of Concern

Source of Impact	Treatment in Ecological Compliance Review
Direct mortality	Potential is defined as high for plants in the areas to be disturbed; low for mobile species
Habitat loss	Potential is evaluated on basis of species/habitat associations and foraging/home range radii
Nest/den/spawning area destruction	Potential is defined as high for nests/dens/redds found in the area
Disturbance during sensitive periods	Potential is defined as high within one home range radius or as defined by management plans/biological assessments
Exposure to toxic substances	Evaluated on a dose-response basis for releases above permitted quantities or rates

result in loss of Level III or IV habitat (losses of Level IV habitats/plant communities generally will not be allowed) will include quantitative descriptions of the habitat and recommendations for mitigation. Detailed descriptions of content are provided in DOE-RL (1995). Reports will be forwarded to the requester and the environmental compliance organizations of the contractor and DOE-RL.

5.1.3.3 Ecological Compliance Review Process: Mitigation Recommendations

Management of impacts to biological resources will be achieved using a hierarchy of mitigation actions identified through the review process and early interaction with project engineers and site development planners.

The hierarchy of mitigation ranges from impact avoidance, the preferred means, to compensation (Table 5.2). Means to accomplish impact avoidance or minimization are identified through the ecological compliance review and project site selection processes before implementation of a proposed project. The need for a particular type of mitigation will be identified in the ecological compliance review reports for individual projects as needed in accordance with the Biological Resources Mitigation Strategy (DOE-RL 1996).

The review process will include, where appropriate, meeting with Hanford project staff to:

- provide information on potentially significant biological issues pertinent to the project
- assist in identifying alternatives to the proposed action that could minimize or avoid adverse biological consequences
- provide information on the location of important biological resources to assist, as necessary, in the site selection process for individual projects
- present information on Hanford policy in regard to mitigation, especially as that policy relates to when mitigation via rectification and or compensation may be appropriate
- develop a common schedule for conducting an ecological compliance review that would minimize impacts to the proposed project's schedule.

For bird species protected under the Migratory Bird Treaty Act, federal regulations require that a permit be obtained from the U.S. Fish and Wildlife Service before harming or collecting individuals, nests, or eggs. The ecological compliance review report will identify temporal or spatial alterations to proposed actions that would prevent the harming of regulated species. If such provisions cannot be implemented, the affected program or project should contact the Hanford Biological Resources Laboratory at PNNL for assistance with obtaining the necessary permit. The Laboratory also can be contacted for assistance with determining the specific applicability of the Migratory Bird Treaty Act's implementing regulations.

5.1.3.4 Ecological Compliance Review Process: Summary of Project Manager Required Actions

The box below outlines those actions that a project manager needs to take to be in compliance with ecological compliance review requirements. Figure 5.1 provides an overview of the ecological compliance review process.

Table 5.2 Hierarchy of Mitigation Actions for Biological Resource Impacts

Mitigation	Utilization Preference	Description of Mitigation Means
Avoid impact	1st	Alter proposed project (timing, location, or implementation) to avoid injury to biological resources of concern
Minimize impact	2nd	Alter proposed project to minimize injury to biological resources of concern
Rectify the impact	3rd	Replace onsite the biological resources to be disturbed
Compensate for the impact	4th	Replace or protect offsite the biological resources to be disturbed

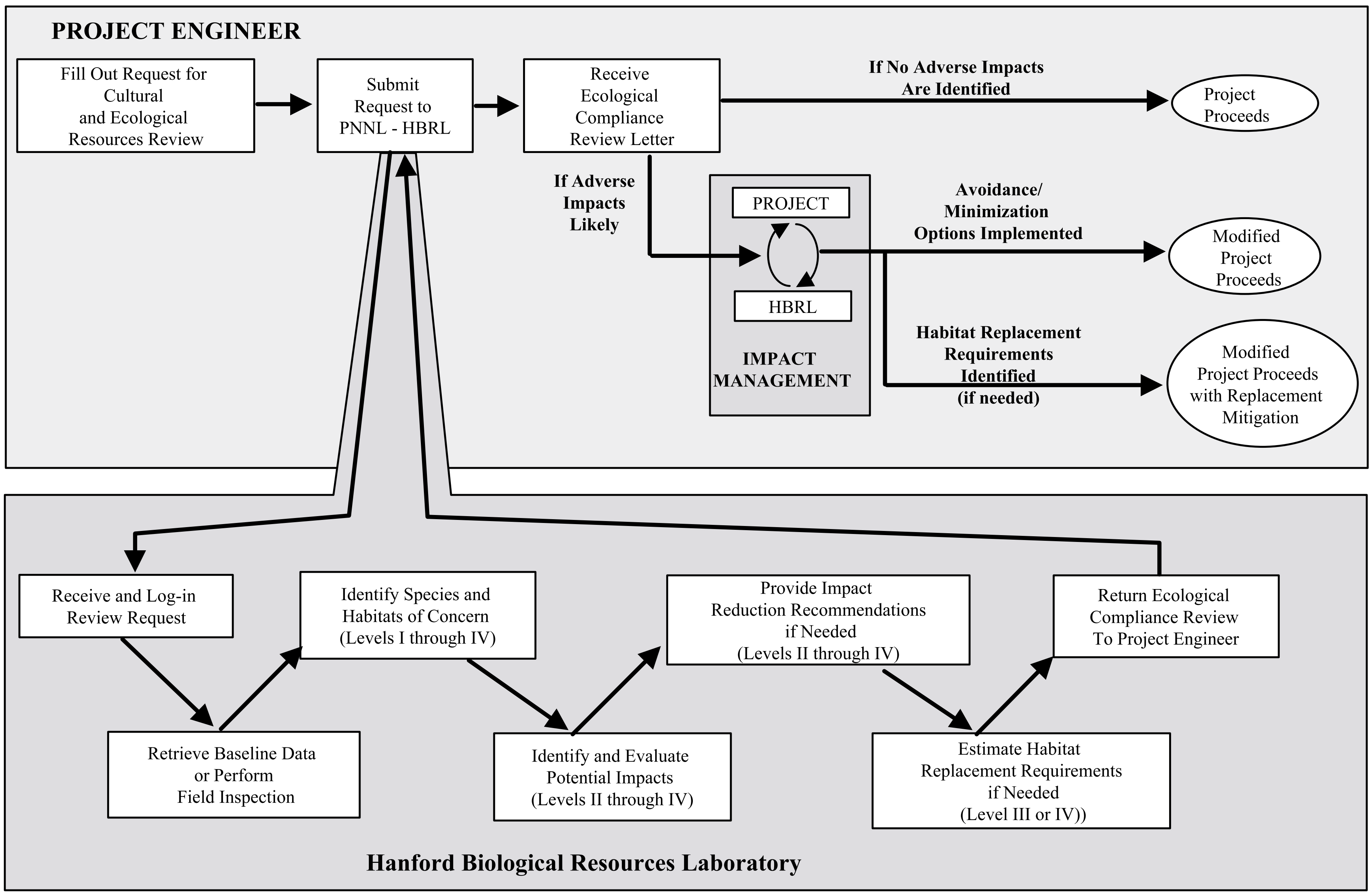


Figure 5.1 Ecological Compliance Review Process (PNNL = Pacific Northwest National Laboratory; HBRL = Hanford Biological Resources Laboratory)

5.1.4 Roles and Responsibilities

Consideration of impacts to biological and other natural resources in the early stages of project planning is the responsibility of the program or project leads. Early consideration of these impacts will ensure that the appropriate ecological reviews are completed and compliance costs minimized, enable appropriate mitigation planning, and avoid costly project delays. The request for an ecological review is the responsibility of the program or project leads as consistent with the relevant contractor procedures. Reviews should be obtained early on to assist in identifying possible project alternatives that incorporate resource values and avoid and/or minimize unnecessary impacts.

Ownership of the ecological compliance reviews is with the Office of Site Services at DOE-RL. Responsibility for conducting ecological compliance reviews is assigned to Pacific Northwest National Laboratory (via the Hanford Biological Resources Laboratory) and the Environmental Restoration Contractor. The Laboratory is responsible for conducting field baseline surveys for the primary activity areas as defined in the relevant Project Documentation Plan for DOE-RL. The Laboratory also is responsible for conducting reviews for non-environmental restoration contractor projects. The environmental restoration contractor, Natural Resources Section, is responsible for coordinating natural resource reviews for all proposed field activities within its contract scope.[5]

Implementing recommendations is the responsibility of the program or project leads in conjunction with the environmental compliance organization(s) of the relevant contractor, as necessary.

Oversight of implementation is the responsibility of the relevant contractor and DOE-RL compliance and program organization(s).

5.2 Mitigation

The basic tenet of biological resource mitigation at the Hanford Site is that projects should proceed through each stage of the mitigation hierarchy and only move to the next action level if all reasonable options for the previous level are exhausted. If careful consideration is given to avoiding and minimizing impacts before they occur, the need for the more expensive levels of mitigation (i.e., rectification and compensation) can be greatly reduced or eliminated.

The *Biological Resources Mitigation Strategy* (DOE-RL 1996) and the *Ecological Compliance Assessment Management Plan* (DOE-RL 1995) provide Hanford Site project managers, planners and engineers, and resource managers with the concepts and information necessary to implement the requirements and guidance identified in this section for mitigation at the Hanford Site.

Ecological Compliance Review Process: Summary of Project Manager Required Actions

Step 1—Determine whether a proposed action requires an ecological compliance review. Consult DOE-RL (1995) for assistance in making this determination.

Step 2—If an ecological compliance review is needed, submit a request to the Hanford Biological Resources Laboratory at the Pacific Northwest National Laboratory if a non-CERCLA action; if a CERCLA action, contact the Environmental Restoration Contractor, Natural Resources Section.

Step 3—After receiving the ecological compliance review report, follow up on the report's recommendations:

- obtain any environmental permits that may be necessary
- plan, budget for, and implement, as necessary, any required or recommended mitigation actions. Contact the Hanford Biological Resources Laboratory if there are questions or to discuss options.

Step 4—Include the ecological compliance review report's findings in appropriate project documentation and act, as needed, on recommendations before proceeding with the proposed action.

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5 These responsibilities are coordinated in accordance with the letter from S. D. Liedle (BHI) to L. K. McClain (DOE-RL): "ERC Operating Procedures for Conducting Cultural and Natural Resource Reviews," March 9, 1995.

5.2.1 Purpose and Goals

Mitigation of adverse impacts to biological resources via rectification and/or compensation is intended to ensure, to the extent practicable, no net loss of Level III and IV biological resources of concern on the Hanford Site. In most cases, it is expected that adverse impacts can be avoided or minimized to the extent that additional mitigative actions are unnecessary. Some projects, however, may be of such a scale and/or have specific siting criteria that make complete avoidance and minimization impossible. In these cases, mitigation via onsite rectification and/or compensation away from the project site would be required.

To facilitate a proper balance of DOE-RL's missions with its resource stewardship obligations, the mitigation requirements and guidance provided in the *Biological Resources Mitigation Strategy* (DOE-RL 1996) will meet the following objectives:

- ensure consistent and effective implementation of mitigation recommendations and requirements
- ensure that mitigation measures for biological resources meet the trust responsibilities of DOE-RL under both NEPA and CERCLA[6]
- enable Hanford Site development and cleanup projects to anticipate and plan for mitigation needs via early identification of mitigation requirements
- provide guidance to Hanford personnel in implementing mitigation in a cost-effective and timely manner.

5.2.2 Legal and Policy Basis

Much of the legal and policy basis for biological resource management in general also is relevant directly to mitigation. Federal acts, regulations, and Executive Orders (described in Appendix B) have specific provisions concerning mitigation including the following:

- National Environmental Policy Act
- Comprehensive Environmental Response, Compensation, and Liability Act[7]
- Endangered Species Act[8]
- Clean Water Act
- Fish and Wildlife Coordination Act
- Mineral Leasing Act of 1920
- Executive Order 11988 - Floodplain Management
- Executive Order 11990 - Protection of Wetlands.

The strategy for biological resource mitigation on the Hanford Site is strongly based on both Washington State and federal mitigation policies. These include:

- U.S. Fish and Wildlife Service Mitigation Policy (46 FR 7644)
- Washington Department of Fish and Wildlife Mitigation Policies (Policies 3000 and 3001).

5.2.3 Implementation

The implementation of the mitigation process at Hanford involves a number of considerations. The following sections address the overall mitigation process and its relationship to remediation/restoration, identification of what constitutes mitigable resources at Hanford, mitigation thresholds for specific types of biological resources, and mitigation ratios, replacement units, and areas. It also summarizes the mitigation process as it affects Hanford Site project managers.

5.2.3.1 Overall Mitigation Process and Its Relationship to Waste Site Remediation and Restoration

Application of the mitigation hierarchy on the Hanford Site includes several prioritized actions (or

[6] See Appendix B.

[7] CERCLA identifies no specific provisions for mitigation; however, its natural resource damage provisions may provide a strong incentive to consider mitigation when appropriate.

[8] Mitigation under the Endangered Species Act is separate from the mitigation that is addressed in 46 FR 7644, U.S. Fish and Wildlife Service Mitigation Policy.

steps) and decision points. The overall decision tree, as well as what documents can be consulted for specific information, are indicated in Figure 5.2. Table 5.2 describes the components of the mitigation hierarchy.

Mitigation planning starts with determining the need for an ecological compliance review (DOE-RL 1995). In general, projects that require an ecological compliance review are those that are conducted outdoors, especially those that also require an excavation permit, or inside abandoned buildings that may contain biological species of concern, such as bats. This encompasses a wide range of projects—from maintenance work on the outside of buildings to large-scale land development for new facilities. The majority of projects reviewed have been determined to have no adverse impacts on any biological resources of concern and have therefore proceeded without delay and without additional mitigative actions. Of those remaining projects, most were able to proceed with only

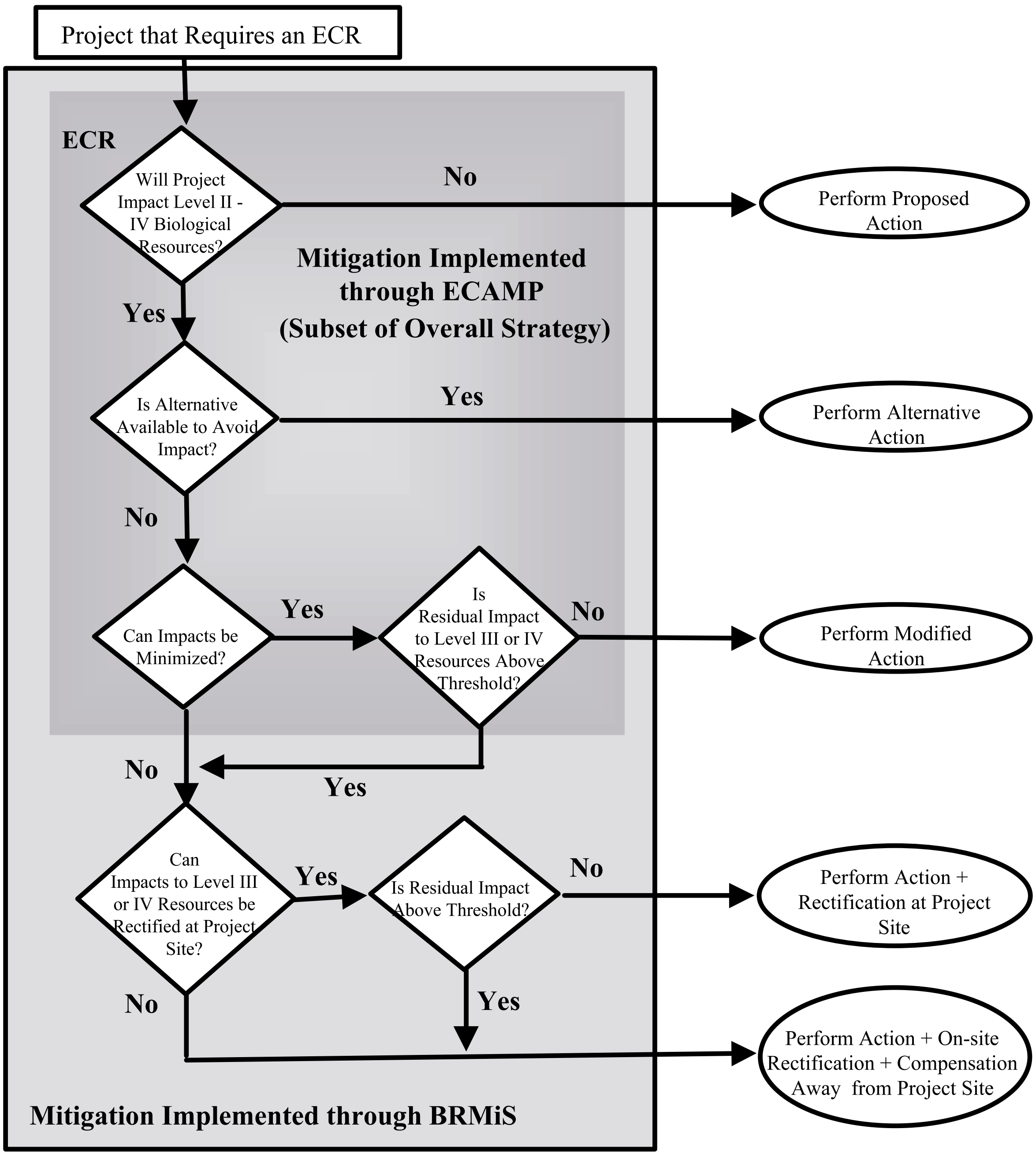

Figure 5.2 Mitigation Decision Tree and Relationship of Reference Documentation (ECR = Ecological Compliance Review; ECAMP = Ecological Compliance Assessment Management Plan; BRMiS = Biological Resources Mitigation Strategy)

minor adjustments, such as moving the site a small distance or timing the action to avoid impacts to nesting migratory birds.

If a significant adverse impact remains after the avoidance and minimization steps, then the amount of rectification or compensation required of a project will be determined using habitat evaluation procedures or equivalent method as described in of the *Biological Resources Mitigation Strategy* (DOE-RL 1996). A number of projects may require some form of onsite rectification, not only to replace the resources lost as a result of the project but also to prevent further resource degradation to the surrounding habitat, such as soil erosion or the introduction of non-native plant species. Compensation may be required if a significant amount of adverse impact remains after onsite rectification. For example, the land area covered by a new facility can not be rectified on site. Rectification or compensation is applicable only to the unavoidable loss of existing resources of concern.

Restoration and stabilization are options encouraged for use at past-practice waste sites (restoration and stabilization also can be used at non-contaminated, human-impacted areas). Although implementing such options may be of benefit to Hanford's biological resources, they do not constitute mitigation for Level III or IV habitat losses. Restoration here refers to the actions taken to create habitat value at a past-practice waste site subsequent to the completion of remediation. Alternatively, if the intended use of a site is not as plant, fish, and/or wildlife habitat, the site may simply be stabilized or converted to other uses. Restoration and stabilization will often include the placement of some type of vegetative cover over a remediated/decommissioned site. The type of vegetation and the habitat or community created, if applicable, will conform with a pre-determined land-use objective for the site and might not resemble the surrounding communities or the pre-disturbance native habitat. Thus, the scope of the action taken depends on the site's land-use objective. If the objective is restoration, then the action will entail recreating a native plant community. If the objective is stabilization, then simply planting a soil-stabilizing cover crop may be the only action necessary.

For a CERCLA-related action, a remediation project may often be expected to perform restoration, but might not be required to conduct replacement mitigation (via rectification and/or compensation) unless a resource of concern is lost during the remediation process. Figure 5.3 provides an aid to understanding the difference between mitigation and restoration as it applies to a CERCLA remedial action.

5.2.3.2 Identification of Mitigable Resources

Distribution of Hanford Site Mitigable Resources by Level of Concern—Not all biological resources are considered mitigable resources at Hanford. All

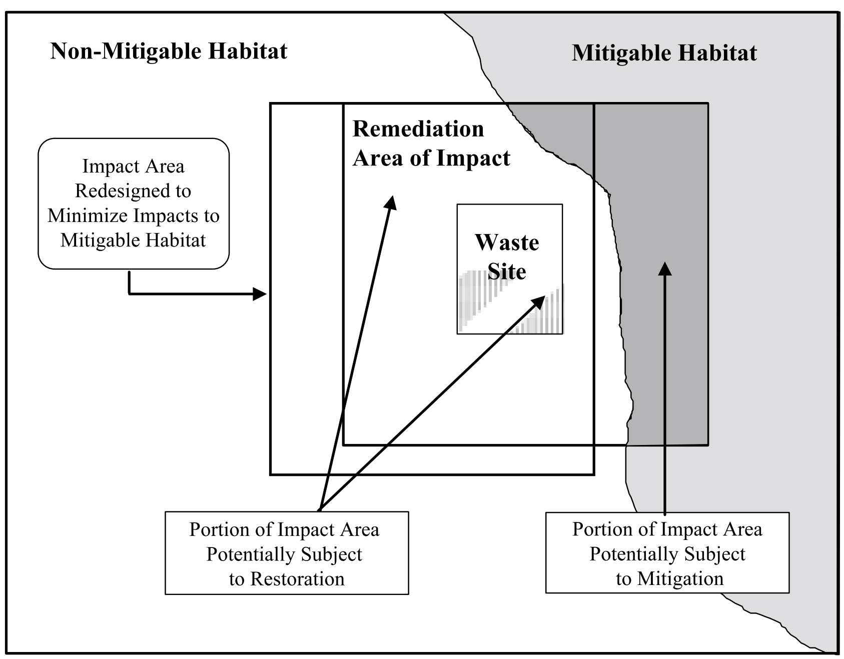

Figure 5.3 Relationship of Mitigation to Restoration in Regard to a CERCLA-Related Remedial Action

biological resources categorized within Levels II - IV should be considered for mitigation via avoidance and minimization; however, only Level III and IV resources must be considered for mitigation via rectification and compensation. The determination of what constitutes appropriate mitigation takes place during the ecological compliance review process.

Because the available options for mitigating Level IV resources are limited, and may be costly, the preferred management strategy for these resources at Hanford is one of protection against impacts. Generally, Hanford Site Level IV resources are not in the vicinity of planned development areas or past-practice waste sites (one potential exception are bald eagle primary night roost or potential nest site locations). Thus, it is unlikely that Level IV resources will be impacted, and therefore require mitigation, by Hanford Site activities.

Some level III resources, however, are located in areas that may in the future be developed or, if a waste site, require remediation. The presence of Level III resources does not preclude a development or cleanup action; however, impacts to Level III resources from such actions should be mitigated (i.e., using rectification and/or compensation if necessary) when such impacts exceed a specified impact threshold. Level III resource areas can be evaluated at the landscape scale as to their on-the-ground potential for requiring mitigation via rectification and/or compensation and in so doing aid project managers in making planning decisions. Five data layers contribute to the composite map of Level III resources; three of these (plant species of concern, ferruginous hawk nest, and bald eagle perch and secondary night roost locations[9]) are based on annually updated biological resource monitoring information. Thus, the locations where these resources are depicted have a high mitigation potential (i.e., projects that plan to work in these areas can reasonably expect to encounter these resources and to have to mitigate any adverse impacts their actions may cause).

The other two data layers—habitats of concern (exclusive of the early-successional habitats such as abandoned old fields) and the Hanford Reach 100-year floodplain—are based to a lesser extent on actual ground surveys, depending on location, and more on either aerial photographs or modeling. The accuracy of these techniques in depicting spatial features is highly dependent on the uniformity of the feature and the scale of resolution being mapped. An on-the-ground assessment is vital for those areas in which the mapping data could be limited in its accuracy.

Project managers should note that the 100-year floodplain is located within the Hanford Reach of the Columbia River Study Area. Because under Public Law 100–605 impacts to those natural resources for which this area is under study must be mitigated, impacts within the 100-year floodplain may require mitigation.

Level II resource areas are limited to early-successional habitats (Figure 4.3). Impacts to these areas will generally not require mitigation via rectification and/or compensation (impacts still should be avoided or minimized to the extent practical). In contrast to Level III and IV resource areas—within which for project planning purposes it is conservatively assumed that the level designations are accurate and mitigation will be necessary unless verified otherwise on-the-ground—within Level II resource areas the lack of accurate understory data and disturbance history leads to an opposite conclusion: mitigation via rectification and/or compensation will not be necessary unless on-the-ground biological surveys indicate the presence of resources that qualify as either Level III or IV. Although Section 5.2.3.3 mostly provides threshold criteria for determining when an assumed Level III resource area may not qualify as Level III, the threshold criteria for Level II resource areas in Section 5.2.3.3 can be used identify when early-successional habitat areas qualify as either Level III or IV resources.

When looked at in combination, there are some spatial overlaps in the resource data provided in Figures 4.3, 4.4, and 4.6. Although Level II and III resource areas are mostly complementary (i.e., no overlap), Level IV resources are in many cases mapped as a subset of Level III resources (e.g., element occurrences represent the highest quality examples of some of the habitat of concern cover classes; see Appendix D). Figure 4.7 is a composite map of the Level II-IV resources of concern. Because a particular biological resource is associated with only one level of management concern (see Section 4.3), a specific location on the Hanford Site is classified at the highest level of concern for which it qualifies (with Level IV the highest level).

[9] Bald eagle primary night roost and attempted nest site locations are considered Level IV resources.

It is important to realize that there are inherent accuracy limitations in data used to develop Figure 4.7 and to restrict its application primarily to landscape-level land-use planning. Although Figure 4.7 may be useful to project managers at the landscape scale for planning projects to avoid costly mitigation, actual mitigation requirements must be determined only by on-the-ground surveys obtained during the ecological compliance review process.

The use of Figure 4.7 to evaluate a project's mitigation potential is only one piece of information that project managers should consider in determining whether their particular project may result in a mitigable impact. Each type of Level III resource also has an associated impact threshold that determines whether mitigation will be needed. Thresholds are addressed in Section 5.2.3.3. The next section provides guidance to project managers on how to prioritize between certain types of mitigable biological resources to ensure that the project alternative is identified that results in the least impact to biological resources of concern and minimizes the need for costly mitigation.

Prioritizing Between Mitigable Shrub-Steppe Resources—The Hanford habitats of concern map (Appendix D) shows all shrub-steppe community types and successional stages that are considered important from the standpoint of impact mitigation. At the first level of mitigation planning, these communities (along with the Columbia River 100-year floodplain) should be protected from significant impact to minimize the potential that mitigation via rectification and/or compensation would be necessary. A composite view of these resource areas, in which the resources are assigned to different levels of management concern (Figure 4.7), indicates, however, that mitigation cost saving can be achieved by avoiding impacts during the site selection process. The steps that are outlined in the following discussion are designed to assist project managers in sorting through different siting options for projects. Careful planning can help avoid and/or minimize impacts to biological resources of concern and reduce or eliminate mitigation costs.

Because the mitigation options for Level IV resources are more restrictive than for Level III resources, the highest mitigation planning priority is assigned to Level IV resources. Thus, the first two steps in planning mitigation priorities are:

- Step 1—Avoid impacts to Level IV resource areas (as indicated on the composite resource maps in Section 4.3.4) at all times.
- Step 2—Avoid impacts to Level III resource areas (as indicated on the composite resource maps in Section 4.3.4) as much as possible.

Within portions of the Hanford Site covered by late-successional plant communities, a mix of shrub types and understory conditions exist that affect any particular location's habitat value. To better assess the quality (condition) of the late-successional communities, and by so doing identify those areas for which significant adverse impacts should be mitigated, a habitat association model is used that relates the condition of the habitat to its suitability for usage by a shrub-steppe obligate species.

The species used is the sage sparrow, a Washington State candidate species. The model does not derive a linear or other relationship between continuous measures of habitat quality or usage. The model output indicates whether a particular locale is suitable for sage sparrows. Full details on the model development are provided in Appendix D. Although the model was derived specifically for big sagebrush-dominated plant communities, the model conditions—adjusted for other appropriate native shrub species (see Section 5.2.3.3 and Appendix D)—will be used to define Level III, late-successional shrub-steppe habitat during ecological compliance reviews.

An estimate of the extent of this habitat on Hanford relative to other Level III resource areas is presented in Figure 4.5. Because this estimate is based on the sage sparrow association model, it represents only big sagebrush-dominated areas. Moreover, actual usage by sage sparrows of the estimated suitable area may depend on landscape effects not examined by the model. Because fragmentation of this habitat may adversely affect sage sparrow usage (as well as other shrub-steppe species) of otherwise suitable areas, any unavoidable project impacts should be directed away from the largest patches of remaining late-successional shrub-steppe. Thus, the next step in the mitigation planning priority is:

- Step 3—Preferentially avoid impacts to large blocks of late-successional shrub-steppe habitat over impacts to smaller blocks; preferentially avoid impacts to areas of late-successional shrub-steppe habitat that are near other Level IV or III resource areas over impacts to areas that are not near such resources (as indicated on the composite resource maps in Section 4.3.4).

Although preservation of a mosaic of different successional stages of shrub-steppe on Hanford is vital for maintaining the full diversity of shrub-steppe-dependent species, the late-successional stages are of most concern because recent past wildfires have removed significant portions of similar habitat and they are at risk because of the potential for land conversion on the central plateau of Hanford. The DOE-RL recognizes both the importance of late-successional shrub-steppe habitat to the Columbia Basin Ecoregion and the role Hanford plays as a refugium for this habitat.[10] Thus, a final prioritization for mitigation planning purposes is appropriate that distinguishes late-successional communities from earlier successional stages.

- Step 4—Preferentially avoid impacts to all areas of late-successional shrub-steppe habitat over impacts to areas of early-successional shrub-steppe habitat (as indicated on the composite resource maps in Section 4.3.4).

Because early-successional shrub-steppe habitat is considered a Level II resource unless it can be demonstrated otherwise (see Section 5.2.3.3), impacts to these areas—though they should be avoided or at least minimized—do not qualify for mitigation via rectification and/or compensation. Thus, in comparison with other shrub-steppe resources, they have the lowest priority for impact avoidance.

The application of a landscape-scale approach to prioritizing between mitigable shrub-steppe resources is best applied to broad scale land-use planning as achieved by the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)* (DOE 1999). Even if the Land Use Plan "zones" a particular area containing biological resources of concern as available for development (but with constraints), the site selection process for a particular project should consider the planning priorities outlined above and avoid as much impact and potential mitigation cost as possible.

5.2.3.3 Mitigation Thresholds

Even after following the mitigation hierarchy and the guidance in Section 5.2.3.2 to the extent possible, a project may still have significant residual impacts on Level III or IV resources. Therefore, once it is determined that a proposed action might adversely impact a potentially mitigable resource, it is then necessary to determine whether the impact will be significant and require mitigation via rectification and/or compensation.

In the sections that follow, mitigation thresholds are provided for each type of mitigable resource. A threshold is an allowable amount of impact above which the impact is considered significant and should be mitigated. It is defined here as the amount of habitat value reduction or potential species population impact that will trigger the requirements for rectification and/or compensatory mitigation. Mitigation thresholds address only human-induced impacts and not natural events. Depending on the type of resource being considered, a threshold determination may need to take into account the on-the-ground condition (or quality) of the resource, its location relative to other biological resources of concern, and the amount (e.g., area or population) of the resource that will be impacted.

The impact thresholds discussed below do not address those impacts (e.g., human proximity or human-caused noises) and their mitigation associated with disturbing the perching, roosting, or nesting behavior of bald eagles or nesting behavior of ferruginous hawks. These considerations are addressed in Section 7.4.9.

Level IV Biological Resources—Any impact to a Level IV resource is considered potentially significant. Therefore, the threshold value for Level IV resources is any reduction in area or loss in ecological function of a habitat-based resource or loss or reduction in use of a fall chinook salmon spawning area (i.e., redds) or documented bald eagle primary night roost or attempted nest site locations. Level IV resources at Hanford must be protected against impacts.

Riparian Habitat/Wetlands/100-Year Floodplain—Any impact to a riparian habitat or to a qualifying jurisdictional wetland resource or to key biological resource values within the Hanford Reach 100-year floodplain is considered potentially significant. Therefore, the threshold value for riparian habitat/wetland/floodplain resources is any reduction in area or loss in ecological function. To qualify for consideration, riparian habitats must either be composed of predominantly native vegetation,

[10] Letter from J. E. Rasmussen to The Hanford Natural Resource Trustees, dated May 22, 1995. Cumulative Impacts on the Mature Shrub-Steppe Habitat of the Central Plateau (200 Area and Vicinity) of the Hanford Site.

provide habitat for Level III or IV species, or serve to protect the ecological functioning of adjoining wetland or deepwater resources. To qualify as a jursidictional wetland, the wetland must meet the appropriate criteria specified in the 1987 U.S. Army Corp of Engineers' wetlands identification manual (ACOE 1987).

Late-Successional Shrub-Steppe—Ideally, it would be beneficial to be able to calculate habitat value on a scale that reflects some measure of relative value. Scaled habitat value models, such as Habitat Suitability Index (HSI) models, currently are not available for habitats at the Hanford Site. Until such models are developed, and at least for large, native shrub-dominated communities (i.e., big sagebrush, bitterbrush, and spiny hopsage), the variables and thresholds used in the sage sparrow habitat association model will be used in conjunction with geographically based area threshold values as an interim mitigation threshold for late-successional shrub-steppe.

The determination of whether a mitigation threshold may be exceeded by a given project is made during the ecological compliance review process and will be based on the on-the-ground, field-verified condition of the habitat and the amount of area to be impacted. Thus, two different thresholds must be exceeded before a project will incur a mitigation commitment to rectify and/or compensate for the impact, as appropriate: one threshold addresses habitat quality and the second the amount of area impacted based on geographic location.

To exceed the habitat quality threshold, the habitat variables at the site of the impact must meet three sage sparrow model conditions:

- at least 10% cover of big sagebrush
- mean big sagebrush height of at least 0.5 m
- no more than 25% ground cover by cheatgrass.

The use of model conditions (i.e., shrub cover and height) for determining appropriate mitigation thresholds will be extended to other late-successional shrub-steppe habitats containing bitterbrush or spiny hopsage. These shrubs often are present at Hanford as pure stands or as part of a mixed shrub community along with big sagebrush. Therefore, the cover and height conditions apply to pure stands of each of these shrubs or to mixed communities in which each shrub type can contribute to the cover and height characteristics of a particular area. Finally, for marginal habitat areas (i.e., those areas that qualitatively are difficult to judge as to whether or not they meet the model conditions), field crews conducting the ecological compliance review will use sighting information for biological species of concern (e.g., sage sparrows) as further confirmation of an area's capability to exceed the habitat quality threshold.

To exceed the area threshold, the project must impact areas greater than those identified in Table 5.3. The area threshold values in Table 5.3 are based on the estimated home range size of the sage sparrow and the land-use and disturbance patterns currently

Table 5.3 Mitigation Area Thresholds for Late-Successional Shrub-Steppe Habitat Areas

Level of Impact	Geographic Area on Hanford			
	600 Area (ha)	200 West Expansion Area; 200 Area Corridor (ha)	200 East: south portion; 200 West: northeast corner (ha)	All other sites within 200, 300 and 400 Area fences, 100 Area perimeter roads, and 1100 Area industrial sites (ha)
Individual site	0.5	1	5	No mitigation of habitat loss required other than avoidance and minimization
Project cumulative	2.5	5	10	

present on the Hanford Site. The home range size for the sage sparrow is conservatively estimated to be 0.5 ha (about 1.24 acres) of late-successional sagebrush-steppe. Different mitigation area threshold levels are set for different geographic areas on the Hanford Site. The area thresholds also apply to late-successional habitats containing bitterbrush or spiny hopsage. The different area threshold levels reflect current land use (industrial versus open space) surrounding the patches of late-successional, shrub-steppe habitat found within these areas, the size of the patches of habitat, and the connectivity of the patches to similar habitat.

Because the shrub-steppe patches within the 600 Area are generally surrounded by open space (i.e., undeveloped land with some habitat value), are often of large size, and tend to be connected to like patches, the 600 Area contains shrub-steppe habitat patches of the highest wildlife usage value. Therefore, this area is assigned the lowest threshold values. The big sagebrush-dominated portions of the 600 Area that are potentially affected by these guidelines are those portions identified as potential sage sparrow habitat areas in Figure 4.5. The 200 West expansion area and 200 Area corridor are assigned intermediate threshold values because, though they are in proximity to developed areas, they still represent significant blocks of suitable habitat. For the 200 Areas, including the 200 Area corridor (i.e., the 200 Area Plateau), potentially mitigable habitat affected by these guidelines, as well as the mitigation area threshold regions, are depicted in Figure 5.4.

Table 5.3 also provides both single site and project-cumulative mitigation threshold levels. This is because a single portion of a project (such as one well site) may have minimal impact and be below the threshold level, but the cumulative impact of an entire project (for instance 20 well sites) may be detrimental. These thresholds are an attempt to balance the effects of habitat fragmentation that could result from numerous small disturbances with the realization that each individual disturbance may have minimal impact.

Early-Successional Shrub-Steppe—To be considered suitable habitat to require mitigation via rectification and/or compensation, a habitat must qualify as a Level III or IV resource area. This section provides criteria that can be used to determine whether early-successional shrub-steppe habitat areas qualify as either Level III or IV resources. Qualification will depend on both the quality of the habitat at the site of the proposed action and its geographical location. Early-successional shrub-steppe habitat areas are assumed to represent Level II resources unless it can be demonstrated otherwise during ecological compliance review field surveys.

An early-successional shrub-steppe habitat area will qualify as a Level IV resource provided its constituent plant community type(s) are of such a condition, rarity, size, and location that they will be accepted as terrestrial element occurrences by the Washington State Natural Heritage Program (WDNR 1995). Evaluations should be conducted in accordance with Natural Heritage Program criteria. All currently identified element occurrences on Hanford have been verified for acceptance by the Natural Heritage Program. Thus, new areas proposed to qualify as an element occurrence—whether currently identified as a Level II area or otherwise—should be reviewed by the Natural Heritage Program for acceptability.

An early-successional shrub-steppe habitat area will qualify as a Level III resource provided it meets the following conditions:

- Cheatgrass ground cover is no more than 25%, and cheatgrass constitutes no more than 25% of total herbaceous (i.e., forbs and grasses) cover.
- Total herbaceous species composition is dominated (i.e., greater than 75%) by native species both in regard to herbaceous cover and species diversity.
- If appropriate to the soil conditions, a cryptogamic crust is present.
- The soil shows no indication of repeated disturbances that have reduced its ability to support a native plant community and associated wildlife. Indications of recent fire is not in itself sufficient to make a determination that soil function has been impacted.
- If native shrub species are reinvading the area, the dominant species are not species of rabbitbrush.
- The stem density of the large, native shrubs (i.e., big sagebrush, bitterbrush, and/or spiny hopsage) that are present can be projected to result in a cover of at least 10% when the shrubs reach maturity.
- The area of habitat that meets the above quality conditions must have a patch size of at least 0.5 ha (about 1.24 acres) and must be located in proximity to other Level III or IV resource areas.

Figure 5.4 Mitigation Area Threshold Regions and Mitigable Habitat on the 200 Area Plateau

(Soil and herbaceous understory conditions, as well as patch size and proximity requirements are mandatory; however, shrub conditions are conditional based on the stage of succession of the area under consideration.)

Rare Plant Populations (Level III or IV)—Any impact to a rare plant population is considered potentially significant. Therefore, the threshold value for a rare plant population is any reduction in the size of the population.

Bald Eagle Perch and Secondary Night Roost Locations—Potential impacts could be CERCLA-related or non-CERCLA related. The U.S. Fish and Wildlife Service concurred through informal consultation pursuant to Section 7(a)(2) of the Endangered Species Act that U.S. Department of Energy activities that are carried out consistent with the *Hanford Site's Bald Eagle Site Management Plan* (Fitzner and Weiss 1994) are "not likely to adversely affect" the bald eagle. The bald eagle management plan addresses only CERCLA-related site characterization and remedial activities. Provided it is consistent with the bald eagle management plan, DOE-RL can set guidance in regard to mitigation thresholds for bald eagle habitat. The following guidance is provided for CERCLA-related impacts:

- Any impact to a bald eagle perch and secondary night roost location that is within 1/4 mile of the average high water mark on either side of the Columbia River and that reduces its capability to function as perch or roost habitat is considered potentially significant. Therefore, the threshold value for bald eagle perch and secondary night roost locations within the 1/4 mile corridor is any loss of function as a potential perch or night roost location.
- Impacts to bald eagle perch and secondary night roost locations that are outside the 1/4 mile river corridor do not require mitigation beyond avoidance and minimization.

Non-CERCLA related actions that will potentially impact bald eagle perch and secondary night roost locations may require concurrence from the U.S. Fish and Wildlife Service that the actions are not likely to adversely impact bald eagles before the action can take place. Additionally, concurrence may depend on appropriate mitigation.

Ferruginous Hawk Historic Nest Locations—Any impact to a historic ferruginous hawk nest substrate (e.g., tree, transmission tower) that makes it unusable as a nest substrate is considered potentially significant. Therefore, the threshold value for a historic ferruginous hawk nest location is a removal of the nest substrate or reduction in physical dimension of the nest substrate that will result in the abandonment of that nesting location.

Administrative Areas—Some areas of the Hanford Site have administrative designations that are associated with a biological resource protection element. To the extent that resources of concern are located within these areas, it is appropriate for Hanford Site program/project managers to consider the threshold values provided in the preceding sections as minimum standards for when mitigation via rectification and/or compensation should be accomplished. Thus, the stated purpose of an area is an additional factor that should be considered when evaluating the need for appropriate mitigation.

5.2.3.4 Mitigation Ratios

Definition—A mitigation (or replacement) ratio can be defined as the ratio of the area over which mitigation measures are applied to the area receiving adverse impacts. The calculation of an appropriate ratio (and any adjustments made to the ratio because of time delays in accomplishing mitigation) ensures that the lost habitat value, and not simply the lost acreage, is replaced.

General Principles of Ratio Determination—Because habitat losses requiring compensatory mitigation are replaced based on habitat value, the replacement of lost habitat is not necessarily hectare for hectare. The difference in habitat value between the impact site and the habitat improvement area determines, in part, the appropriate mitigation ratio; however, what may be more of a determining factor is actually how much value can be added to an area by habitat improvements. Mitigation credit generally is granted only for the habitat value created by the habitat improvement and not for the previously existing value at the habitat improvement site.[11]

[11] There is an exception. Mitigation credit can be granted when it involves the preservation of high-quality, at-risk, habitat (not necessarily accomplished on a hectare-for-hectare basis).

Other factors may need to be considered in calculating an appropriate ratio. For example, if mitigation is implemented after project construction, or if replacement of habitat value takes a long time, then the mitigation ratio may need to account for additional habitat value (over and above replacement value) equal to the loss through time. Additionally, the mitigation ratio may need to be increased for a project that fragments habitat, as well as directly removes habitat, to account for the loss of value due to fragmentation. To avoid the consequences of these adjustments to the mitigation ratio, projects should minimize the time between impact and compensation and avoid project siting decisions that fragment Level III or IV resources.

A mitigation ratio can be based on the feasibility of how much habitat value can be added to an area. Other approaches also have been used for calculating a mitigation ratio. A ratio can be based on known or expected failure rates for mitigation. This approach is, in part, how wetland mitigation ratios have been determined. Additionally, ratios can attempt to account for the inability to ever replace the full ecological function of what has been lost. In this instance, a ratio can be proposed that is arbitrary and severe.

Current Guidance—The following mitigation ratio guidelines apply:

- For Level III plant species of concern the ratio is 1:1 (individual plants).
- For riparian or jurisdictional wetland habitats the ratio is 2:1 based on area in accordance Washington Department of Ecology requirements (Castelle et al. 1992a).
- For shrub-steppe habitats identified as Level III resources of concern, the following ratios are provided:
    1. For mitigation accomplished via rectification (i.e., the entire lost habitat value is to be replaced at the site of impact), the ratio is 1:1 based on area. No additional compensatory mitigation is required.
    2. For mitigation accomplished via compensation [i.e., the lost habitat value cannot begin to be replaced at the site of impact during the first two full planting seasons available following the actual impact and thus must be replaced away from the site of impact (e.g., if spring is the appropriate planting season, then revegetation should commence before the end of the second spring following the impact)], the guidance value for the ratio is 3:1 based on area.
    3. For significant impacts to mitigable habitat within the northeast corner of 200 West Area or the southern portion of 200 East Area, a minimum mitigation ratio of 1:1 based on area applies regardless of whether mitigation is accomplished via rectification or compensation. Because the surrounding areas include disturbed industrial sites, the preferred kind of mitigation may be compensatory regardless of whether or not the impact can be rectified onsite.
    4. For significant impacts to mitigable early-successional habitat that is mitigated using the replacement unit for late-successional sagebrush-steppe (i.e., out-of-kind mitigation), a mitigation ratio of 1:1 based on area applies regardless of whether mitigation is accomplished via rectification or compensation.

For projects that involve a mix of rectification and compensation (i.e., some portion of the impact site will remain impacted for periods greater than two full planting seasons), the 3:1 ratio, when otherwise applicable, applies only to that area that cannot be rectified. Mitigation ratios are not provided for Level IV resources as these resources should be protected against impacts. Should impacts to a Level IV resource be unavoidable, the ratio that may be applied can be expected to exceed that for Level III resources. The *Biological Resources Mitigation Strategy* (DOE-RL 1996) provides additional detail on mitigation ratios and their application.

Basis for the Shrub-Steppe Habitat Interim Compensatory Mitigation Ratio of 3:1 and Development and Use of Alternative Ratios—The shrub-steppe habitat mitigation ratio is interim in that, ultimately, it should be based on accurately known failure rates for improving habitat and quantitative evaluations of habitat value at the impact site and the habitat improvement site (which in turn are dependent on the development of Habitat Suitability Index models or equivalent that currently are unavailable). The interim ratio is based on an expected amount of increased habitat value that reasonably can be achieved at any particular habitat improvement site (i.e., about 33%). If based on failure rates, the 3:1 ratio also is reasonable based on previous, but limited, habitat improvement experience at Hanford. As experience is gained in habitat improvement methods, a ratio based on failure rates can be expected to improve somewhat (i.e., be less conservative) over time. The interim ratio also is consistent with guidance provided by Washington Department of Fish and Wildlife and U.S. Fish and Wildlife Service for the New Tanks Project.

Because the mitigation ratios identified above are provided to Hanford Site program/project managers as guidance, the use of other ratios is possible. The advantages of implementing the guidance are that the ratio values have been used before, have some technical backing, or in certain applications have gained the approval of some stakeholders. Thus, programs and projects are free to pursue development and use of alternative mitigation ratios; however, they must ensure the ratios are technically based and are subject to tribal and stakeholder review and, if necessary, concurrence (i.e., a mitigation ratio should not be arbitrarily determined and used).

5.2.3.5 Replacement Units

The use of a mitigation ratio implies that a certain level of habitat improvement is necessary on a per area basis to replace lost habitat value. To provide an appropriate basis for determining how much habitat improvement is needed, the concept of a replacement unit is used. A replacement unit is the amount of habitat improvement, per resource type and per unit area, that is necessary to achieve the mitigation goal. For example, for a mitigation ratio of 2:1 and a replacement unit defined on a per hectare basis, if 10 hectares are impacted then 20 replacement units of mitigation will be necessary. The quantification of the replacement unit is dependent on the resource impacted (i.e., the replacement unit for wetlands will be different from that for late-successional sagebrush-steppe with respect to the type and amount of vegetation seeded/planted and any physical amendments made to a site).

The *Biological Resources Mitigation Strategy* (DOE-RL 1996) will be the source of specific definitions of replacement units by resource type. Initial emphasis will be on a replacement unit definition for late-successional sagebrush-steppe. Appropriate replacement unit definitions for other mitigable habitats will be developed on an as-needed basis.

Each replacement unit definition will focus on replacing those attributes of native species composition, habitat structure, and ecological function that existed at the impact site in a cost-effective manner and will emphasize natural processes to aid replacement whenever appropriate. For example, the replacement unit for late-successional sagebrush-steppe should be defined so that habitat improvement actions result, within a reasonable timeframe, in achieving at least a 10% cover of big sagebrush (i.e., the threshold value for this variable in the sage sparrow habitat association model).

Replacement unit definitions will need to account for the likelihood of survivability of planted or seeded vegetation in determining how the mitigation goal will be achieved. The *Biological Resources Mitigation Strategy* (DOE-RL 1996) also will indicate for each replacement unit when corrective action would be necessary in response to excessive habitat improvement failures that will preclude the mitigation goal from being achieved. Finally, use of replacement units should be flexible. For example, if achieving the mitigation goal relies on out-of-kind mitigation, it may then be permissible, for example, to use the late-successional sagebrush-steppe habitat replacement unit as the mitigation goal for rectifying and/or compensating impacts to early-successional habitats.

In summary, by defining a replacement unit, and by providing guidance on what can be considered successful mitigation, the uncertainty of what constitutes adequate mitigation is removed.

5.2.3.6 Mitigation Areas

General—Mitigation areas are (1) onsite—impact rectified at the site of the impact by replacing the lost habitat value through habitat improvement—and (2) offsite—impact compensated away from the site of the impact through habitat improvement.[12] An offsite compensatory mitigation area must include locations where habitat improvements can occur adjacent to native habitat areas. The latter provide the relevant ecological context that enables the habitat improvements to effectively replace lost habitat value. The *Biological Resources Mitigation Strategy* (DOE-RL 1996) outlines the specific technical criteria that must be

[12] Offsite as used in this section refers to an area away from the project site but still on the Hanford Site. Compensatory mitigation also can be accomplished by acquisition of suitable habitat that meets the mitigation goal. In this case, the mitigation area is located off the Hanford Site.

considered when siting a mitigation area. The siting of a mitigation area also must be consistent with Hanford's land-use planning goals and constraints. Once established, mitigation areas that have been designated as part of a commitment in a Mitigation Action Plan, Record of Decision, or as part of a proposed NEPA action are considered either a Level III (onsite mitigation or rectification areas) or Level IV (compensatory mitigation areas) resource area.

Offsite mitigation areas can be established as either compensation areas (post-impact mitigation) for individual projects or as a mitigation bank (generally, pre-impact mitigation). Depending on how far DOE-RL implements the concept of a mitigation bank, the bank area can be operated either as a specific location where habitat improvements are made in advance to offset anticipated, future multiple-project-impacts or as a common compensation area that future projects can continue to use without the need for new siting decisions. In the absence of a mitigation bank, the selection of a project-specific compensatory mitigation area must be determined for each individual project.

The Special Case of Mitigation Banking—The long-term goal of the mitigation strategy is that most compensatory mitigation will be accomplished via participation in a mitigation bank. Under a true mitigation banking concept, habitat improvement actions are taken before impacts occur in anticipation that unavoidable future losses will need to be compensated.

Although a true mitigation bank would be the most desirable approach to compensatory mitigation at Hanford, the degree to which compensatory mitigation is coordinated sitewide can range from a project-by-project approach (no coordination) to complete coordination with pre-emptive habitat value replacement (true bank). Thus, there are intermediate options to a true bank should that level of coordination be unattainable. Four different levels of coordination can be identified:

1. Each project (or program) identifies its own compensatory mitigation areas, plans and implements its own habitat improvements, and maintains responsibility for maintenance and monitoring of the mitigation areas.

2. One or more common mitigation areas are identified, but each project continues to plan and implement habitat improvements within that area and is responsible for the continued monitoring and maintenance of its portion of the mitigation area.

3. A pseudo-mitigation bank is created that uses one or more common mitigation areas. The habitat improvements are coordinated by the bank managers using standardized implementing procedures, and the maintenance and monitoring of the mitigation areas are the responsibility of the bank managers. Under a pseudo-bank concept, credits are created (e.g., through habitat improvement) as a response to project needs; however, most likely, such credits are created after the losses already have occurred.

4. A true mitigation bank is created. This is essentially the same as a pseudo-bank, except that credits are created in anticipation of future project needs and before the project-induced losses occur.

Use of a common mitigation area will save time and money because siting decisions need to be made only once. Use of a banking system saves additional money because individual projects will not be required to engineer the habitat improvements or set up individual sub-contracts to accomplish the improvements. Under a bank system, each project would simply pay into a common pool operated by the bank managers (tentatively Office of Site Services) who would then coordinate the habitat improvements for all projects. Use of a true mitigation bank would ultimately be the most cost effective, but it would require that non-project-specific "seed money" be identified and appropriated to create the initial bank credits before they are needed by projects.

The advantages of mitigation banking include:

- better overall coordination of Hanford Site mitigation
- elimination of the learning curve on a project-by-project basis
- reduction of the time required for preparation of NEPA documents
- reduced cost because of the economy of scale
- improved consistency in mitigation practices
- elimination of extended project durations required to complete mitigation and monitoring

- enabling projects to adequately budget for mitigation
- ensuring mitigation will be performed by experienced personnel.

The two key concepts of the mitigation bank are:

- Impacts of a similar nature are treated in a similar but comprehensive manner
- Mitigation efforts are begun (and objectives are met, if possible) before the impact occurs.[13]

Under these concepts, projects may begin mitigation efforts (pay into the bank) before any disturbance to the resource takes place. When a balance accrues in the bank, the project may take credit for the mitigation when the impact occurs (withdraw from the bank). Although pre-payment is preferred, projects would be allowed to pay into the bank at any time.

Mitigation banking provides a means both to minimize the risk to resource health and survival posed by future projects and to perform the habitat improvement and monitoring in a manner that takes advantage of economies of scale. Mitigation banking is a concept that has been well developed for addressing wetlands impacts (e.g., Castelle et al. 1992b), but has been less well-defined for impacts in other areas, although it is recognized as a potential component of mitigation by both the U.S. Fish and Wildlife Service (46 FR 7644, USFWS 1988) and the Washington State Department of Fish and Wildlife (Policy 3000, October 1992).

The *Biological Resources Mitigation Strategy* (DOE-RL 1996) describes the following components of a mitigation bank system:

- bank objectives and currency
- bank site(s), including necessary site protection and controls
- a policy for bank operation, including payments, construction, use of credits and debits, and bank management responsibilities
- funds and schedule for monitoring, remedial actions, and reporting on bank operations.

5.2.3.7 Mitigation: Summary of Project Manager Required Actions

The mitigation associated with a proposed action can be determined in a number of ways. For a project that is tied to a specific location, the ecological compliance review report will contain mitigation recommendations that the project manager should consider. By being tied to a specific location, however, much of the flexibility associated with the mitigation hierarchy of actions is not available.

For projects that include a site selection component as part of the proposed action, there is more flexibility available to use the mitigation process. This can help to reduce the amount of impact to biological resources of concern and the associated mitigation cost by first following the mitigation hierarchy and second by using mitigation requirements as part of the trade-off analysis for choosing between alternative locations and actions.

The step listed in the box on the bottom of the page outline actions a project manager needs to take to be in compliance with mitigation requirements. The steps can aid avoiding unnecessary adverse impacts to biological resources of concern (and thereby reducing the amount of costly mitigation) and determining what additional mitigation may be necessary for a proposed action when adverse impacts are unavoidable.

5.2.4 Roles and Responsibilities

Effective implementation of the mitigation strategy requires that the roles and responsibilities be well defined for DOE-RL and each of the contractors. The roles and responsibilities for each of these organizations or groups are described in the *Biological Resources Mitigation Strategy* (DOE-RL 1996). The overall relationships are depicted in Figure 5.5.

5.3 Restoration

Restoration can be distinguished from mitigation by the nature of the impacts to biological resources they each address. Mitigation addresses those

13 Beginning mitigation before the impact occurs may act to reduce the required mitigation ratio. The calculation of lost habitat value is partly time-dependent. If mitigation is delayed, the amount of habitat value needed to be replaced may increase.

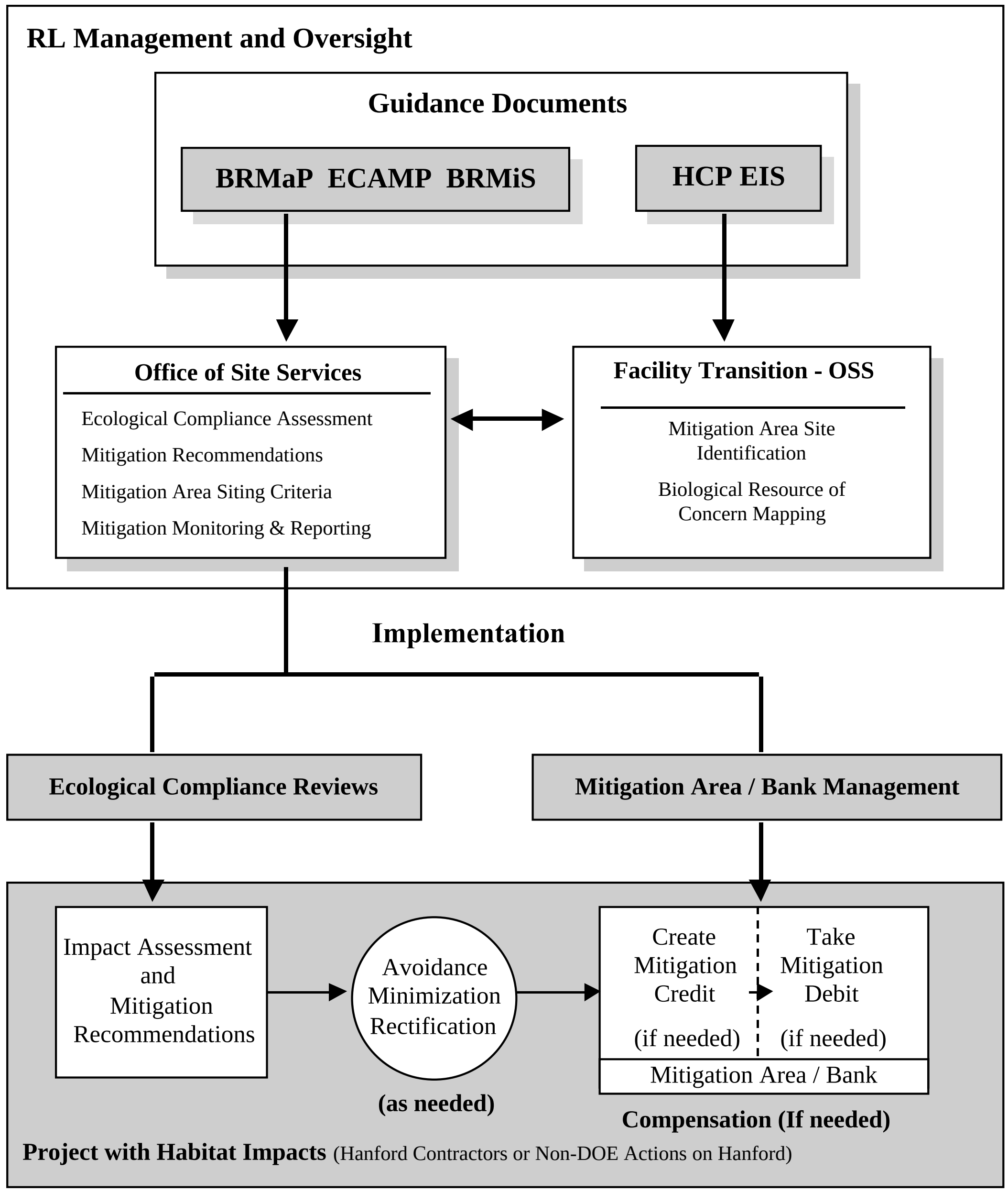

Figure 5.5 Organizational Structure and Flow for Implementation of Biological Resource Mitigation (BRMaP = Biological Resources Management Plan; BRMiS = Biological Resources Mitigation Strategy; ECAMP = Ecological Compliance Assessment Management Plan; HCP EIS = Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement; OSS = Office of Site Safety)

impacts to existing resources that will occur as a result of a proposed action. In contrast, restoration addresses human-caused impacts that may have occurred in the past (e.g., at a past-practice waste site). Although this example may be restoration's chief application at Hanford, the concept also can be applied more generally: for example, the site of a decommissioned, but previously non-contaminated building, also is a candidate for restoration. Finally, restoration also can be considered at scales larger than an individual waste site or building.

This section provides an overview of what restoration entails at Hanford. As will be discussed below, there are a number of constraints that preclude specifying specific requirements for restoration. What can be provided at this point are some guiding principles and the beginning outlines of a Hanford Site restoration strategy.

Mitigation: Summary of Project Manager Required Actions

Step 1—If site selection has yet to be determined or can be modified for a proposed action, use the composite biological resource level of concern maps in Chapter 4.0 to determine where constraints for siting may exist (for the 200 Areas, use Figure 5.4).

Step 2—As applicable, follow to the extent practicable the mitigation planning priority guidance outlined in Section 5.2.3.2 for avoiding adverse impacts to the highest valued shrub-steppe resources.

Step 3—For the site selected, determine whether a mitigation threshold has been exceeded based on the kinds of resources potentially impacted in accordance with Section 5.2.3.3. When it becomes necessary to formally document this determination, the documentation will be provided to the project manager via the ecological compliance review report. The project manager may desire, however, to make his/her own preliminary determination.

Step 4—If a mitigation threshold has been exceeded, determine the applicable mitigation ratio (Section 5.2.3.4) and replacement unit (Section 5.2.3.5) for the kind(s) of resource(s) impacted. Determine the overall mitigation requirement for this proposed site/action. As for Step 3, final mitigation requirements will be documented in the ecological compliance review report. The Hanford Biological Resources Laboratory can be contacted for assistance with any of the preceding determinations.

Step 5—If alternative site locations and/or actions are being compared, repeat any of the necessary steps above for each location/action.

Step 6—If compensatory mitigation is required, work with the Hanford Biological Resources Laboratory to identify potential mitigation areas. The Laboratory will assist in determining whether a common mitigation area already exists and is available or whether a new mitigation area must be selected to mitigate for the proposed action (Section 5.2.3.6).

Step 7—Define the mitigation goal for the project. Plan, budget for, and implement, as necessary, any required or recommended mitigation actions.

Step 8—Plan to monitor the success of any mitigation action conducted and be prepared to correct any failures.

5.3.1 Purpose and Goals

The narrow purpose of restoration is to create some amount of habitat value at a site (e.g., past-practice waste site, industrial area, road, etc.) at which at the time of remediation, decommissioning, or end of use little or no value exists. A broader purpose of restoration is to replace habitat value and ecological function over a broad geographic area to account for accumulated losses of value and function attributable to human-induced impacts.

The general goal of restoration is to establish, through the use of habitat improvement methods and the aid of natural processes, the necessary species composition, structural components, and ecological processes at a site such that it can support native plants, fish, and/or wildlife.

The specific restoration goal depends in part on what future use is planned for the site and, if the land-use goal is to create habitat value for the benefit of plants, fish, and wildlife, in part, on the kind of habitat that is desired (i.e., it may not be necessary or prudent to attempt to establish the same kind of habitat that existed at the site before the initial human-induced disturbance). In those cases in which the land-use goal is not to create habitat value at a particular site subsequent to remediation, decommissioning, or end of use, the site may simply be stabilized (e.g., for dust control purposes) or it may be converted to other uses (e.g., putting in a new building, a parking lot, etc.).

5.3.2 Legal and Policy Basis

Restoration already has occurred at Hanford. Most recently, this involved revegetating some sites associated with the Basalt Waste Isolation Project. Today, however, there is little legal basis for determining when restoration may be appropriate for the types of activities conducted at Hanford. For example, for terrestrial waste site cleanup scenarios in which site remediation occurs under CERCLA, there is little specific guidance provided, let alone legal requirements that address restoration of habitat lost incidental to the release of hazardous substances and conducted subsequent to remediation.

No specific, broadly applicable policy exists at Hanford for waste site restoration or any other form of restoration; however, in March 1996, DOE-RL became a signatory to a Memorandum of Agreement in which the agency agreed to participate in the Hanford Natural Resource Trustee Council.[14] One objective of the Trustee Council is: "To integrate, to the extent practicable, natural resource restoration into remedial actions taken at the Hanford Site..." A second objective encouraged: "...the development and implementation of sitewide natural resource planning which supports mitigation, restoration, and management goals, and encompasses good stewardship practices." Any future policy in regard to restoration will reflect DOE-RL's participation as a Natural Resource Trustee.

5.3.3 Implementation

General Principles—Although restoration and mitigation have been distinguished by the types of impacts they address, they share a commonality when their actions are directed at replacing lost habitat value. Moreover, instead of just considering restoration in the narrow sense of what occurs at an individual site subsequent to remediation, decommissioning, or end of use, restoration also can be viewed from a broader, sitewide perspective. Given that Hanford is in the midst of a large-scale remedial effort, decisions will need to be made about which lands will be restored and which will not subsequent to remediation. This decision process can be aided if it is understood that the success of restoration is better judged at ecological scales and not necessarily at the scale of an individual waste site. Therefore, restoration can be more successful if it is fully integrated with a Hanford sitewide mitigation strategy. This is especially true in those instances in which restoration efforts (i.e., the creation of habitat value) are better served if they are performed other than at the remediated waste site.

Restoration planning decisions should be made in concert with sitewide land-use planning decisions. Thus, restoration should be accomplished with a broad vision in mind. What should the entire site look like for the foreseeable future? Where are the best places to restore, or where should restoration otherwise occur when a particular remedial/decommissioning site cannot be successfully restored or its intended land use is not to provide habitat for plant, fish, or wildlife populations? Thus, whenever possible, restoration should be planned based on a landscape perspective of sitewide restoration needs rather than just on an individual remedial or decommissioning site basis.

Because restoration involves creation of habitat value, it can use the same technical approaches as have been outlined in Section 5.2 for mitigation via habitat improvement (e.g., the use of replacement units insofar as the concept helps guide how much habitat improvement effort may be needed to achieve the restoration goal). Further technical guidance (i.e., specifically in regard to revegetation) is provided in Section 7.2 and the *Biological Resources Mitigation Strategy* (DOE-RL 1996). Finally, as is the case for designated onsite mitigation or rectification areas, areas that have been restored as part of a commitment in a Mitigation Action Plan or Record of Decision should be regarded as Level III biological resources of concern (see Section 7.4.5 and Table 7.1).

Restoration in a CERCLA Context—Ultimately, a restoration strategy, insofar as it will be driven by CERCLA-related needs, will probably reflect the consensus viewpoint of members of the Hanford Natural Resource Trustee Council. Because of this likelihood, it would be inappropriate to unilaterally outline here the specifics of a restoration strategy.

As a starting point, however, it may be helpful to identify a few considerations in regard to CERCLA-related restoration. These are:

- Restoration agreements can be either negotiated waste site by waste site or at larger scales. For reasons provided previously, at least from an ecological perspective, the latter approach is preferred.
- Restoration agreements, especially if they cover a broad geographic area, may necessitate a comprehensive (perhaps sitewide) restoration plan.

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14 Signatories to the Hanford Natural Resource Trustee Council Memorandum of Agreement are the U.S. Department of Energy (Richland Operations Office), U.S. Department of Interior, Nez Perce Tribe, State of Oregon, Confederated Tribes of the Umatilla Indian Reservation, state of Washington, and the Confederated Tribes and Bands of the Yakama Nation.

- An agreement on restoration that arises out of a cooperative relationship between DOE-RL and the other Hanford Natural Resource Trustees is preferable to one that is dictated via a formal Natural Resource Damage Assessment process.
- Implementation of a landscape-scale restoration effort does not, and perhaps should not, wait until all waste site remediations are complete.
- To facilitate an early agreement on the scope of restoration, it may not be necessary to tie the need for restoration directly to the effects of contaminant exposure.

Non-CERCLA Related Restoration Actions—Restoration in a non CERCLA-related context will not necessarily be subject to Hanford Natural Resource Trustee Council purview, though at its discretion DOE-RL can invite non-DOE Trustee input. With no specific impetus for restoration, it is important that restoration decisions are based on intended land use and are, in general, in concert with other sitewide initiatives (i.e., mitigation and CERCLA-related restoration). Thus, the considerations for non-CERCLA related restoration are as follow:

- Unless some formal commitment has been made through mechanisms such as a NEPA document in which it is identified that following the useful life of a project site conditions will be restored, restoration is otherwise discretionary.
- When restoration will take place, then its goal should be to replace habitat value commensurate with the site's location and other resource management initiatives (e.g., perhaps a management objective is to enhance the status of a particular resource at Hanford).
- If the intended land use for an area is not to function as plant, fish, and/or wildlife habitat, then site stabilization or conversion to other uses should be pursued, as appropriate.

Toward a Hanford Site Restoration Strategy—A prerequisite for the development and implementation of a Hanford Site restoration strategy is a comprehensive, long-term vision of the Hanford Site and its public uses. Implicit in this vision is that, for the foreseeable future, there will be a considerable federal presence at Hanford. To be successful, a sitewide restoration strategy must enable DOE-RL to pursue those missions society deems appropriate and must have the backing of local tribes and stakeholders.

A Hanford Site restoration strategy should encompass the following considerations:

- The strategy should be developed and implemented in conjunction with comprehensive land-use planning for the Hanford Site and be consistent with a future vision of the Site (DOE 1999). Thus, constraints on restoration planning, such as areas intended to remain industrial for the foreseeable future, should be acknowledged.
- The strategy should be developed and implemented in accordance with the principles of ecosystem management as outlined in other sections of this document. Thus, restoration planning should consider ecological boundaries as well as administrative and consider restoration needs within the context of the surrounding ecoregion.
- The strategy should be developed and implemented in concert with Hanford's sitewide mitigation strategy. Common areas for conducting habitat improvement should be considered and concepts such as banking should be investigated for their mutual applicability and overall benefit to resource management.
- The strategy should be developed and implemented with the meaningful participation of local tribes and stakeholders.

Restoration: Summary of Project Manager Required Actions—Nothing specific is required of project managers at this time. For CERCLA project managers, individual restoration actions, at least in the short-term, will be a result of coordination between DOE-RL and the other members of the Hanford Natural Resource Trustee Council. For non-CERCLA project managers, restoration will more than likely remain discretionary. The lack of a restoration requirement, however, does not preclude a project from having to at least stabilize a site based on other requirements (e.g., dust suppression).

5.3.4 Roles and Responsibilities

The performance of restoration actions is the responsibility of the relevant DOE-RL program or project lead in conjunction with the relevant contractor, as necessary. For CERCLA-related projects, the environmental restoration contractor is responsible for all restoration actions. Until a sitewide restoration strategy is in place, there is no overall oversight responsibility for restoration.

5.4 Tribes and Stakeholders

Several Tribes and stakeholders have both concerns for and interests in the impact management of, mitigation of impacts to, and restoration of Hanford's biological resources. These include the Yakama Nation, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, and the Wanapum people, USFWS, WDFW, and Washington Department of Natural Resources.

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 USFWS, the WDFW, and Washington Department of Natural Resources (WDNR) 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 depends 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, described in Appendix B, have specific provisions concerning monitoring. These include:

- 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 one 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 one 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 one 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, and 1998) 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, 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

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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 cover-age 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 impov-erishment because of their particular suscep-tibility 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 communi-ties. 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

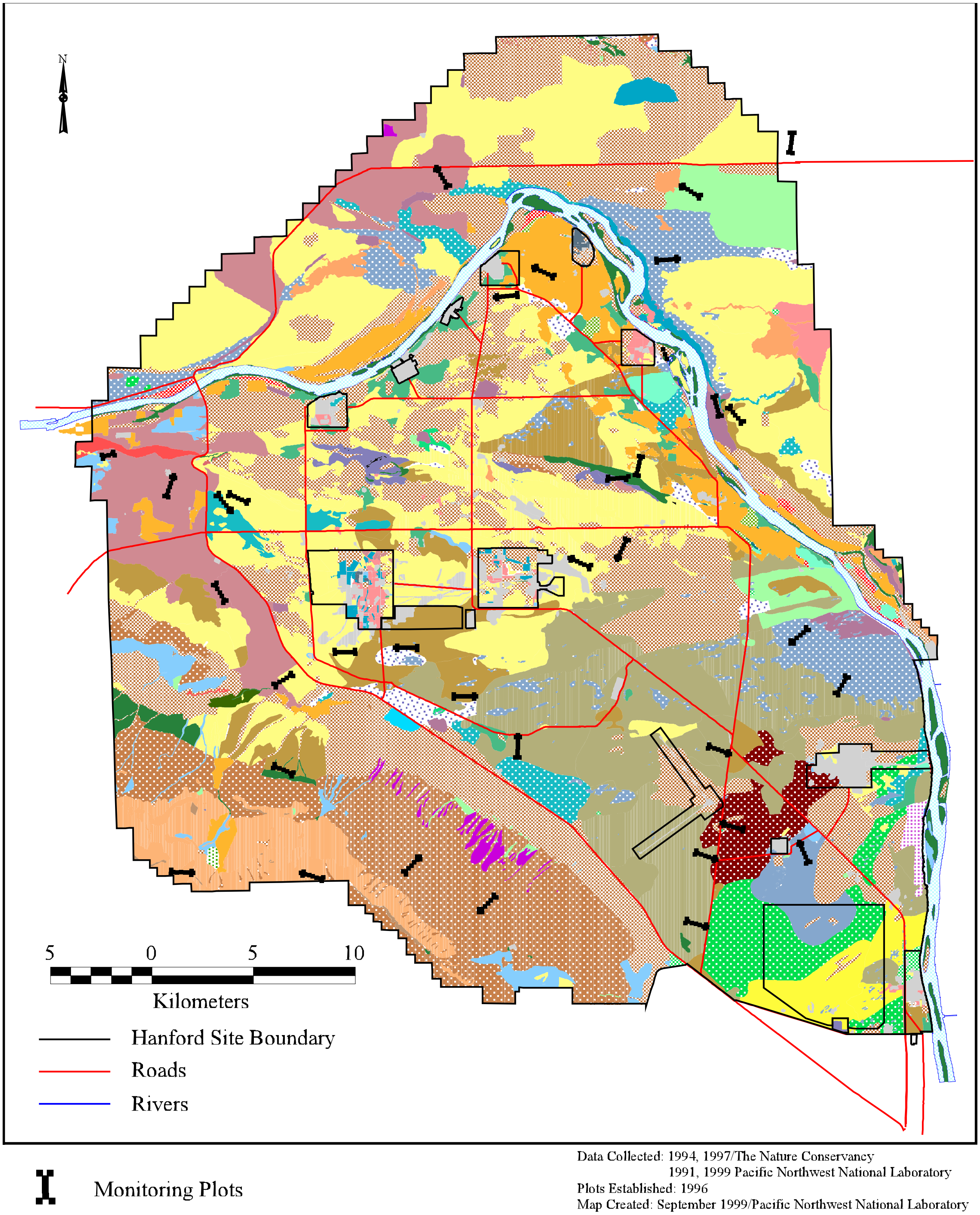

Figure 6.1 Hanford Site Monitoring Plot Locations (Map)

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.

7.0

Landscape Management

Landscape management addresses actions and processes that affect multiple species, habitats, and ecosystems. Individual fish and wildlife species are held in trust for the public benefit by the state of Washington (i.e., Department of Fish and Wildlife) and, for specific resources such as migratory birds and federally threatened or endangered species, by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Because of these other authorities, DOE-RL does not have the authority to directly manage species outside of impact assessment and status monitoring. However, this limitation does not necessarily constrain DOE-RL's ability to manage Hanford's biological resources. Most single species concerns are best addressed by maintaining functional native habitat and plant communities within a landscape-based perspective.

Thus, management topics addressed in this section cover such areas as fire management; habitat fragmentation; landscape-level human activities such as road construction and agriculture; revegetation practices; and administrative control areas.

7.1 Fire Management

Although many plant communities on Hanford and their associated wildlife species have evolved in the presence of natural fires, past and present land-use practices, and the presence of non-native plant species, have altered the frequency and severity of fires. More frequent and severe fires have reduced the availability of late-successional shrub-steppe habitat for species that are dependent on this habitat type for at least part of their life cycle. Also, in addition to fire itself, many plant communities on Hanford are sensitive to and slow to recover from the impacts of certain fire-fighting activities (e.g., the creation of firebreaks).

7.1.1 Fire Ecology and Hanford Habitat Classes

Fire is both a natural and human-caused occurrence in shrub-steppe environments. Compared to historic times, vast expanses of unfragmented, high-quality (i.e., mostly native plant species composition) shrub-steppe no longer exist; however, high quality shrub-steppe occurs at Hanford in scattered tracts of land. When these areas are burned and altered by fire, it may result in the loss or degradation of much of the remaining high-quality shrub-steppe habitat within the Columbia Basin Ecoregion.

Typically, shrubs are killed by fire, but bunchgrasses are not. Recovery to a native habitat (even to bunchgrasses), however, is today less certain given that the surrounding lands may be a ready source of non-native plant seeds of the type that may enjoy a competitive advantage following a fire. Many animal species dependent on the sagebrush component of the southcentral Washington shrub-steppe are species of concern (e.g., sage sparrow).

Fire management is today an important factor in biological resource management at Hanford because Hanford contains high-quality shrub-steppe habitat of significant regional value, the nature of shrub-steppe fire ecology makes recovery following fire less certain, and human-caused fire can increase the rate of habitat loss from fire.

Portions of the Hanford Site where plant species composition has been badly degraded and now consists largely of invasive, non-native annual plants (e.g., the abandoned old fields[1]) are not of immediate concern for fire protection, because fire will not degrade their species composition or habitat value any further. Post-fire habitat areas (i.e., those areas burned within the last 20 years or so) or those areas that have intermediate value as habitat to species of concern, warrant protection from fire because they have current habitat value for some shrub-steppe species or because they represent future high-quality habitat if allowed to recover unimpeded by burning. Fire management for Hanford's biological resources is most important for those areas containing element occurrences and for those habitats of concern having an abundance of mature sagebrush shrubs.

7.1.2 Consideration of Biological Resource Values in Fire Management at Hanford

Fire management policy for Hanford's habitats of concern (includes post-fire, late-successional shrub-steppe and element occurrence areas) is to minimize the potential for human-caused fires and aggressively fight fires. Fire management measures also may need to be applied to low-quality habitat areas (e.g., abandoned old fields) if they are adjacent to habitats of concern and can "carry" fires into these areas.

The use of heavy equipment to create fire breaks around the perimeter of a burn can result in permanent damage to the soil and existing vegetation. Plowed fire breaks also facilitate the establishment and spread of weedy species (primarily non-native) into areas where they may have not existed previously. For areas without shrubs but with native understory (i.e., grasses and forbs), which on Hanford are areas that have been burned previously but where past soil disturbance from activities such as farming have not occurred, and areas otherwise containing element occurrences, fire-fighting should emphasize minimizing the creation of new fire breaks to the extent that life or property are not put at greater risk.

The land cover map for the Hanford Site shows the locations of shrub-dominated areas and post-fire areas. This map, along with the map of element occurrences, can provide the basis for discussions between the Ecosystem Monitoring Project and the Hanford Site Fire Department. These discussions will be aimed at identifying and planning for three specific categories of fire management for habitats/ plant communities on the Hanford Site.

Category 1: Non-Habitats of Concern—These low-quality habitat areas receive the least consideration for protection from fire. Fire fighting in these areas should occur as necessary to protect structures and/or facilities or to prevent fires from spreading into category 2 or 3 areas. Category 1 areas are the preferred location to place fire breaks. Fire breaks do not require any post-fire treatment.

Category 2: Post-Fire and Other Habitats of Concern Not Already Addressed—Intermediate fire protection should be provided to these areas. Fires that threaten these areas should be aggressively fought; however, fire fighting actions should be tied to the need to protect structures and/or facilities. Any necessary fire breaks should be placed preferentially in category 1 areas. Any temporary firebreaks that may be constructed during fire-fighting should be reseeded with an appropriate mix of locally occurring native plant species and the edges of the break re-contoured.

Category 3: Element Occurrences and Late-Successional Shrub-Steppe—The maximum fire protection should be provided to these areas. Protection includes aggressively fighting fires that threaten these areas, independent of the need to protect structures and/ or facilities, and by planning any necessary fire breaks to be placed preferentially in category 1 areas first and category 2 areas second. The decision to fight fires *within* a category 3 area should depend on whether the greater risk to long-term habitat/ plant community condition is from the fire or from the fire-fighting actions themselves (e.g., creation of fire breaks). If the decision on whether to fight a fire that is impacting a category 3 area primarily is dependent on the need to protect biological resource values, then the Hanford Site Fire Department should make every effort to contact staff from the Ecosystem Monitoring Project to assist in planning the appropriate fire-fighting strategy. Any temporary firebreaks that may be constructed during fire-fighting should be reseeded with an appropriate mix of locally occurring native plant species and the edges of the break re-contoured.

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[1] Land cover classes discussed in this paragraph are shown in Appendix D.

All fires over 10 ha in size should be delineated by a GPS and the data maintained in the Ecosystem Monitoring Project's GIS-based data base.

7.1.3 Prescribed Burns

Prescribed burning for the purposes of habitat management is not a current element of the Hanford Site biological resources management strategy. Small, controlled burns as an element of research programs can be considered on a case-by-case basis, but requires the approval of the Hanford Site Fire Department. Controlled burning of accumulations of dry plant material, particularly along roadways, is conducted to remove large potential sources of fuel that, if accidentally ignited, could provide a mechanism for rapidly accelerating uncontrolled burns.

7.2 Revegetation Practices

Revegetation on the Hanford Site is not conducted through a single program or even through a single contractor. Revegetation, however, is an important component of many Hanford Site activities, including waste site restoration or interim stabilization and mitigation actions.

7.2.1 Types of Revegetation Actions and Their Application

The specific protocol followed for a particular revegetation action will depend on the purpose of the action, the length of time the vegetation must remain viable and functional, and the desired revegetation endpoint. The latter is dependent on the location of the revegetation action. There are five major types of revegetation actions:

1. short-term interim stabilization
2. long-term interim stabilization
3. habitat improvement via habitat amendment
4. habitat improvement via reclamation or habitat creation
5. landscaping.

Short-Term Interim Stabilization—Short-term interim stabilization is appropriate when an exposed soil surface must be protected for periods of up to several months. For example, if habitat removal is required for a project, it may need to be conducted before migratory birds begin nesting; however, the actual construction phase of the project may not be scheduled to begin until a later date. In the interim, the exposed soil surface may need to be vegetatively stabilized. This stabilization can be accomplished using a temporary ground cover such as sterile rye or spring wheat. The species selected should not be one that has a potential to escape from cultivation and become established in surrounding native plant communities. If stabilization is required for periods of only several weeks, chemical soil fixatives can be considered.

Long-Term Interim Stabilization—Long-term interim stabilization is appropriate when a site requires stabilization for an indefinite period of time, normally measured in years. In these situations, it is assumed that eventually the site will be re-disturbed for either final remediation or for other site development purposes. This is often the case for inactive waste sites (cribs, burial grounds, ponds, etc.) that will be re-disturbed and remediated at some point in the future.

Species used for long-term interim stabilization should be perennial bunchgrasses that are either native to the Hanford Site or introduced species such as crested wheatgrass. If an introduced species is used, it should not be one that can readily expand into adjacent native plant communities. In general, shrubs are not useful for interim stabilization because the site eventually will be re-disturbed (therefore, the added expense of planting shrubs would be unjustified) and, if the site is an inactive waste site, deep-rooted shrubs have a higher likelihood of contacting and uptaking radioactive or hazardous wastes than would bunchgrasses.

Habitat Amendment—Habitat improvement via habitat amendment is normally performed to fulfill all or part of a project's compensatory mitigation requirements. Habitat improvements are intended to increase the habitat value of a particular site for selected wildlife evaluation species. The site will often already have some habitat components required by the evaluation species. Habitat improvements of this type are intended to be permanent; therefore, the site should be identified as a Level IV biological resource area in appropriate land-use plans for the Hanford Site. Species used for habitat amendment should be native to the Hanford Site and should preferably be of locally derived genetic stock. Improvements may be made to the understory (grass and forb components), to the shrub component of the community, or to both.

Reclamation or Habitat Creation—Habitat improvement via reclamation is necessary when an area has experienced intensive disturbance (e.g., an overgrazed area or previous agricultural area). Vegetation may be present; however, it typically is weedy or at worst, composed mostly of non-native species. The cryptogamic crust is mostly absent. Habitat improvement via creation of new habitat is necessary when an area is essentially devoid of plants and some amount of soil amendments may be necessary to restore a vegetative cover (e.g., a waste site that has received extensive herbicide treatment, a borrow site, or an abandoned infrastructure site). For both types of habitat improvement, the desired endpoint depends on the intended land-use for the site.

Within areas to be used as wildlife habitat, the goal of reclamation or habitat creation will be to create functional wildlife habitat that resembles native plant communities in the vicinity. Other endpoints, however, are possible if alternative future land-uses of the site are envisioned or if an alternative type of habitat is desired. If native wildlife habitat is the planned revegetation endpoint, the plant species selected should be native to the Hanford Site and should preferably be of locally derived genetic stock. All habitat components should be included in the revegetation effort, including shrubs, perennial bunchgrasses, and forbs.

Landscaping—A recent Executive Memorandum (discussed at 59 FR 43122) directed the use of regionally native plants on federal landscaped grounds. Commensurate with other considerations, such as budget and availability, projects that have a landscape component should give strong consideration to the use of plant species native to the Hanford Site and of locally derived genetic stock.

For all types of revegetation actions, it is important that all materials (seed, mulch, soil amendments) are certified to be weed-free to prevent the inadvertent introduction of unwanted plant species to the Hanford Site. Procedural guidance for revegetation is currently being developed by the environmental restoration contractor.

7.2.2 Selection of Appropriate Plant Seed and Stock Materials for Revegetation

The selection of appropriate plant species for revegetation depends on the goals of revegetation. In almost all cases, the seed or plant materials used for habitat improvements should be (1) species representative of broad community (shrubs, forbs, grasses) to include species of plants that have cultural significance to the tribes, (2) species native to the Hanford Site, and (3) the appropriate specific genetic or ecotypic derivation for Hanford. Stabilization or landscaping efforts that desire to use native plant material also should consider the preceding criteria.

Basis for the Use of Locally Derived Plant Materials—The use of plant material that simply has the correct native Latin binomial is not necessarily adequate. A species may show significant genetic differentiation and adaptation in response to factors such as climate, soils, aspect, and many other selective forces that may not always be obvious. This tends to be especially true for species with large geographical ranges. The Society for Ecological Restoration (1994) also recommends the use of regional ecotypes for revegetation projects. Linhart (1995) provides an excellent review of the genetic and evolutionary basis for the use of local plant material for habitat improvement.

Locally derived plant materials are preferable over non-local stock for two reasons. First, local populations have been exposed to hundreds or thousands of years of selective pressures under the local conditions and are therefore well adapted to those conditions. Plants materials collected from distant areas will most likely be less well adapted to the local conditions at a particular site than plants growing in nearby, similar areas. The uniqueness of Hanford's climate relative to its surroundings—as exemplified especially on the Columbia River plain by the low amount of annual precipitation and hot summers—make this an important consideration.

Therefore, the chances for successful habitat improvement are increased by using the best-adapted material available. Plant materials obtained from distant locations also run a higher risk of being contaminated with weedy species not locally present. The definition of "local" is by necessity species-specific and depends on factors such as life history, breeding systems, pollination mechanisms, and specific selective forces. In extreme cases (i.e., those with strong selective pressures), significant genetic differentiation has been shown over distances of as little as several meters (Aston and Bradshaw 1966; McNielly 1968). Even wind pollinated conifer trees can show significant differentiation over distances less than 500 m (Linhart et al. 1981).

Second, less-adapted genotypes introduced to a site may recombine with the surrounding native genotypes. The result could be a decrease in the fitness of the native populations. The genetic changes within populations that occur could lead ultimately to ecosystem disruption at various levels. For instance, genetic changes within a particular plant species population could cause a decrease in plant biomass production, which could then adversely affect small animal populations. Alternatively, genetic changes could render the indigenous plants less competitive with aggressive, non-native weedy species such as cheatgrass.

Prohibitions Against the Use of Non-Native Species—In general, the use of non-native species for habitat improvement, whether or not the intended end use is as wildlife habitat, is not recommended. Non-native plant species can seriously affect native plant community structure and composition, especially if the non-native species are capable of reproducing and expanding into the adjacent native communities. The best local example of this is the rapid spread of cheatgrass throughout the Intermountain-West over the past century (Mack 1981).

The Society for Ecological Restoration (1994) has issued a policy statement explicitly recommending that non-native species not be introduced as part of a restoration (i.e., revegetation) plan. This policy also recommends the highest priority be given to the control of those non-native species that potentially could replace key indigenous species, reduce native species diversity or richness, or that could significantly alter the structure or function of native communities or ecosystems. Because it can be difficult, if not impossible, to predict which non-native species may affect natural systems, none should be considered for use in habitat improvement actions, including waste site restoration applications.

Selective Use of Non-Native Species—On the Hanford Site, *interim* stabilization of inactive waste sites, via revegetation, is not specifically intended to provide wildlife habitat. The primary purpose of these plantings is to prevent contaminant uptake and migration and to minimize erosion. By definition, the stabilization is intended to be non-permanent (i.e., until the waste site is fully remediated and restored). Over the past 15-20 years a number of sites, primarily within the industrialized portions of the Hanford Site, have been planted with non-native grasses—primarily crested wheatgrass and Siberian wheatgrass. Scattered individuals of these species are occasionally observed in areas where they were not planted, but in general, these species do not appear to spread extensively into the surrounding native plant communities. Therefore, these species may be used in the interim stabilization of inactive waste sites that will eventually be re-disturbed during the site remediation process; however, the use of native species is still strongly encouraged, especially in situations in which the waste site is located adjacent to native habitat.

Guidelines for Selecting Native Plant Material—For the purposes of habitat improvement on the Hanford Site, plant materials (i.e., seed, plant parts, or whole plants) should, at a minimum, be collected on or in the immediate vicinity of the Hanford Site. Preferably, collection should occur near the site to be revegetated, within the same soil type, and at roughly the same elevation. In the case of small projects, it may be possible to collect plant materials from areas immediately adjacent to the site to be revegetated. For larger projects that may not be practical. In such cases, materials should be collected and pooled from several different locations on or near the Hanford Site when feasible. Plant materials gathered outside the Columbia Basin Ecoregion should not be used for revegetation efforts. The application of these guidelines will help maintain or promote native genetic richness and will increase the likelihood that a well-adapted ecotype will be established on the site.

7.3 Management of Landscape-Level Attributes and Processes

With a landscape-based management approach, no specific species is targeted for management. All native species and species assemblages are considered important. Threatened and endangered species have achieved their status mostly because of habitat loss or degradation and, for the most part, can be protected when habitat is protected. Moreover, landscape management usually can be conducted in a more cost-effective manner than management for a variety of single species. The BRMaP emphasizes a landscape-based approach to biological resources management over a species-based approach for the Hanford Site.

Goals for the landscape-based approach reflect the broadly defined biological resources management goals identified in Section 2.2.2. The specific goals are to:

- maintain all native terrestrial and aquatic resident species at viable population levels
- have no adverse impacts on populations of migratory species
- maintain viable representatives of all native plant and animal communities
- maintain the functionality of both biotic and abiotic ecosystem processes.

These goals will be met in the following ways. First, management actions will be implemented in a graded approach that reflects the level of concern assigned to different habitats/plant communities (i.e., landscape attributes). The assigned levels of concern are in part based on state of Washington priorities for habitat/plant community preservation. The level or intensity of management is adjusted appropriately to fit each landscape attribute. Second, processes that operate at the level of the landscape, such as fragmentation, will be considered when designing appropriate management strategies.

7.3.1 Landscape Attributes of Concern Requiring Management

Landscape attributes requiring management include all habitats/plant communities identified as Level II, III, or IV. Management of landscape attributes will focus on three classes of management actions:

- evaluation and management of DOE-RL impacts
- status monitoring
- preservation actions.

Table 7.1 shows the graded management approach. Resource maps for individually defined resources (e.g., 100-year floodplain) are provided in Appendix D; composite maps for a particular resource level of concern (e.g., Level IV resources) are provided in Section 4.3.4.

Via the graded approach, impact management will be implemented at three levels. Impacts to habitats because of implementation of proposed projects will be evaluated during the ecological compliance review process outlined in Section 5.1. Details of this process are defined in DOE-RL (1995).

For Level II and III resources, the 100-year floodplain, wetlands, and late-successional shrub-steppe habitat (identified for medium-level impact management) are distinguished from the early-successional shrub-steppe habitat (identified for low-level impact management) in Table 7.1 because they either have specific impact assessment requirements (i.e., wetlands and floodplain impact assessment is required by 10 CFR 1022) or they are at higher risk from significant impacts compared with other habitats of concern (i.e., late-successional shrub-steppe). Additionally, designated onsite habitat restoration or rectification areas also are identified for medium-level impact management. When impacts are unavoidable, mitigation recommendations will show a preference for directing impacts away from habitats identified for medium-level impact management versus habitats identified for low-level impact management. Mitigation of residual impacts (i.e., via rectification and/or compensation) is likely to be more costly at the medium level than at the low level.

For Level IV resources (all identified for high-level impact management in Table 7.1), impact management will rely initially on land-use "zoning" restrictions arising out of the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)* (DOE 1999). Level IV resource areas (i.e., rare habitats, element occurrences, and designated compensatory mitigation/habitat improvement areas) will be identified as areas major constraints against development.

Based on DOE-RL's currently identified mission, DOE-RL programs and projects are expected to avoid consideration of Level IV resource areas for planned future activities. In the event DOE-RL's mission changes and these Level IV resource areas are proposed to be impacted, the ecological compliance review process will assess the impact based on the significance of these resources within the Columbia Basin Ecoregion. Mitigation actions are expected to be costly and limited in options for Level IV resources (i.e., acquisition of in-kind resources may be the only option available for compensatory mitigation).

Status monitoring will be implemented at three levels and in one special case situation. With one exception, all monitoring of landscape attributes will be accomplished as part of the Hanford ecosystem integrity monitoring strategy (see Section 6.4.3). Status monitoring of habitat improvement areas, whether done as a commitment for mitigation or

Table 7.1 Management Levels for Landscape Attributes of Concern at Hanford

Landscape Attribute	Classes of Management Actions		
	Impact Management Level	**Status Monitoring Level**	**Preservation Level**
100-year floodplain	*Medium* Avoid impacts to the maximum extent possible, and minimize unavoidable impacts. Mitigation of residual impacts via rectification and/or compensation is required. The ecological compliance review report will specifically address impacts to biological resources within the floodplain.	*Low* No specific monitoring strategy is designed for the entirety of the floodplain. Instead, specific areas within the floodplain, such as sloughs, will receive attention at the medium level of monitoring.	*Low* Absolute protection from impacts is a low priority.
Wetlands and associated deepwater habitats	*Medium* Avoid impacts to the maximum extent possible and minimize unavoidable impacts. Mitigation of residual impacts via rectification and/or compensation is required. The ecological compliance review report will specifically address impacts to wetland habitats.	*Medium* Level assignment does not indicate a lower level of importance for these areas; instead, it reflects that monitoring here will focus on ensuring conditions within these areas are not degrading.	*Medium*[a] Protection from impacts is strongly encouraged but not mandatory.
Late-successional shrub-steppe habitat	*Medium* Avoid impacts to the maximum extent possible, and minimize unavoidable impacts. Mitigation of residual impacts above threshold values via rectification and/or compensation is required. The ecological compliance review report will specifically address impacts to late-successional habitats.	*High* Monitoring information on this habitat has the highest priority. Together with the early-successional shrub-steppe habitat these areas represent a mosaic of good condition native habitat interspersed with some poorer quality habitat areas that may contain a non-native species component. How these respective habitat areas function ecologically relative to one another is poorly understood; however, combined they represent most of the land area of Hanford, especially on the Columbia River plain.	*Low* Absolute protection from impacts is a low priority.

Table 7.1 Management Levels for Landscape Attributes of Concern at Hanford (continued)

Landscape Attribute	Classes of Management Actions		
	Impact Management Level	**Status Monitoring Level**	**Preservation Level**
Early-successional shrub-steppe habitat	*Low* Avoid impacts to the maximum extent possible, and minimize unavoidable impacts. Mitigation of residual impacts above threshold values via rectification and/or compensation is recommended. The ecological compliance review report will generally address impacts to these habitats.	*High* Monitoring information on these habitats has the highest priority. Together with the late-successional shrub-steppe habitats these areas represent a mosaic of good condition native habitat interspersed with some poorer quality habitat areas that may contain a non-native species component. How these respective habitat areas function ecologically relative to one another is poorly understood; however, combined they represent most of the land area of Hanford, especially on the Columbia River plain.	*Low* Absolute protection from impacts is a low priority.
Rare habitats	*High* Avoid the impact. Impact management will rely initially on land-use "zoning" restrictions arising out of the *Final Hanford Comprehensive Land-Use Plan Environment Impact Statement (HCP EIS)* (DOE 1999).	*Medium* Level assignment does not indicate a lower level of importance for these areas; instead, it reflects that monitoring here will focus on ensuring conditions within these areas are not degrading. Additionally, monitoring information from these areas will serve as controls for the resources identified for high level status monitoring.	*High* Protection from all human-induced impacts is the top priority for these areas.
Element occurrences	*High* Avoid the impact. Impact management will rely initially on land-use "zoning" restrictions arising out of the *Final Hanford Comprehensive Land-Use Plan Environment Impact Statement (HCP EIS)* (DOE 1999).	*Medium* Level assignment does not indicate a lower level of importance for these areas; instead, it reflects that monitoring here will focus on ensuring conditions within these areas are not degrading. Additionally, monitoring information from these areas will serve as controls for the resources identified for high level status monitoring.	*High* Protection from all human-induced impacts is the top priority for these areas.

Table 7.1 Management Levels for Landscape Attributes of Concern at Hanford (continued)

Landscape Attribute	Classes of Management Actions: Impact Management Level	Status Monitoring Level	Preservation Level
Designated compensatory mitigation/ habitat improvement areas (see Table 4.5 and Section 4.3.3)	*High* Avoid the impact. Impact management will rely initially on land-use "zoning" restrictions arising out of the *Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan* (DOE 1999)	*Special* See Section 6.4.4.	*Special* Protect from human-induced impacts for as long as needed to fulfill the mitigation commitment for which they were established.
Designated onsite habitat restoration or rectification areas (see Table 4.5)	*Medium* Avoid impacts to the maximum extent possible and minimize unavoidable impacts. Mitigation of residual impacts via rectification and/or compensation is required. The ecological compliance review report will specifically address impacts to designated onsite habitat restoration and rectification areas.	*Special* See Section 6.4.4.	*Medium* Protection from impacts is strongly encouraged but not mandatory.

[a] Some areas considered wetlands, specifically sloughs along the Columbia River and Snively Creek on the ALE Unit, are included with rare habitats for the purpose of identifying preservation priorities.

restoration, is considered special case monitoring and will be conducted in accordance with Section 6.4.4.

The low, medium, and high levels identify the priority each attribute will receive within the monitoring strategy. Thus, as compared with resources identified for low- and medium-level status monitoring, the frequency of monitoring, its extent, and the number of monitoring locations will be the most intensive for resources identified for high level status monitoring.

The levels outlined in Table 7.1 indicate different priorities for preservation. There are three levels and one special case. Preservation refers to a management action that specifically targets certain resources for protection from any human-induced impacts. Thus, these are resource areas whose primary land use at Hanford is the preservation of their biological resource values. The Level IV resource areas, rare habitats, and element occurrences, fall into this land-use category. Compensatory mitigation areas and their associated habitat improvement areas represent a special case of preservation. These areas will be protected from human-induced impacts for as long as they are needed to fulfill the mitigation commitment that established them. Wetlands and associated deepwater habitats, except for those areas qualifying as Level IV resources, receive a medium priority for preservation, as do designated onsite habitat restoration and rectification areas. All other habitats receive a low priority for outright preservation.

7.3.2 Priority Habitat and Element Occurrence Management Guidelines

Priority Habitats—The Washington Department of Fish and Wildlife created the Priority Habitat and Species Program to ensure species and habitats of concern to the state are identified and managed correctly to ensure their long-term survival. The program develops management recommendations for different priority habitats through a comprehensive review and synthesis of the best scientific information available (www.wa.gov/wdfw/hab/phspage.htm). The program habitat management guidelines applicable to Hanford are still being developed.[2] Even after they are completed, they should be viewed as dynamic. As better information becomes available, the guidelines are updated. As the management guidelines for Hanford's priority habitats become available, DOE-RL will coordinate with WDFW to determine which recommendations are appropriate and can be implemented (if not already in place at Hanford).

Element Occurrences—The Washington Natural Heritage Plan (www.wa.gov/dnr) identifies different terrestrial, wetland, and aquatic ecosystem elements that are present in the state. The Natural Heritage Plan assigns to each ecosystem element a priority ranking based on the element's rarity, the degree of threat to its continued existence, and the adequacy with which it is currently protected. Terrestrial ecosystem elements usually are defined as plant communities and their dominant species by vegetational layer, whereas wetland and aquatic ecosystem elements are defined by their major physical environmental characteristic. Terrestrial element occurrences (areas qualifying for a priority ranking) for Hanford are shown in Appendix D. Wetland and aquatic element occurrences are included the rare habitat map.

Natural areas are administratively recognized locations, both state and federal, that contain element occurrences (or cells as used by the federal program) and are established for the protection of such occurrences. The ALE Unit is a federally designated Research Natural Area because of the element occurrences it contains.

The Natural Heritage Plan (www.wa.gov/dnr) provides a brief discussion on the management of natural areas. Management should recognize that protecting just the elements themselves may not be adequate. Consideration also must be given to protecting the ecological processes that sustain the elements. Often what makes the occurrence of an element important is not just its condition; rather, it is the size of the element and its relative isolation from human-induced disturbance that makes it worthy of continued protection. These attributes also contribute to the maintenance of ecological processes.

As a result of the preceding considerations, management actions often can be passive provided the elements themselves are not directly impacted by human activities and adequate buffer areas are maintained around the elements. Management actions can be limited to status monitoring, maintaining the integrity of the natural area's borders, preventing the invasion of non-native species, and enhancing degraded resources that may exist within the natural area's boundary.

Both the ALE Unit and the area south of Highway 24 on the North Slope qualify as areas to be managed as natural areas. Currently, only the ALE Unit has received either federal or state status as a natural area. The DOE-RL will coordinate with the Washington Department of Natural Resources and U.S. Fish and Wildlife Service to manage the area south of Highway 24 on the North Slope as a natural area.

7.3.3 Landscape Processes Requiring Management

Fragmentation of habitat, either by natural or human-induced causes, can result in both a direct loss of habitat and the formation of habitat edges. Both effects can be detrimental to some native wildlife and plants, especially if the edges are unnatural (e.g., if the edge is created by the presence of a road). Unnatural habitat edges, and the associated disturbance that creates them, often are conducive to the establishment of non-native species. Although some species may require the maintenance of a mosaic of habitats, natural disturbance patterns that in the past created these mosaics are now altered by human activities. Instead of mosaics of different kinds of native habitat (i.e., different native shrub or grass dominants) and different seral stages, the human-induced pattern is more often disturbed (e.g.,

[2] The relationship of Hanford's habitats of concern map to Washington Department of Fish and Wildlife priority habitat designations is described in Appendix D.

contains non-native species) or developed areas interspersed with small patches of perhaps quality habitat.

The management approach at the Hanford Site will be to avoid or otherwise minimize fragmentation of Level II, III, and IV habitats/plant communities of concern. This strategy will be flexible enough to recognize that some fragmentation, such as from firebreaks, may be a necessary management method for increasing the overall resilience of shrub-steppe to disturbance in a human-impacted landscape. An avoidance strategy can be achieved in part by including within the ecological compliance review process an evaluation of whether a proposed action results in adverse fragmentation and by adhering to the land-use "zoning" restrictions referred to in Section 7.3.1 in which fragmentation becomes a major constraint. Additionally, when habitat improvement areas for compensatory mitigation are selected, the areas ability to recreate connectivity between habitat patches should be considered.

7.4 Administrative Designations Related to Resource Protection Areas

Some areas of the Hanford Site have administrative designations that to some degree have a biological resource protection element. Such designations can relate to particular geographic portions of the Site, particular resource areas, areas held under lease, withdrawn public land, or buffer areas that serve as protected areas for species of concern.

7.4.1 Hanford as a National Environmental Research Park

The National Environmental Research Park Program was established by DOE in the 1970s to set aside land for ecosystem preservation and study and environmental education (DOE 1994). The Hanford Site is one of seven such DOE sites. The Hanford National Environmental Research Park's specific purpose is to provide a protected area for research demonstrations and education in ecology (PNL 1977). Procedures for the administration of the Hanford area can be found in PNL (1977). Although execution of program missions of DOE sites must be ensured, ongoing environmental research projects and protected natural areas must be given careful consideration in any site-use decisions within a NERP (DOE 1994, Appendix: Charter for the National Environmental Research Parks).

7.4.2 Arid Lands Unit

The ALE Unit was designated the Rattlesnake Hills Research Natural Area as a result of an interagency federal cooperative agreement (PNL 1993). Designation of the ALE Unit as a research natural area was specifically identified in the permit by which DOE-RL transferred management authority to the U.S. Fish and Wildlife Service.[3] Natural areas are examples of relatively unaltered ecosystems that represent storehouses of natural diversity. They are set aside to serve scientific and educational purposes and to act as baselines for comparison with similar, but intensely managed, areas. The state of Washington tracks the occurrence and status of natural areas throughout the state, including those on federal property (WDNR 1995). Research Natural Areas are the federally administered equivalent to the state of Washington system of natural areas (WDNR 1995). The ALE Unit currently is managed by the U.S. Fish and Wildlife Service.

The ALE Unit constitutes the single largest track in the federal RNA system for Oregon and Washington (Franklin et al. 1972; Rickard 1972). The management of the ALE Unit is accomplished via the ALE Facility Management Plan (PNL 1993).

Because of the ALE Unit's status as an RNA, its management stresses the protection of biological resource values. Highlights of the ALE Unit's management requirements include:

- access is restricted to those activities related to research, education, Native American cultural practices, or facility/infrastructure maintenance
- agriculture and domestic livestock grazing are prohibited, except for experimental purposes

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3 Section 1 of the U.S. Department of Energy, Richland Operations Office (DOE-RL) renewable land use permit—which grants the U.S. Fish and Wildlife Service (FWS) use of the Fitzner/Eberhardt Arid Lands Ecology Unit—requires that the "FWS' use of the property shall be for the purpose of operating the ALE Unit as a Research Natural Area."

- access for mineral and energy resource exploitation is prohibited with the exception of two borrow sites located alongside Highway 240
- vehicular traffic off of established roads is expressly prohibited.

7.4.3 Areas Containing Element Occurrences

Areas containing a significant number or size of individual element occurrences can best protect these examples of rare plant communities and other natural features if they are managed as natural areas. The ALE Unit is a federally recognized natural area. Although not formally registered with the state of Washington's natural area system, the state's Natural Heritage Program database does include the ALE Unit de facto because of its RNA status (WDNR 1995). Information gathered by The Nature Conservancy of Washington in 1994, 1995, and 1997 (TNC 1995, 1996, 1998, and 1999) and by the Natural Heritage Program in 1996 added additional element occurrence information for the ALE Unit (see Appendix D for details).

The TNC study also identified element occurrences on the North Slope south of Highway 24 (TNC 1995). These areas, leased to USFWS and WDFW, are not located within a formally designated natural area.

The 1997 TNC surveys (TNC 1998) and subsequent work by the Natural Heritage Program resulted in additional element occurrences on central Hanford.

The state of Washington's law (Revised Code of Washington 79.70) and regulations (Washington Administrative Code 332–60) regarding natural areas enable registration or execution of a cooperative agreement concerning protection of federal natural areas, even if they are already protected, as components of the statewide Natural Area System (WDNR 1995).

7.4.4 Mitigation/Restoration Areas

Compensatory mitigation areas and their associated habitat improvement areas, once designated, are to be managed as Level IV resources. Thus, they will be:

- protected from impact for the length of time their presence is necessary to fulfill a mitigation commitment
- monitored to determine if mitigation commitments are met.

Should it be necessary to acquire a mitigation area off the Hanford Site to accomplish the mitigation goal, the area shall be administratively protected and managed. Mechanisms to accomplish this include:

- legislative set-aside or protective designation for public lands
- acquisition of a conservation (wildlife) easement
- acquisition of land in fee title or exchanges of land
- partnerships with natural resource agencies and other entities for management.

Onsite rectification and restoration areas, once designated, are to be managed as Level III resources. Thus, they will be:

- mitigated to replace their lost resource values should it be necessary in the future to impact their location
- monitored to determine if mitigation/restoration commitments are met.

7.4.5 Collection/Propagation Areas for Native Plant Materials

Mitigation and restoration actions at Hanford will require plant material that is locally derived (Section 7.2). The *Biological Resources Mitigation Strategy* (DOE-RL 1996) describes a number of approaches for acquiring such material. Depending on the approach taken, locations on Hanford may be used either as seed/transplant collecting sites or as areas dedicated to the propagation of seeds (i.e., native grass farm) or of transplants (i.e., native plant nursery). To ensure that existing Site resources are not adversely impacted by such activities, the following requirements are established.

Seed collection shall cause negligible impact to existing resources. The method of collection shall leave the host plants intact. Excessive compaction or disturbance of the soil as a result of the collection method shall be avoided. No new access roads shall be built. As much as possible, seed collection should concentrate on the target species and not disrupt seed set in non-target species. Seed collection areas should be mapped for future reference. If not already identified as an area that contains a habitat/plant community of concern, the collection site should be evaluated for such designation.

Areas to be used for collecting transplant material generally should be located near the location where the plants will be replanted. The same restrictions described for seed collection sites relative to soil disturbance (other than that needed to remove a plant), road construction, non-target species, and mapping apply for transplant sites as well. Additionally, collection of transplant material should not result in the creation of extensive bare areas. The community shall be left in a viable condition. Sites to be used as a source of transplant materials require an ecological compliance review (unless the collecting site is to be disturbed as part of project already has been so reviewed).

Siting a native plant nursery or native grass farm will be in areas that do not qualify as habitats of concern and, as much as possible, are located next to existing roads. Siting such a facility will require an ecological compliance review.

7.4.6 Properties Used Under Permit and Leased Properties

Properties Used Under Permit that are Principally Managed to Protect their Biological Resource Values—The DOE-RL makes properties that serve as buffer zones during Hanford environmental restoration available to both the USFSW and WDFW for management. All of those properties are within the recently designated Hanford Reach National Monument.

The USFWS-managed properties include three distinct units, each with somewhat different management objectives. The ALE Unit is managed as a federal Research Natural Area as a condition of the permit (97-SID-311) from the DOE-RL. The Saddle Mountain Unit is managed for site preservation, and the Wahluke Unit is managed for recreation. Planning for future management of these three units is in progress by the USFWS, and is subject to the development of a management plan that is consistent with the DOE-RL's environmental restoration mission and the recently established national monument status of the Hanford Site. In addition, the Washington Department of Fish and Wildlife manages the Vernita Bridge Fishing Access Area, which lies west of Vernita Bridge, north of the Columbia River, and south of State Highway 223. Both the USFWS and WDFW land management agreements are by 30-day revocable permit.

- Domestic livestock grazing is not permitted on any DOE land except U.S. Fish and Wildlife Service-administered lands north of Highway 24.
- The U.S. Fish and Wildlife Service shall report annually to DOE-RL's Office of Site Services on the condition of grazed lands.
- No new agriculture is permitted without the approval of DOE's Office of Site Services.
- No motor-powered off-road motor vehicles for recreational use are permitted; human-powered transportation must stay on established roads or designated pathways.
- Revegetation practices shall be consistent with the intent of maintaining native flora and fauna.

Leased Properties—The DOE-RL leases portions of the Hanford Site for a variety of purposes not related to biological resources management. Lease renewals and new leases should consider the provisions of BRMaP and, as appropriate, requirements for leaseholders should be consistent with BRMaP.

7.4.7 Bureau of Land Management and Bureau of Reclamation Parcels

Bureau of Land Management—Certain parcels scattered across the Hanford Site are Bureau of Land Management withdrawn lands that have been transferred to the control of DOE-RL. The Bureau retains an interest in these parcels, in part because of their natural resource values. Thus, DOE-RL, subject to its other mission requirements, will consider using these parcels in a manner that protects the quality of natural resource values present and thereby provides food and habitat for fish and wildlife.

Bureau of Reclamation—Bureau of Reclamation parcels are concentrated on the North Slope. The DOE-RL uses Bureau of Reclamation parcels under a Memorandum of Agreement. Reclamation retains the right to construct, operate, and maintain the irrigation infrastructure on these parcels. An indirect result of some of this infrastructure has been the artificial creation of wildlife habitat (i.e., irrigation return ponds).

7.4.8 Species of Concern Administrative Control Areas

Bald Eagle Buffer Zones—The *Bald Eagle Site Management Plan* (Fitzner and Weiss 1994) specifies six primary night roost locations. All these locations require buffer zones to preclude disturbance of eagles, a state and federal threatened species, or their roosting habitat. Additionally, three locations at which eagles have attempted nesting are identified. One of these locations currently requires a buffer zone. These seven locations and their buffer zones are shown in Figure D.25.[4] Buffer zone size is an 800-m radius circle. An exception is for the roost site at 100 K Area. Here, the buffer zone does not extend northeast beyond the fenceline between the roost and 100 K Area (the fence is within 100 m of the roost).

To avoid direct impacts to the eagles themselves, the buffer zones have temporal limits of November 15 to March 15 for the primary night roosts and January 1 to August 15 for nest locations (the actual duration of the latter timeframe is dependent on whether birds continue the nesting cycle instead of abandoning the site; Fitzner and Weiss 1994). Although a variety of activities, precluded when eagles are present, can occur outside these temporal limits, permission to conduct activities within buffer zones does not extend to activities that would result in modifications to the habitat (at all times of the year).

Fall Chinook Salmon and Steelhead Spawning Locations—Appendix D shows the locations of the major fall chinook salmon and steelhead spawning areas within the Hanford Reach. All DOE-RL activities will be conducted in a manner that avoids or minimizes impacts to these areas.

Ferruginous Hawk Buffer Zones—At Hanford, most ferruginous hawks, a state threatened and federal candidate species, nest on transmission towers isolated from human activities (Fitzner et al. 1994). To avoid disturbing nesting ferruginous hawks, Fitzner et al. (1994) recommended avoidance of nest locations from March 1 through August 1 with a buffer distance of 1 km. Active or potentially active nest sites (i.e., historic nest sites should be avoided after March 1 until it is certain a particular location will not be used for nesting that breeding season) are to be avoided as described above. Impacts to nest substrates that occur during the non-breeding season are to be appropriately mitigated (e.g., if a historic nest platform is removed, an artificial platform should be erected elsewhere).

Plant Species of Concern (Level III and IV) Population Locations—Documented locations of plant species of concern populations are concentrated along the Hanford Reach, on the ALE Unit and Umtanum Ridge, and to a lesser extent in the central core. All these areas have been designated for some level of protection based on the combination of their resource values; therefore, no specific administrative areas for the protection of plant species of concern are recommended at this time.

7.5 Domestic Livestock Grazing

Domestic livestock grazing is not permitted within the central core area of Hanford because grazing is not compatible with activities associated with environmental restoration work being conducted by the DOE-RL. Grazing is also excluded from the balance of the Hanford lands outside the central core, including lands managed both by the DOE-RL (McGee Ranch and Riverlands) and the USFWS (Fitzner/Eberhardt Arid Lands Ecology Reserve Unit, Saddle Mountain Unit, and the Wahluke Unit) by presidential proclamation (7319) that established the Hanford Reach National Monument.

7.6 Agriculture

The Hanford Site presents a number of biological resource management issues relative to agriculture. These include:

- potential agricultural uses of Hanford lands and the impacts of those uses on biological resources
- impacts of wildlife populations that at times migrate from Hanford to offsite agricultural areas
- Hanford's native biodiversity serving as a potential source of biological control agents for agricultural applications

[4] Subsequent to the issuance of the *Bald Eagle Site Management Plan* (Fitzner and Weiss 1994), eagles have attempted nesting at a fourth location. The location approximates the center point of one of the primary night roost locations that is situated southeast of 100 H Area.

- research value of Hanford's biological resources for evaluating impacts of agricultural chemical drift on natural plant and animal populations.

The only recent use of the Hanford Site for agriculture occurred on the Wahluke Unit when it was managed by the WDFW. There, the Department of Fish and Wildlife maintained three separate lease arrangements on lands used for agriculture as well as several small agricultural plots that it maintains itself. The agricultural areas and their use relative to wildlife were as follows:

- a 70-acre parcel just north of the Ringold fish hatchery—10% of the leased area is left standing for wildlife as a grain crop; the remainder is harvested by the leasee.
- a 25-acre portion of a circle pivot field (the remainder is on private property) 5 or so miles north of Ringold on the eastern boundary of the Site—10% of the harvested crop is used to make forage for wildlife (e.g., deer pellets).
- a 12-acre portion of a circle pivot field (the remainder is on private property) 5 or so miles north of Ringold on the eastern boundary of the Site—Washington Department of Fish and Wildlife receives a cash payment from the leasee.
- three to four small plots totaling about 10 acres the Washington Department of Fish and Wildlife maintains to produce wildlife forage.

With the exception of the past wildlife management related farming (above), agriculture is not practiced on the Hanford Site and is not included as part of the land use plan for the future (DOE 1999). There is no specific reference to, or exclusion of, farming in the Hanford Reach National Monument proclamation. Specific management practices for those portions of the national monument managed by the USFWS are pending the development of a management plan for the Monument. At the time of this writing, it is unknown whether limited agriculture for the benefit of wildlife will be practiced on lands where such farming occurred in the recent past. It is also unknown whether the USFWS will develop, or has, a policy that specifically prohibits farming for wildlife on national monument lands under their management.

What is clear is that past land conversion in the Columbia Basin Ecoregion outside of Hanford has had a major impact on the occurrence, abundance, and distribution of native species and the habitats they depend on. The significance of impacts from any future planned development, including agriculture, will need to be carefully weighed for the Hanford Site. The Hanford Site now contains a significant amount of the few remaining examples of high-quality shrub-steppe habitat in all of the Columbia Basin Ecoregion.

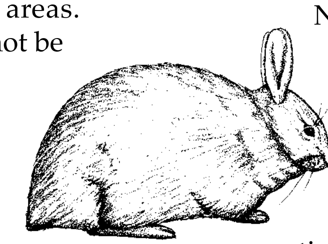
Several animal species that occur on Hanford have destroyed, or are perceived to have destroyed, crops and livestock on adjacent private property. Issues raised by local farmers and ranchers have included damage to crops by elk and sheep kills by coyotes, both of which supposedly originated from Hanford. Rock doves that occupy Hanford facilities also are known to frequent near-by private feed lots in search of grain. By monitoring populations of animals that are potential agents for damage to nearby agricultural interests and by sharing that information with the Washington Department of Fish and Wildlife and other agencies involved in wildlife management, DOE-RL will be able to minimize potential liability from wildlife damage claims.

The relative isolation of much of Hanford from agriculture has resulted in recent interest from the agricultural research community in using Hanford as a source for identifying parasitic insects with the potential for use as biological pest control agents. There is a general recognition, supported by recent Nature Conservancy studies (TNC 1995, 1996, 1998, 1999), that Hanford contains perhaps the greatest remaining biological diversity in the North American shrub-steppe. The primary reason is that habitat loss from development and the use of pesticides elsewhere have resulted in the elimination of many insect species. Substantial social and economic values may be derived from identifying pest-controlling predatory insects from within the biologically diverse fauna at Hanford. These values should be considered in any land-use decisions that could act to reduce biological diversity on the Hanford Site.

Since 1993, the U.S. Environmental Protection Agency has conducted herbicide drift-related studies on Hanford. The question being studied is whether agricultural herbicide drift is having a detrimental impact on native plants. Because of its large size and relative isolation, portions of the Hanford Site have been used as control areas for evaluating pesticide drift. Areas adjacent to agricultural fields are not suitable because they may be within the drift impact area of locally applied chemicals. Thus, the Hanford natural plant community, to the extent that it is remote, and free from herbicide drift, provides a research laboratory for evaluating impacts of agriculture on the environment. Hanford's importance as a control area should be considered in any land-use decisions that could act to impact native plant communities on the Hanford Site.

7.7 Road/Railroad/Utility Corridor Construction, Maintenance, and Usage and Off-Road Restrictions

Because it leads to habitat fragmentation, new road/railroad/utility corridor construction should be avoided. When new roads/railroads/utility corridors are unavoidable, they should be built, as much as possible, through already disturbed areas. Roads/railroads/utility corridors shall not be built through Level IV resource areas.



Road/railroad/utility corridor maintenance shall account for the biological resource values of the surrounding area and avoid unnecessary disturbances. Seldom-used roads should be closed to vehicular traffic when it is necessary to protect disturbance-sensitive wildlife species. When resources become available, roads that are no longer needed should be replanted with native vegetation.

The following specific management actions are established in regard to road/railroad/utility corridor maintenance and usage and their impact on biological resources of concern:

- identify and post all roads for seasonal or limited access that approach known primary roost and nesting locations for sensitive bird species (e.g., bald eagles and ferruginous hawks).
- identify unimproved roads that transect Hanford habitat of concern areas and post closure signs that identify the roads as closed to vehicular traffic unless entry is required for official business.
- through the ecological compliance review process, advise on an annual basis all road, railroad, and utility corridor maintenance organizations on the Hanford Site of the occurrence (general locations), seasons of use, and sensitivity of nesting migratory birds, raptors, and other species of concern that could be adversely impacted by routine maintenance activity. These organizations should incorporate this information into their maintenance planning schedules to minimize adverse impacts to disturbance-sensitive species.

No vehicles are permitted off established roads on the Hanford Site unless specifically approved by DOE-RL's Office of Site Services for conducted work activities or if required by an emergency situation. Before vehicles will be permitted off-road as part of a work activity, the activity generally will require an ecological compliance review. The Hanford Biological Resources Laboratory can be contacted for assistance in determining whether a review will be necessary.

Additionally, no motor-powered or mechanized off-road recreational vehicles are permitted onsite, including properties used under permit and leased properties. A Hanford Site policy that in general prohibits all off-road driving and the use of recreational off-road vehicles on Hanford will be advertised by the Office of Site Services in appropriate Hanford Site publications generally accessible to Site employees. This policy also will be made available to permit and lease holders.

8.0

Species Management

The DOE-RL does not manage wildlife populations on the Hanford Site nor fish populations in the Columbia River per se. The DOE-RL recognizes the Washington State Department of Fish and Wildlife and U.S. Fish and Wildlife Service and the National Marine Fisheries Service, as appropriate, as the cognizant state and federal agencies, with responsibility for fish and wildlife management. The DOE-RL, however, does assist the fish and wildlife management agencies by providing monitoring data on selected populations, conducting impact assessments for individual species of concern and adjusting its actions accordingly, protecting and/or manipulating habitat, and otherwise cooperating with the agencies on wildlife issues of mutual interest.

This section focuses on management actions that DOE-RL can take insofar as they involve single species or class of species concerns. Included are sections on integrated pest management, species introductions, and management actions associated with state or federally listed species or recreationally and/or commercially important species.

8.1 Integrated Pest Management

Pests are defined as animals or plants in a location or situation where they are not desired. Because pest species and the methods used to control them can pose significant problems for non-target biological resources (as well as for people and property), DOE-RL has adopted the use of integrated pest management strategies and methods to control pests at Hanford facilities. Although originally developed for agriculture, and based on economic thresholds, these strategies now are applied to structural and industrial pest control situations such as occur at Hanford. The relevance of this approach to biological resource management at Hanford is that it reduces potential impacts to non-target biological resources of concern.

8.1.1 Description

Pest control is required by law and regulation and represents a good business practice. Pest control can be beneficial to both non-pest species and site employees. Integrated pest management is a decision-making process created to control biological pests that achieves long-term, environmentally sound pest control through a combination of a wide array of technologies and management practices (GSA 1993; NPCA 1994). Pest control practices generally fit within one of five categories:

- cultural: modify management and use patterns of an area
- physical: create physical perturbations disruptive to the pest species
- biological: enhance or introduce desirable species that compete with or prey on pest species
- chemical: apply chemical agents, usually pesticides or fertilizer
- no action: allow a pest situation to resolve itself or take no action because of other overriding considerations.

8.1.2 Purposes and Benefits

Certain species on the Hanford Site can become pests by impacting employee health and safety (e.g., mosquitos, wasps, or mice), actively causing the spread of radioactive or hazardous chemical materials (e.g., deep-rooted shrubs or forbs, termites or ants, birds, or burrowing rodents or carnivores), creating a threat to nearby agriculture (e.g., noxious weeds), or occurring in areas that could result in harm to species and/or habitats of concern (e.g., nest parasites or undesirable plants). An effective pest control program serves to protect human health and property. A pest control program founded on the principles of integrated pest management also serves to ensure that impacts to non-target biological resources are minimized. Finally, a pest control program can be used to protect biological resources of concern from adverse impacts from pest species. Pest species that may negatively impact biological resources of concern at Hanford are considered Level B resources (see Section 4.4).

An integrated pest management strategy interacts with and complements other components of the Hanford Site biological resources management strategy. Professional pest managers (e.g., from the Hanford Site Integrated Pest Management Services organization) will use the information in the BRMaP to identify species and habitats of concern that could be impacted by pest control practices. Control of pest species is then weighed against impacts to non-target species and habitats before prescribing control methods. Impacts are either avoided or minimized by adjusting the timing of when the control method is applied, selecting the least harmful yet still-effective method (e.g., prescribing structural modifications rather than chemical treatment), or establishing buffer areas to prevent impacting potentially sensitive non-target resources (e.g., long-billed curlew nesting sites).

8.1.3 Legal and Policy Basis

Control of pest species is conducted on the Hanford Site in a manner that complies with federal, state, and local laws and regulations. Several federal and state laws and regulations play a role in shaping Hanford's Integrated Pest Management program by either defining what constitutes a pest species or by placing restrictions on control practices. The laws include, but are not limited to the following:

- Federal Noxious Weed Act
- Revised Code of Washington Chapter 17.10—Noxious Weed—Control Boards
- Migratory Bird Treaty Act
- Revised Code of Washington Title 77—Game and Game Fish
- Federal Insecticide, Fungicide and Rodenticide Act
- Revised Code of Washington Chapter 15.58—Washington Pesticide Control Act
- Revised Code of Washington Chapter 17.21—Washington Pesticide Application Act.

Control of noxious weeds is mandated by both federal and state statutes. Washington law and regulations (Revised Code of Washington 17.10 and its implementing regulation, Chapter 16–750 of the Washington Administrative Code) require all landowners to control noxious weeds on their property and impose specific penalties for failure to do so. Definitions of noxious weeds differ somewhat between federal and state laws. The state definitions focus on the destructiveness or competitiveness of the plant species and its difficulty of control. Several categories of noxious weeds are defined that relate to the state distribution and degree of threat posed by the weed and the severity of the fine for failure to control it. The plant has to be non-native to the state to be considered a noxious weed (see Section 8.1.4).

Although Washington does not define what the object of the plant's destructiveness or competitiveness needs to be to be considered noxious, federal definitions do include weeds that can directly or indirectly injure the fish and wildlife resources of the United States. Moreover, federal implementing regulations (i.e., 7 CFR 61, Section 2814) authorize federal agencies to manage undesirable plants (a somewhat broader definition than noxious) in cooperation with state agencies and by use of an integrated management system approach.[1] Finally, DOE is a signatory to a Federal Interagency Memorandum of Understanding,[2] in accordance with which agencies agree to control noxious and exotic (non-native) weeds on federally managed lands.

The Migratory Bird Treaty Act places restrictions on actions that could harm migratory birds, including

[1] The Federal Noxious Weed Act of 1974 was amended by the Food, Agriculture Conservation and Trade Act of 1990, Section 1453. This section established federal law in regard to the management of undesirable plants on federal lands.

[2] Memorandum of Understanding for the Establishment of a Federal Interagency Committee for the Management of Noxious and Exotic Weeds. 1994.

those considered to be pests. Failure to comply could result in enforceable penalties. Permits that allow the harming or collecting of birds, nests, or eggs protected under the Migratory Bird Treaty Act are available from the U.S. Fish and Wildlife Service. Permits also may be required under Washington State law if certain species, not limited to birds, are to be impacted by control measures (RCW 77.12.265 and 77.16.120).

Pesticide application is regulated by a number of restrictions including federal and state law, DOE Orders, and contractor guidance manuals.

8.1.4 Implementation

General—Overall implementation of integrated pest management operations at Hanford is directed via the Hanford Site Integrated Pest Management Plan (Giddings 1996). The plan provides guidance on:

- how to select the most appropriate control practice
- how to choose and apply a chemical control agent (when other control practices are not viable options; thus, non-chemical pest control methods are the preferred method and use of a chemical agent must be justified accordingly)
- action thresholds that specify the level of pest activity at which control measures are initiated[3]
- strategies that can be applied for different situations.

An integrated pest management approach takes advantage of all pest management options possible including, but not limited to, the judicious use of pesticides (EPA 1993). By using information on the life cycles of pests and their interactions with the environment, the success of other less hazardous (to non-target resources) control measures can preclude reliance on pesticides. When pesticides are found to be necessary, the pesticide and its application method will be selected on the following criteria (subject to other considerations not strictly related to protecting biological resources):

- pesticide has low mammalian toxicity[4]
- pesticide and its application method focus on the target species and minimize impacts to non-target species
- pesticide is biodegradable (residual effective for its purpose but poses no long-term impact to the environment).

The application of any pesticide on Hanford will be accomplished in such a manner that avoids or minimizes the potential of impact to non-target biological resources.

The use of introduced biological control agents for pest control is discussed in Section 8.2.

Ecological Compliance Review Requirements—Some integrated pest management activities may require an ecological compliance review before an action is performed (see Section 5.1). In general, the methodology to determine the need for an ecological compliance review is defined in the *Ecological Compliance Assessment Management Plan* (DOE-RL 1995). Pest control practices that take place in occupied buildings typically do not require an ecological compliance review; however, practices that occur inside unoccupied buildings (i.e., those that could be occupied by bat species of concern) or outside may require such a review. For routine practices, a review may be required only once; thereafter, provided there are no significant changes, the initial review should suffice.[5] At a minimum, however, an ecological compliance review shall be requested each time before spraying pesticides or performing any other integrated pest management activity in areas containing Level IV habitat/plant community

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[3] Action thresholds will be individually assessed with objective and subjective criteria for each pest, location, hazard, situation, and unique set of extenuating circumstances pertaining to impacts on personnel health, morale, activities, and property use.

[4] Pesticides generally are tested for their toxicity on mammalian species.

[5] Certain routine maintenance practices at Hanford may have already been the subject of an environmental review and may be covered by a categorical exclusion. For example, the use of vegetation control measures as part of interim remediation of active and inactive waste sites has been previously reviewed (Memorandum from Westinghouse Hanford Company, NEPA Documentation to B. J. Hobbs: "Categorically Excluded Routine Maintenance: Noxious Weed Control, Hanford Site, Richland, Washington)." As for all previously reviewed actions, they are not valid: for previously unsurveyed areas, if actions go beyond the scope of what was previously reviewed, or if biological conditions or the status of particular biological resources have changed (e.g., a protected species, not previously present, may now be impacted by an action or an already present species is now listed).

resources or in areas that contain federal or state listed species. In addition to an ecological compliance review, practices that may harm federally protected migratory birds, their nests, or their eggs may require mitigation and/or a permit. When in doubt as to requirements, the pest control manager and/or practitioner should contact the Hanford Biological Resources Laboratory for guidance.

Because of health or safety considerations, some situations may arise for which pest control is required immediately (i.e., within 24 hours). All reasonable efforts shall be made to notify the Hanford Biological Resources Laboratory staff of impending actions. Emergency applications of pesticides or pest control activities will take into consideration, when possible, avoidance of impact to non-target species and habitats. When such impacts are unavoidable, additional reasonable mitigation will be implemented.

Control of Pest Animals—Certain species such as the house mouse (*Mus musculus*), the domestic pigeon (*Columba livia*), and the starling (*Sturnus vulgaris*) are common pest species on the Hanford Site. Control of these species is not typically controversial, and management actions generally do not require specific approval in each instance. Other species, however, though not typically thought of as pests in their natural habitat, can on occasion become pests. Usually this occurs when a species invades a human-created habitat in which the invading species may have deleterious impacts on human health or property. Examples of such species include the western rattlesnake (C*rotalus viridis*), barn swallow (*Hirundo rustica*), and deer mouse (*Peromyscus maniculatus*). Control of these species should be in accordance with the Nuisance Wildlife Control permit for the Hanford Site issued by the Washington Department of Fish and Wildlife and implemented by the Animal Control Operations organization within Integrated Pest Management Services, as well as with the ecological compliance review requirements described above. Additionally, control actions involving federally protected migratory birds may require a permit from the U.S. Fish and Wildlife Service.

The action required for pest control shall not be in excess of the needed level of effort to control the situation. Steps for control shall utilize the method of least environmental impact. Table 8.1 summarizes some possible types of management actions that could be taken to control an animal pest species.

Control of Noxious Weeds and Undesirable Plants—A special category of nuisance vegetation has been legislatively classified as "noxious weeds" and has been targeted throughout the state of Washington for eradication or strict control. Noxious weeds are non-native species that once they are introduced proliferate because of the lack of natural predators or because they can out compete native plant species in disturbed habitats. Because these species pose a threat to natural environments or crop species, they have been targeted for special attention by regulatory agencies. Within the state of Washington noxious weeds are grouped into three categories: Class A species require eradication, Class B species require control (i.e., prevent seed production and the spread of the species into areas it does not presently occupy), and Class C species require measures similar to Class A (Chapter 16–750 of the Washington Administrative Code). Washington State designated noxious weeds that potentially occur on Hanford are indicated in Table 8.2. Figure 8.1 shows the distribution of some currently mapped noxious weed locations across the Hanford Site. The map is preliminary in that not all species or all locations have been mapped.

As a subset of integrated pest management, control of noxious weeds and unwanted vegetation (e.g., on waste sites) on Hanford is implemented through a number of guidance documents, such as the *Guidelines for Coordinated Management of Noxious Weeds at the Hanford Site* (Roos 1996) and the *Industrial Vegetation Management* manual (Looney 1995). Table 8.1 summarizes some possible types of management actions that could be taken to control a plant pest species.

The control of noxious weeds and other undesirable plants is not simply a component of integrated pest management; it also is an important component of biological resource management in general. The control of these species, especially when their presence may be impacting Level IV resource areas, should receive strong consideration for control actions. The use of appropriate control strategies when plant populations are small and localized is the most cost-effective means of minimizing the impacts of noxious weeds and other undesirable plants to biological resources of concern.

Table 8.1 Possible Management Actions for Pest Control

Type of Pest	Hazard Posed	Possible Management Actions
Vegetation	Radioactive	Physical removal or herbicides; education
Vegetation	Nonradioactive (fire, native species competitor)	Physical removal; biological predators; cultural changes; habitat modifications; herbicides; education
Animal: arthropods	Health or safety	Physical removal; habitat modifications; sanitation improvements; pesticides; education
Animal: arthropods	Radioactive	Physical removal or pesticide treatment followed by habitat modifications and/or sanitation improvements; education
Animal: non-arthropods	Radioactive	Capture and radiological survey: destroy if contaminated or relocate if non-contaminated; determine attractant; habitat modification; education
Animal: non-arthropods	Health or safety	Determine attractant; capture and relocation; habitat modification; education

8.1.5 Roles and Responsibilities

The Office of Site Safety of DOE-RL has oversight responsibility for Hanford's Integrated Pest Management program. Notwithstanding this role, the Office of Site Safety should coordinate, as needed, with DOE-RL's Office of Site Services when pest management actions may either impact biological resources of concern (whether as targets or non-targets) or when actions are taken for the express purpose of protecting biological resources from Level B (i.e., undesirable) biological resources.

Integrated Pest Management Services is the lead organization responsible for the control of biological pests on the Hanford Site. Examples of the types of pest control responsibilities include the following:

- control insects, rodents, snakes, and other nuisance wildlife in and around facilities
- rescue injured or trapped animals
- dispose of road-killed animals
- control industrial (e.g., at hazardous waste site) weeds
- manage noxious weeds
- accomplish all the above in accordance with applicable federal and state laws and regulations and DOE-RL requirements (e.g., requesting ecological compliance reviews when necessary).

More specific roles and responsibilities are delineated in the Integrated Pest Management Plan (Giddings 1996). Hanford contractors support the implementation of integrated pest management practices within the charter of their organizations. For example, crafts groups implement exclusion recommendations in support of Integrated Pest Management Services pest control recommendations (see Table 2–1 in Giddings 1996). All contractors are subject to the review and permit requirements identified in this section.

The conduct of ecological compliance reviews are the responsibility of the Hanford Biological Resources Laboratory or the Natural Resources Section of the Environmental Restoration Contractor, as appropriate. See Section 5.1.4 for details.

8.1.6 Stakeholders

Stakeholders for the Hanford Site Integrated Pest Management program include the U.S. Fish and Wildlife Service and Washington State Department of Fish and Wildlife. These agencies may need to be consulted to acquire needed permits and permission for pest control activities insofar as they affect biological resources. Additionally, these

Table 8.2 Washington State Designated Noxious Weeds Potentially Occurring on the Hanford Site

Scientific Name	Common Name	Class
Sorghum halepense	Johnsongrass	A
Alhagi psedalhagi (= A. maurorum)	Camelthorn	B
Acroptilon repens	Russian knapweed	B
Carduus acanthoides[a]	Plumeless thistle	B
Cenchrus longispinus	Longspine sandbur	B
Centaurea diffusa	Diffuse knapweed	B
Centaurea maculosa (= C. biebersteinii)	Spotted knapweed	B
Centaurea solstitialis	Yellow starthistle	B
Chondrilla juncea	Rush skeletonweed	B
Cyperus esculentus	Yellow nutsedge	B
Lepidium latifolium	Perennial pepperweed	B
Linaria genistifolia dalmatica	Dalmation toadflax	B
Lythrum salicaria	Purple loosestrife	B
Myriophyllum spicatum	Eurasian watermilfoil	B
Sonchus arvensis arvensis	Perennial sowthistle	B
Sphaerophysa salsula	Swainsonpea	B
Agropyron repens	Quackgrass	C
Cardaria draba[a]	Hoary cress	C
Cirsium arvense	Canada thistle	C
Cirsium vulgare	Bull thistle	C
Conium maculatum	Poison hemlock	C
Convolvulus arvensis	Field bindweed	C
Hypericum perforatum	Common St. Johnswort	C
Gypsophila paniculata	Babysbreath	C
Kochia scopria	Kochia	C
Linaria vulgaris	Yellow toadflax	C
Secale cereale	Cereal rye	C
Solanum dulcamara	Bitter nightshade	C
Tamarix spp.	Saltcedar	C
Tanacetum vulgare	Common tansy	C
Tribulus terrestis	Puncturevine	C
Verbascum thapsus	Common mullein	C
Xanthium spinosum	Spiny cocklebur	C

[a] Suspected but not confirmed to occur on the Hanford Site.

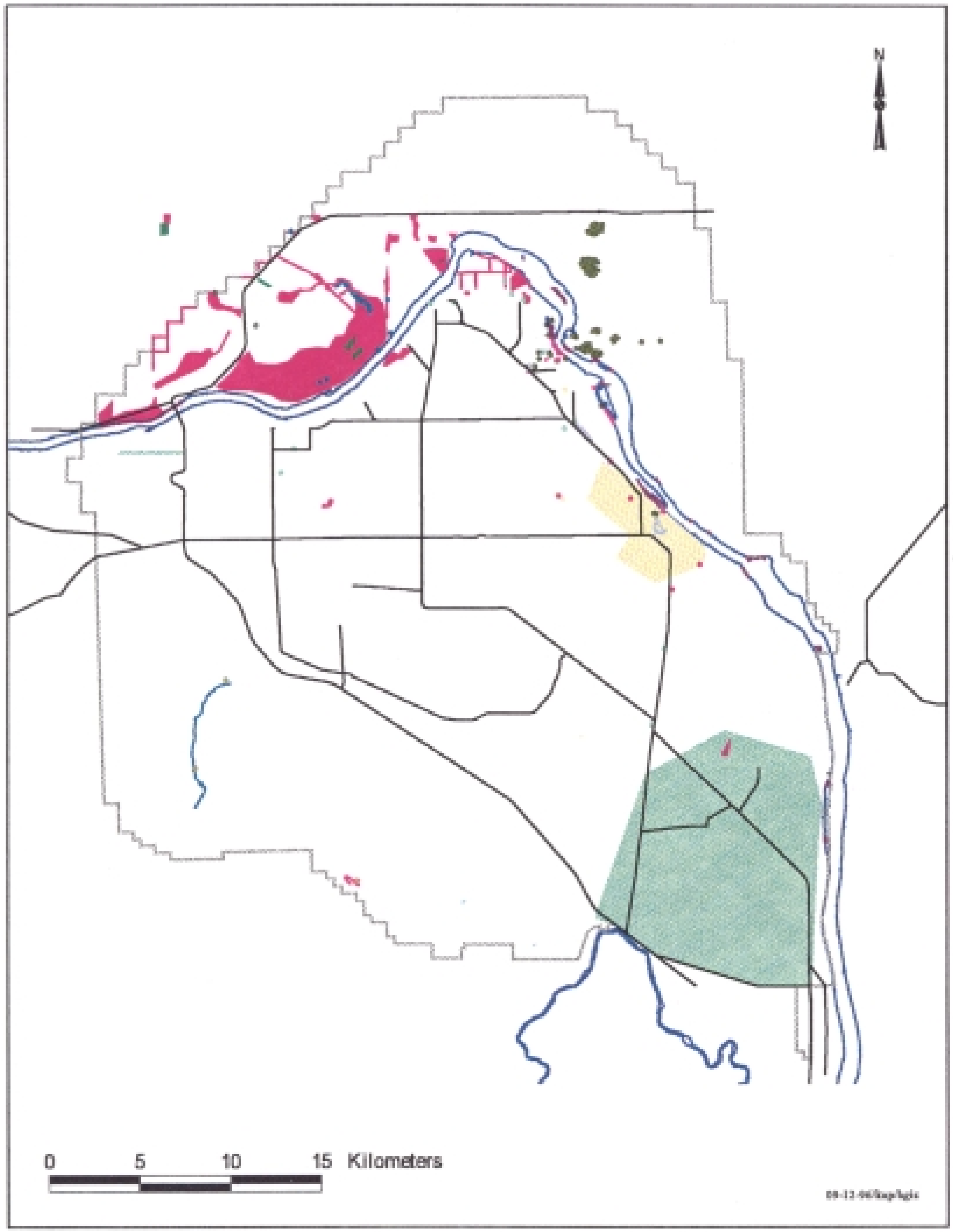


Figure 8.1 Distribution of Noxious Weeds Across the Hanford Site (Map)

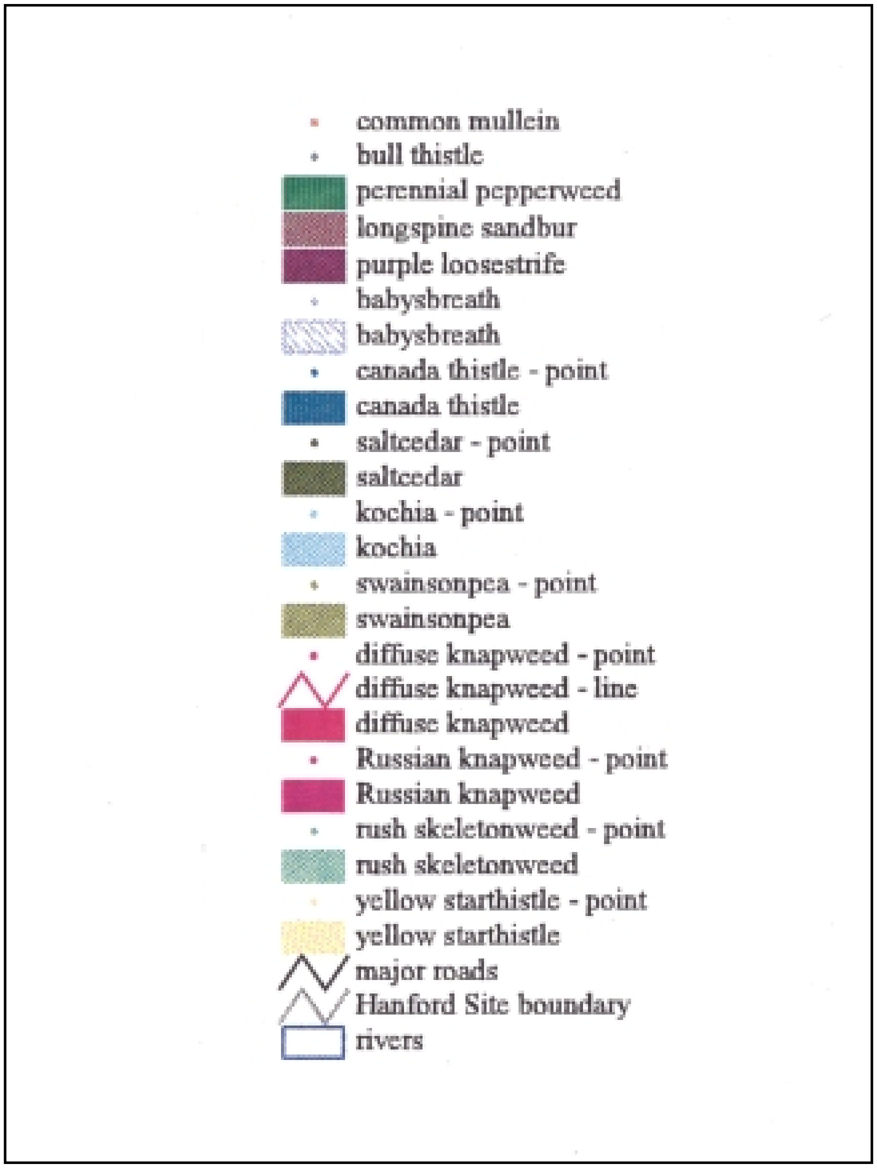


Figure 8.1 Distribution of Noxious Weeds Across the Hanford Site (Legend)

agencies, along with the local Tribes, can help identify biological resources of concern for which impacts from integrated pest management practices should be avoided or minimized. Practices that could adversely affect listed federal species will require at least informal consultation with the Fish and Wildlife Service under the Endangered Species Act. Noxious weed control efforts will be of interest to the U.S. Department of Agriculture and to state and county weed boards. Finally, the control of undesirable plants at Hanford may be of interest to federal and state resource agencies, Tribes, and local conservation organizations that are concerned about protecting Hanford's native biological resources.

8.2 Species Introduction

The significant biological resource values of the Hanford Site have resulted in large measure from the more than 55 years of protection of its native fauna and flora through restricted development and non-intrusive land use. As a result, the Site retains much of its pre-1940 biological diversity. To a large extent, native species thrive, although there have been losses or dramatic reductions in some species that were once characteristic of the area. For example, sage grouse, which were historically abundant and relatively common through the 1960s, have not been sighted on Hanford during recent surveys.

Much of the reduction in Hanford's biodiversity can be attributed to the introduction (mostly unintentional) of non-native species, both animal and plant.[6] Native species, whether plants or animals, often do not fare well in direct competition with introduced non-natives. Cheatgrass, for example, when once established in disturbed shrub-steppe soils, is highly competitive and capable of preventing the natural reestablishment of many native plant species.

The continued introduction of non-native species to Hanford could do irreparable harm to both the abundance and diversity of the native flora and fauna. A number of state and federal laws and regulations and presidential Executive Orders address this threat to natural ecosystems. Among these are the following:

- Federal Noxious Weed Act and its implementing regulations (7 CFR 61)
- Executive Order 11987—Exotic Organisms
- Revised Code of Washington Title 77—Game and Game Fish.

The role of the federal noxious weed laws and regulations in regard to plant species introductions was described in Section 8.1. More broadly, Executive Order 11987 directs executive (federal) agencies to restrict the introduction of any plant or animal exotic (non-native) species into the natural ecosystems on lands and waters under their control or ownership. An exception may be permitted if either the Secretary of Agriculture or the Secretary of Interior finds that such introduction will not have an adverse effect on natural ecosystems.[7] It is DOE-RL's policy to prohibit the intentional introduction of non-native species on all Hanford Site lands under its immediate control and management authority and on leased properties. Exceptions to this policy in regard to the use of non-native plants outside of native habitats for landscaping or waste management purposes are addressed in Section 7.2.

Washington State law (RCW 77.16.150) through its implementing regulation (WAC 232-12-271) establishes criteria for planting aquatic plants (and seeds) and releasing wildlife. This includes the reintroduction of species in areas that they formerly inhabited. Persons other than the Director of the Department of Fish and Wildlife are prohibited from planting aquatic plants/seeds or releasing any species, subspecies, or hybrids of animals that do not already exist in the wild in Washington. If the aforementioned organisms do exist in Washington, they may be planted or released in their established range by permit obtainable from

[6] As discussed in Chapter 6.0, increases in artificial biodiversity can represent losses in native biodiversity even if native species are not immediately lost.

[7] Although not strictly dealing with the issue of introductions to natural ecosystems, a recent Executive Memorandum (discussed at 59 FR 43122) directed the use of regionally native plants (as well as reducing the amount of chemical applied) on federally landscaped grounds. Additionally, although major restoration of natural habitats was not envisioned to be accomplished under the memorandum, part of its intent was to: (1) maintain and promote the existing natural habitat, (2) minimize disturbance to the natural habitat, and (3) integrate design and construction of federal projects with the surrounding natural habitat.

the Director. It will be the policy of the DOE-RL to observe the provisions of Washington state law regarding the release of wildlife and planting of aquatic plants and seeds on all Hanford Site lands under its immediate control and management authority and on leased properties.

An exception to the general prohibition on the introduction of non-native species to the Hanford Site may occur in association with the use of biological control agents as part of an integrated pest management strategy. The Washington State Department of Agriculture approves the use of specific biological control agents. These agents are selected on the basis that they are natural predators of a particular pest species but may not be present if the pest species has been introduced to a new environment. Also, these agents are generally host-specific; therefore, they should die out after the host is eradicated. Specific biological control agents can be considered for release on the Hanford Site provided they have been:

- approved by the state Department of Agriculture
- determined to be in compliance with RCW 77.16.150 and WAC 232-12-271
- received an ecological compliance review (see Section 5.1).

Because the Hanford Site retains huge expanses of native shrub-steppe habitat, it is possible that the Site could be used as a recovery area for species of concern, historically present on the Site but now more or less extirpated, that are in decline regionally. It will be DOE-RL's policy to cooperate with the appropriate Washington State or federal agencies for the reintroduction of species of concern if all of the following criteria are met:

- Hanford is suitable habitat for the species.
- Hanford lands are within the natural range of the species.
- Reintroduction can be accomplished for the public good.
- Reintroduction would not adversely impact the DOE-RL mission or operations supporting that mission.

8.3 Listed or Otherwise Protected Species Requiring Special Management

Species requiring special management include all species identified as Level II and above (as defined in Section 4.3.2). (Although Level I species require monitoring, they do not qualify for any additional management attention.) Management of these species will focus on three classes of management action:

- evaluation and management of DOE-RL impacts
- species/habitat tracking
- focused enhancement.

These management actions will be implemented in a graded approach that reflects the level of concern for each species group. The level or intensity of management is adjusted appropriately to fit each species group. This graded approach is shown in Table 8.3.

Impacts on resources due to implementation of proposed projects will be evaluated during the ecological compliance review process outlined in Section 5.1. Details of this process are defined in DOE-RL (1995). Via the graded approach, impact management will be implemented at four different levels. Species tracking consists of monitoring for status and trends. Monitoring will be implemented at three levels.

Focused enhancement includes restoration/compensation actions in response to project impacts plus non-project-specific enhancement in response to unacceptable declines in the resource within the Hanford ecosystem or the Columbia Basin Ecoregion. Focused enhancement will be implemented at three levels as described in the table.

8.4 Management of Some Recreationally and/or Commercially Important Species

8.4.1 Ungulate Management

The Rattlesnake Hills elk herd, which frequents the ALE Unit and adjoining lands, has grown steadily

Table 8.3 Management Levels for Species of Concern at Hanford

Species Group	Classes of Management Actions		
	Impact Management Level	Species/Habitat Tracking Level	Focused Enhancement Level
State monitor species	*Low* Avoid or minimize impacts to the extent possible without impacting the project's budget or schedule.	*Low* Monitor the species habitat on a periodic basis (less than annual) and note occurrences during: (1) the annual Ecological Compliance Assessment Project baseline environmental surveys, and (2) the monitoring of habitat and species outside the baseline areas (i.e., 600 Areas) that occurs under the Ecosystem Monitoring Project.	*Low* Will receive low consideration for focused enhancement when restoration/ compensation actions are considered or when significant declines occur on Hanford or within the Columbia Basin ecoregion, unless it is otherwise a state or federal listed species or candidate species.
State sensitive/ candidate	*High* Avoid and/or minimize the impact to the maximum extent possible. Residual impacts, if significant, will require mitigation by rectification and/or compensation.	*Low* Monitor the species habitat on a periodic basis (less than annual) and note occurrences during: (1) the annual Ecological Compliance Assessment Project baseline environmental surveys, and (2) the monitoring of habitat and species outside the baseline areas (i.e., 600 Areas) that occurs under the Ecosystem Monitoring Project.	*High* Will receive high consideration for focused enhancement when restoration/ compensation actions are considered or when significant declines occur on Hanford or within the Columbia Basin ecoregion.
State threatened/ endangered	*High* Avoid and/or minimize the impact to the maximum extent possible. Residual impacts, if significant, will require mitigation by rectification and/or compensation.	*High* Monitor the species habitat and, except for plants, track species locations/numbers on an annual basis.	*High* Will receive high consideration for focused enhancement when restoration/ compensation actions are considered or when significant declines occur on Hanford or within the Columbia Basin ecoregion.

Table 8.3 Management Levels for Species of Concern at Hanford (continued)

Species Group	Classes of Management Actions		
	Impact Management Level	Species/Habitat Tracking Level	Focused Enhancement Level
Federally designated migratory birds	*Medium* Avoid the impact to the maximum extent possible (i.e., do not harm the bird or its habitat) and minimize impacts that are unavoidable (i.e., time the work so that habitat but not the bird, or its nest or eggs, are impacted). If direct impacts to migratory birds cannot be avoided or minimized, then a recommendation will be made for the project to obtain an incidental take permit under the Migratory Bird Treaty Act from the U.S. Fish and Wildlife Service.	*Low* Monitor the species habitat on a periodic basis (less than annual) and note occurrences during: (1) the annual Ecological Compliance Assessment Project baseline environmental surveys, and (2) the monitoring of habitat and species outside the baseline areas (i.e., 600 Areas) that occurs under the Ecosystem Monitoring Project.	*Low* Will receive low consideration for focused enhancement when restoration/ compensation actions are considered or when significant declines occur on Hanford or within the Columbia Basin ecoregion, unless it is otherwise a state or federal listed species or candidate species.
Federal candidate	*High* Avoid and/or minimize the impact to the maximum extent possible. Residual impacts, if significant, will require mitigation by rectification and/or compensation.	*Medium* Monitor the species habitat and note occurrences on an annual basis under the Ecosystem Monitoring Project and track species location annually under the Ecological Compliance Assessment Project's baseline surveys.	*High* Will receive high consideration for focused enhancement when restoration/ compensation actions are considered or when significant declines occur on Hanford or within the Columbia Basin ecoregion.

during recent years (see www.pnl.gov/ecology/ecosystem for the latest documented census results). Although the elk occupy both the Hanford Site and nearby private property, the herd occupied the Hanford Site almost exclusively during the years that it grew from about five animals in 1972 until it reached nearly 200 by 1992. By 1994, the herd approached 300 animals. At that point, the elk began causing crop damage on private property and attracted hunters to those lands. Hunters subsequently shot elk on private land without first obtaining permission, which led to trespass complaints from the landowners. The Washington Department of Fish and Wildlife began meeting with the landowners, including the DOE-RL, to address elk-related problems.

Other Hanford-related elk issues revolve around the question of whether elk are causing excessive habitat damage on the ALE Unit and whether continued growth of the herd will prompt the herd to expand into the Hanford central core area where waste management facilities are located. The shrub-steppe (and riparian) communities of the Hanford Site developed over the past several thousand years without the influence of large herds of ungulates,

Table 8.3 Management Levels for Species of Concern at Hanford (continued)

Species Group	Classes of Management Actions		
	Impact Management Level	Species/Habitat Tracking Level	Focused Enhancement Level
Federal proposed/ threatened/ endangered	*Special* Potential impacts to these species will be evaluated during the ecological compliance review process. Any finding of impact will trigger, at a minimum, informal consultation with the Fish and Wildlife Service under Section 7 of the Endangered Species Act. Any mitigation recommendations for these species will be defined by the Fish and Wildlife Service through the consultation process. No project action that could impact these species will be initiated until consultation is completed and mitigation actions have been identified.	*High* Monitor the species habitat and track species locations/ numbers on an annual basis.	*Special* Enhancement actions for federal threatened or endangered species depends on specific action recommendations defined in conservation plans and agreements between DOE-RL and the Fish and Wildlife Service.

though small numbers of deer, antelope, and elk may have been present (Daubenmire 1970; Mack and Thompson 1982). As relatively recent invaders to the Site, the elk herd potentially could affect adversely these fragile communities. As the Hanford Site biological resources monitoring strategy (see Chapter 6.0) becomes more defined in subsequent years, DOE-RL or the future land administrator will need to monitor possible elk-induced habitat impacts and make appropriate management adjustments.

Since the elk colonized Hanford in the early 1970s, DOE-RL has monitored the elk population growth and provided information to Washington State Department of Fish and Wildlife for their use in managing the herd. DOE-RL also initiated research to determine whether immunocontraception of the elk herd might provide the state with a management tool for limiting future herd growth. There exists a continued need for all affected parties, including the Washington Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, DOE-RL, and private landowners to cooperate on policies and actions that will permit the elk herd to stabilize at a level that minimizes adverse impacts on both federal and private lands. Beginning in 1998 and continuing to the present, the Washington Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, and the Richland Office of the Department of Energy have been reviewing and implementing actions that could be initiated to effectively reduce the Rattlesnake Hills elk herd.

8.4.2 Hunting, Fishing, and Trapping

When addressing hunting, fishing, and trapping, the Hanford Site can be divided into separate management units that are based on several distinct areas of management responsibilities. The ALE Unit and the central core (consisting of all lands south and east of the Columbia River exclusive of the ALE Unit) of the Site are closed to outdoor recreation as a result of DOE-RL administrative direction and enforcement through trespass restrictions. The ALE Unit is both a National Environmental Research Park and a designated Research Natural Area. Plant and animal species are protected on the ALE Unit, and no hunting or trapping is permitted. No fish-holding water occurs on the ALE Unit. The basis for restriction of trespass within the central core has been both for security and public safety reasons. Even with the change in Hanford mission from weapons material production to environmental restoration, the basis for continuing trespass restrictions within the central core seems to have changed little in recent years. Thus, access for the purposes of hunting or trapping seems to be a static issue at this time.

Saddle Mountain Unit, which lies north of the Columbia River on the western portion of the Site, is managed by the Fish and Wildlife Service via a revocable use permit with DOE-RL. Hunting, fishing, and trapping on that portion of the Site also is restricted. Public use policy for Saddle Mountain Refuge is determined by the Fish and Wildlife Service.

North and east of the Columbia River is a portion of the Hanford Site managed by the Washington State Department of Fish and Wildlife (also via a revocable use permit with DOE-RL). The area is known as the Wahluke Unit and it is managed by the Department for outdoor recreation, which includes hunting, fishing, and trapping. Access to that portion of the Site for hunting, fishing, and trapping is available to the public during the appropriate, legally established hunting, fishing and trapping seasons. There is access to the Columbia River along the shoreline within the state-managed area.

At the boundary of the central core, in areas below the normal high water line (not under DOE-RL control), and the Columbia River and on the Columbia River islands, hunting, fishing, and trapping also are permitted for that portion of the River below the wooden powerline crossing at the old Hanford Townsite. The Columbia River and all islands in the River and the Benton County shoreline below the highwater mark, including any pennisula originating on the Benton County shoreline, between Vernita Bridge and the wooden powerline crossing the River near the old Hanford townsite are closed to all hunting by the state Department of Fish and Wildlife. Although DOE-RL is owner/administrator for portions of several islands on the Columbia River, ownership and management responsibility among the several other state and federal agencies is not always clearly defined and obvious to the public. Because of boat access, one DOE-RL island (Wooded Island) has been generally available to the public for hunting, fishing, and trapping. Because state regulation of hunting, fishing, and trapping on the island does not interfere with any DOE-RL-related responsibilities on Wooded Island, state regulation of hunting is viewed by DOE-RL as valid and appropriate (Appendix B addresses the applicability of state hunting and fishing regulations on federal property).

The harvest of deer along and within the Hanford Reach seems to have increased in the past 2 to 3 years as deer hunters routinely hunt the Columbia River Islands. During that time, several deer tagged from within the central core have been taken by hunters during legal hunting seasons. Evidence also suggests that trespass on both the ALE Unit and the central core for the purpose of hunting has increased in recent years, particularly since the Hanford helicopter patrols were eliminated.

Hunting, fishing, and trapping are currently not high-priority biological resource management issues for DOE-RL because management policy and authority are well-established for each of the several land management areas of the Site. Large populations of trophy-sized deer and elk in areas that are not open to public access will continue to attract poachers. There will be a continuing and perhaps even enhanced need for enforcement against unauthorized trespass in the future if DOE-RL is to maintain the effectiveness of the current Research Natural Area basis for protecting the ALE Unit's biological resources and for maintaining the effectiveness of the security and public safety restrictions within the central core.

9.0

Biological Resource Data Management

To facilitate biological resource management, procedures are necessary to define how site flora and fauna survey data are maintained. Data are more easily accessible if they are eventually consolidated into an automated data base. This data base should be capable of integration with a GIS and should facilitate the following objectives:

- efficient determinations of potential project impacts to fish, wildlife, plants, and their habitat
- identification of the locations of priority habitats and species of concern
- identification of data gaps or areas where necessary administrative controls are lacking
- identification of trends in population levels of species of concern
- identification of locations where biological resource concerns can be relaxed
- efficient incorporation of survey data as they are accumulated by onsite contractors and offsite governmental (including local Tribes) and non-governmental organizations.

9.1 Species of Concern and GIS-Based Data Bases

A primary data base will be maintained that contains up-to-date data on plant, fish, and wildlife species of concern associated with the Hanford Site. This data base will be maintained by the Hanford Biological Resources Laboratory and will be DOE-RL's official reference source for documenting the occurrence of a particular species on the Hanford Site, its federal and state listing status, and its level of management concern as assigned in BRMaP.

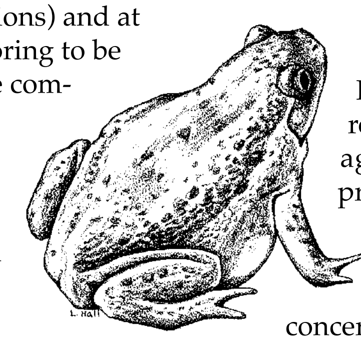
The Ecosystem Monitoring Project will be the primary repository of most of the GIS-based biological resources maps provided in the BRMaP. The Hanford Biological Resources Laboratory will maintain the resource maps for BRMaP associated with the industrial areas (i.e., baseline survey maps). The combination of the Ecosystem Monitoring Project and Hanford Biological Resources Laboratory's GIS-based information will be DOE-RL's official reference source for documenting habitat/plant community-based level of concern information. The resource maps will be updated as new data become available (e.g., through annual baseline surveys).

Inventory and monitoring data collected in accordance with Section 6.0 will be maintained by the contractor project assigned the lead responsibility for accomplishing the specific monitoring objective. Data bases will be maintained as follows:

- inventory, single species status monitoring, and Hanford ecosystem integrity monitoring data: Ecosystem Monitoring Project
- mitigation action results monitoring data: if mitigation is accomplished project-by-project, the host DOE-RL program and their particular contractor are responsible; if mitigation is accomplished by a mitigation bank or pseudo-bank approach, then tentatively DOE-RL's Office of Site Services through the Hanford Biological Resources Laboratory is responsible
- contaminant monitoring data: Surface Environmental Surveillance Project.

9.2 Release of Data/ Interactions with other Hanford Databases

There is a need to make plant, fish, and wildlife species and habitat/plant community data available to interested parties (e.g., U.S. Fish and Wildlife Service, Washington State Department of Fish and Wildlife, Washington Department of Natural Resources's Natural Heritage Program, local Tribes, private conservation organizations) and at the same time enable research/monitoring to be conducted and the resultant data to be compiled, reviewed, and entered into data bases before it is made accessible offsite. At times, client interests also may have to be protected; however, data from any data collection effort on plant, fish, and wildlife species and habitat/plant community on Hanford should be made accessible, in a reasonable time-frame, to other interested parties including the Natural Heritage Program and the state Department of Fish and Wildlife's nongame data bases.



All appropriate biological resource compliance and monitoring data collected on the Hanford Site and entered into one of the data bases identified in Section 9.1 will be made available within a reasonable timeframe for entry into the Hanford Environmental Information System and/or Hanford GIS databases, as appropriate. Dissemination of electronically transferred data to interested parties off the Hanford Site will be made via these latter databases.

The Ecosystem Monitoring Project will coordinate with the Hanford Biological Resources Laboratory and environmental restoration contractor team database management staff to establish data transfer procedures that will address the appropriate handling of sensitive biological resource data when it involves information about the location(s) of species of concern and rare plant communities. These procedures will be established within one year of issuance of BRMaP as a final document.

Appendix A

Ecosystem Management

This appendix introduces and discusses the concept of ecosystem management as it relates to DOE stewardship of biological resources on lands that it administers. Section A.1 highlights federal policy development in regard to ecosystem management. Section A.2 describes in detail the background to and implementation of the DOE-RL's approach to ecosystem management. The appendix concludes with brief overviews of a General Accounting Office review of federal ecosystem management efforts (Section A.3) and ecosystem/natural resource management planning at other DOE sites (Section A.4).

Contents

A.1 Policy Development in Regard to Ecosystem Management

On December 21, 1994, the Secretary of Energy (hereafter referred to as the Secretary) issued a Departmental policy whose intent was to strengthen the stewardship of DOE lands.[1] The Land and Facility Use Policy states:

> It is Department of Energy policy to manage all of its land and facilities as valuable national resources. Our stewardship will be based on the *principles of ecosystem management* (emphasis added) and sustainable development. We will integrate mission, economic, ecologic, social and cultural factors in a comprehensive plan for each site that will guide land and facility use decisions. Each comprehensive plan will consider the site's larger regional context and be developed with stakeholder participation. This policy will result in land and facility uses which support the Department's critical missions, stimulate the economy, and protect the environment.

Prior to the Secretary's policy statement, the Executive Office of the President had issued a report recognizing that federal land use planning should be organized around the concept of ecosystem management (NPR 1993). This report is the basis for the Secretarial policy statement. The report also recommended that the President issue a directive that establishes a national policy to ensure sustainable ecosystems through ecosystem management (NPR 1993). These policy initiatives indicate the importance placed by the Executive Branch on having federal environmental policy reflect more of an ecological basis.

The DOE also has indicated their support for a more holistic approach to natural resource management by becoming a signatory to a Memorandum of Understanding (MOU), along with 13 other federal agencies, that fosters an ecosystem approach. The policy portion of this MOU states:

> The federal government should provide leadership in and cooperate with activities that foster the ecosystem approach to natural resource management, protection, and assistance. Federal agencies should ensure that they utilize their authorities in a way that facilitates, and does not pose barriers to, the ecosystem approach. Consistent with their assigned missions, federal agencies should administer their programs in a manner that is sensitive to the needs and rights of landowners, local communities, and the public, and should work with them to achieve common goals.[2]

In accordance with the MOU, each signatory agency was directed to examine the specific recommendations made in the report of the Interagency Ecosystem Management Task Force (IEMTF 1995) and identify those recommendations that may apply to its programs. Based on its review of these recommendations an agency could then undertake appropriate actions to implement the recommendations. The IEMTF made 31 specific recommendations grouped into the following areas of focus:

- Improve federal agency coordination;
- Improve partnerships with non-federal stakeholders;
- Improve communication with the public;
- Improve resource allocation and management;
- Support the role of science;
- Improve information and data management; and
- Increase flexibility for adaptive management.

Many of the IEMTF recommendations may be directly applicable to the implementation of the ecosystem (management) approach at Hanford.

[1] Memorandum from H. R. O'Leary, Secretary of Energy, to Secretarial Officers and Operations Office Managers, dated December 21, 1994, Land and Facility Use Policy. See Attachment 1.

[2] Memorandum of Understanding to Foster the Ecosystem Approach between the Council of Environmental Quality, Department of Agriculture, Department of the Army, Department of Defense, Department of Energy, Department of Housing and Urban Development, Department of the Interior, Department of Justice, Department of Labor, Department of State, Department of Transportation, Environmental Protection Agency, and Office of Science and Technology Policy, dated December 15, 1995. See Attachment 2.

As a follow-on to the preceding policy initiatives and in furtherance of its own stewardship responsibilities, DOE-RL has established its own biological resources protection policy that emphasizes an ecosystem management approach. The policy states:

> It is the policy of the U.S. Department of Energy, Richland Operations Office to be responsible stewards of the natural environment on the Hanford Site. The Richland Operations Office will work with its contractors, resource agencies, stakeholders, and the Indian Tribes to preserve or enhance the biological resources under its stewardship in a manner that is consistent with the principles of ecosystem management and sustainable development.[3]

A.2 Department of Energy Approach to Ecosystem Management at Hanford

[Ecosystem management: a process that]

> *...integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term*
> —Grumbine (1994).

The Executive Branch recently issued a report as part of a National Performance Review that stated: "It is self-evident that the federal government should do its utmost to ensure the sustainability of our human communities and the ecological systems upon which we depend." (NPR 1993). Because too often, however, the federal government itself has contributed to the degradation of ecosystems, management approaches that can best integrate agency mission requirements with resource protection are vital. An evolving management strategy intended to accomplish the reconciliation of these often competing objectives is that of ecosystem management.

Although the concept of ecosystem management has yet to be uniformly defined or consistently applied by federal or state management agencies, consensus is developing (Grumbine 1994). Still, ecosystem management is not a panacea and it has its detractors (for example, see Stanley 1995). Acceptance of ecosystem management will depend, in part, on the validity of its scientific underpinnings (ESA 1995).

In its simplest form, ecosystem management represents a proactive approach to federal environmental policy. Because of their vast land holdings and the nature of their activities that have the potential for significant impacts on the environment, federal agencies such as the Department of the Defense (DoD) and the DOE can make important contributions to sustaining healthy ecosystems by employing an ecosystem management approach (NPR 1993).

Recently, the DoD issued a policy memorandum on the implementation of ecosystem management principles across the DoD complex.[4] Soon after the Secretary followed with her policy statement on land and facility use that adopted ecosystem management as a governing principle. In an attempt to gain the benefits of a more holistic approach toward accomplishing its stewardship responsibilities for biological resources and in accordance with the Secretarial policy, DOE-RL will implement principles of ecosystem management. The purpose of this section is to define DOE-RL's approach to ecosystem management at Hanford and to describe how this approach will be integrated into the different biological resource management activities covered under this plan.

Although there is as yet no overall consensus as to what ecosystem management is and what it should specifically accomplish, there is enough common ground to enable a description of the important elements that define it as a process. First, ecosystem management is a goal-driven approach to environmental management. Second, temporal and geographical scales and biological hierarchies of interest define the scope of management. Third, human values and their priorities help define what will be the desired social benefits of management actions. Fourth, partnerships among responsible government agencies and public interest groups are necessary for successful implementation.

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3 See Attachment 3 for the complete text of the policy statement.

4 Memorandum from S. W. Goodman, Deputy Under Secretary of Defense (Environmental Security) to Assistant Secretaries of the Army, Navy, and Air Force, dated 8 August 1994, Implementation of Ecosystem Management in the DoD.

With the above as a framework, it is possible to tailor the process of ecosystem management to fit site-specific needs and conditions. The approach to be taken for the application of ecosystem management at Hanford as it applies to biological resources will involve the following: (1) identification of the goal of ecosystem management, (2) identification of principles that will act as guidance for how the ecosystem management goal will be attained, and (3) identification of the management tools that will enable successful implementation of ecosystem management at Hanford.

A.2.1 Hanford's Ecosystem Management Goal

The goal of ecosystem management at Hanford is to enable the accomplishment of RL's mission of: (1) cleaning up the Hanford Site, (2) providing scientific and technical excellence to meet global needs, and (3) partnering in the economic diversification of the region while at the same time preserving or enhancing over the long term the integrity of Hanford's ecosystem within its bioregional context. More specific biological resource management principles that taken together define what is meant by preserving or enhancing ecosystem integrity are identified in Section 2.2.2.

The three components of DOE-RL's mission could impact the integrity of the Hanford ecosystem in a number of ways. For example, remediation of past-practice waste sites could modify, both positively and, at least in the short-term, negatively, the environmental pathways through which a species's exposure to contaminants could occur. Moreover, the physical disturbance caused as a result of remediation could have significant impacts on plants, fish, and wildlife and their habitats. Additionally, site development that results from technology development and economic diversification also could have significant impacts on species and their habitat. These impacts are not only site-specific; cumulative impacts resulting from aggregated habitat loss and associated fragmentation of what remains could threaten ecosystem integrity. Thus, the preceding environmental stressors need to be addressed in any ecosystem management strategy whose intent is to preserve ecosystem integrity.

The basic assumption embodied in the above ecosystem management goal is that Hanford's missions and its associated activities are sustainable within an ecological context. Although sustainability is often used in the context of appropriately managing the exploitation of renewable resources to ensure their availability for future generations, sustainability here means that DOE-RL will conduct its mission activities in such a manner that ecosystem integrity is not adversely impacted. The challenge of ecosystem management at Hanford is to provide the policies, principles, and resources necessary to achieve sustainability.

The other important elements of the goal statement relate to the temporal and spatial scales over which management is considered. Insofar as recognizing that choosing the appropriate scale is an important principle of ecosystem management, it will be mentioned here only briefly; the concept will be discussed more in depth in the following section. The salient points are that ecosystem management at Hanford must look beyond the Site's borders to understand the ecological context in which Hanford's biological resources exist, and it must consider ecosystem integrity over longer time scales than previously considered.

A.2.2 Principles of Ecosystem Management at Hanford

Identified and described below are DOE-RL's ecosystem management principles. They form the basis for biological resource management at Hanford.

1. Hierarchical Context—All levels of the biodiversity hierarchy (i.e., genes, species, populations, ecosystems, and landscapes) and their connections are important. Populations and species requiring specific management needs, such as threatened and endangered species, will continue to be addressed. In addition, DOE-RL intends to focus increased attention on the overall integrity of the Hanford ecosystem and its connectivity to the surrounding landscape.

2. Ecological Boundaries—Under an ecosystem management approach, it is vital to set management goals and methods at scales, both spatially and temporally, that are compatible with natural processes (Goodman 1994), achieve management optima (Lackey 1996), and reflect local, regional, and national resource values. The correct scale to consider may differ with the particular management problem to be addressed. Importantly, the

appropriate scale over which ecological information is needed and should be evaluated to make management decisions will more than likely not coincide with administrative and political boundaries.

3. Ecosystems are Limited in Their Ability to Accommodate Stress—To continue to provide desired social benefits, an ecosystem and each of its integral parts must over the long term continue to function. There are, without question, limitations on how far an ecosystem, a species, or any level of the ecological hierarchy can be stressed before irreparable injury will be caused (Lackey 1996). Thus, ecosystem management assumes that not all activities are sustainable. Societal desire to continue certain actions must be balanced against the real threat to ecosystem integrity. If ecosystem integrity is an important social value, then management actions must be conservative: i.e., the benefit of the doubt is given to the resource rather than to development (Kaufmann et al. 1994).

4. Role of Human Values and Priorities and Their Dynamic Nature—Within the framework of an ecosystem management approach, human values will determine the overall ecosystem management goal and the specific biological resource management goals that are its derivatives. Ecosystem management, for better or worse, is still based on an anthropocentric viewpoint (Stanley 1995). The missions of DOE-RL will reflect those missions that society deems to be of the greatest social benefit. These missions are not necessarily static. As society changes the priority it places on the benefits it wants from Hanford, the state necessary for the Hanford ecosystem to provide these benefits may change as well. For ecosystem integrity to take precedence over all other missions, humans have to make that choice.

5. Partnerships—Because ecosystem management is based on ecological boundaries, and not administrative or political boundaries, and because ecosystem management must account for a myriad, and often conflicting number, of human values and desired social benefits, it will be best accomplished at Hanford by DOE-RL forming collaborative partnerships with other federal agencies, state, tribal, and local governments, non-government entities, private landowners, and the general public. Together these entities can decide what they desire to be the future state of the Hanford ecosystem, what social benefits they want it to provide, and how much importance they want to place on its long-term integrity. Additionally, an informed and involved public can provide valuable input to the ecosystem management process.

6. Scientific Information—Ecosystem management at Hanford will be based on the best science available. To the extent that the focus of management efforts will change, new (and perhaps more) information and new ways of looking at this information will have to be used. A new approach also could involve a change in the types of scientific data collected and in the kinds of research conducted. Research topics such as the effects of fragmentation, habitat classification schemes, and the dynamics of disturbance regimes at different scales may take on increased importance. Data sharing among agencies will have to be increased. Management of existing and new data also may need to be improved. Most importantly, the tendency to assume that science and technology can provide all the answers, and by so doing provide the illusion that ecosystem integrity can be maintained in the face of any environmental stressor, must be avoided. Science and technology have their limitations, and it follows that an important principle of ecosystem management is to acknowledge uncertainty and apply caution to management decisions.

7. Adaptive Management—Ecosystems and the expectations humans place on their services are dynamic. As such, management must be adaptive. Adaptive management focuses on management as a learning process and recognizes the provisional nature of scientific knowledge (Grumbine 1994). Management must remain flexible to: (1) incorporate new information and the lessons learned from previous management actions, (2) account for the complexity of ecosystem structure and function, and (3) allow for uncertainty (Grumbine 1994). Management actions should be reviewed on a regular basis and adjustments made as necessary.

8. Organizational Change—Effective implementation of ecosystem management may require changes in organizational structure and relationships as well as changes in the manner in which organizations operate.

9. Humans as a Part of the Ecosystem—People are a part of the ecosystem they inhabit (Grumbine 1994). By their activities, humans can have enormous impacts on ecosystem components, their function, and their interrelationships. Importantly, however, humans are in turn affected by their environment. What sort of environment (quality of life) humans want is, in part, dictated by how humans treat their environment.

10. Integration—Ecosystem management can be effectively implemented only if it is incorporated site- and program-wide as the way of doing business. The goals and objectives of ecosystem management (here as they relate principally to biological resources) need to be an integral part of Hanford's strategic planning, project planning, and budget decisions if any measure of success is expected to be achieved. Adoption of ecosystem management across the board can prevent duplication of effort, minimize inconsistencies, and create efficiencies for programs that will impact ecosystems.

A.2.3 Tools of Ecosystem Management at Hanford

The preceding discussion of principles helps to define and bound the process of ecosystem management. The principles also provide operational meaning. From these principles, the tools of ecosystem management can be derived and so provide substance (i.e., tangible outcomes) as well as process. The tools described below will be integrated, as applicable, into the management strategy for each biological resource management component.

1. Data Collection and Management—Data collection will need to focus on those areas that are necessary to support the biological resource management goals (those goals that when met combine to achieve the preservation or enhancement of ecosystem integrity) identified in Section 2.2.2. This includes continuing the process of inventorying Hanford's biological resources. Inventory of biological resources is covered in Chapter 6.0 of BRMaP. Data collection may result in the collection of different types of data from that previously collected. Thus, data management will have to accommodate these new types of data, as well as the new ways in which existing data may be used and retrieved. Data management is described in Chapter 9.0.

2. Impact Assessment—The assessment of the potential and realized impacts of Hanford activities on biological resources will continue to be under ecosystem management an important component of overall biological resources management. Impact assessment is necessary both to ensure regulatory compliance and to maintain stakeholder and public confidence in DOE-RL's stewardship of public resources. Impact assessment is covered in Chapter 5.0.

3. Monitoring—An effective monitoring program will be a key component to the successful implementation of ecosystem management at Hanford. Monitoring creates a feedback loop that enables the results of management actions to be evaluated and, when necessary, corrected. Adaptive management is not possible without monitoring. An effective monitoring program monitors those resources whose status provides an indication of not only their individual viability but also the overall integrity of the Hanford ecosystem. To be effective, monitoring must be a long-term enterprise. It complements impact assessment and also replaces it when it is necessary to determine what the actual impacts from a project are after its completion and during its operational life. Moreover, monitoring enables an evaluation of the effects of cumulative impacts on biological resources. Long-term monitoring also is important for determining the success of mitigation actions. Monitoring is covered in Chapter 6.0.

4. Timely Use of Biological Resource Data—Consideration of biological resource values will need to be made an integral part of the decision process that determines the location, timing, and extent of Hanford Site remediation and development actions. In many cases, biological resources values may not take precedence. To avoid or minimize not only resource impacts, but also cost and schedule impacts, it is imperative in all cases, including when resources values are not the prime consideration, to at least bring resource information to bear early in the planning phases of a project.

Integration of the biological resource information and management framework provided within BRMaP with the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)* (DOE 1999) and the project site selection process will facilitate this timely use of biological resource data (see Section 1.2). Chapter 4.0 identifies Hanford's biological resources of concern and a framework for their management. Chapter 5.0 describes the procedures by which biological resource impacts will be avoided or minimized during remedial and developmental activities at Hanford.

5. Mitigation Hierarchy—Mitigation is a series of prioritized actions that, when accomplished in full, ensures that a project will not have a net adverse effect on a particular biological resource. The key to minimizing the cost of mitigation and the uncertainty associated with the success of complex mitigation actions is to follow the hierarchy. Avoid is

always preferred over minimize, minimize is preferred over rectification, and so on. Mitigation is covered in Chapter 5.0.

6. Focus on the Appropriate Level of the Biodiversity Hierarchy—All levels of the biodiversity hierarchy have value. Still, management resources will always be limited. An ecosystem management approach, though still cognizant that some individual species require specific management attention, shifts the focus to higher levels of the hierarchy when it is efficient to do so. Ultimately, the particular management problem will dictate the level at which attention is placed. Management strategies that address habitat and other landscape-level concerns are covered in Chapter 7.0. Species management is covered in Chapter 8.0.

7. Performance Standards—As described in Section 2.2.2, each biological resource management goal should include as part of its implementation strategy specific objectives. Each objective should be referable to measurable biological benchmarks against which the success of management actions can be compared. The effectiveness of an adaptive management strategy relies on clearly defining the desired outcomes of management actions, tailoring a monitoring strategy that measures performance against these outcomes, and providing flexibility when outcomes dictate a change in management direction.

8. Organizational Changes—As an aid to the implementation of ecosystem management at Hanford, DOE-RL recently created an organizational structure that focuses the responsibility for site- and program-wide natural resource (biological, cultural, groundwater) management policy development within a Analytical Services and Natural Resources Team. This team is located organizationally within the Office of Site Services. Chapter 3.0 provides an overview of the organizational relationships that are germane to the administration of BRMaP. To further aid implementation, DOE-RL established an internal (DOE-RL and contractor) advisory board that is charged with the responsibility to help the Natural Resources Team ensure consistent and effective implementation of DOE-RL's biological resource management policies and direction and to assist team staff in addressing unforeseen management problems.

Interaction between DOE-RL programs and their contractor support with the Natural Resources Team and the advisory board will be encouraged to address issues of concern to the programs and to facilitate implementation. Other changes in organizational structure, relationships, or manner of operation that may facilitate ecosystem management at Hanford are possible and may need to be considered as an outcome of the implementation of BRMaP. For example, encouraging the participation of federal and state resource agencies on an external advisory board also is a possibility.

A.3 General Accounting Office Review of Federal Ecosystem Management Efforts

In response to a Congressional request, the U.S. General Accounting Office (GAO) initiated a review of ecosystem management efforts at the federal level (GAO 1994). The GAO focused its study on (1) the status of federal initiatives to implement ecosystem management, (2) additional actions necessary to implement the approach, and (3) barriers to its implementation government-wide. As a result of its study, the GAO found that the primary federal land management agencies (Bureau of Land Management, Fish and Wildlife Service, Forest Service, National Park Service) are beginning to implement an ecosystem approach to resource management; however, the GAO also found that, in spite of these efforts, additional actions must be taken and barriers must be overcome to realize government-wide implementation of ecosystem management.

In order for an agency to implement ecosystem management at the field level, the agency must clarify its policy goals and take practical steps at applying the principles of ecosystem management (GAO 1994). These practical steps include:

- delineating geographic areas to be managed as ecosystems
- understanding the ecology of the ecosystems
- making resource management choices
- using adaptive management principles (GAO 1994).

Even when taking these necessary steps, federal agencies are expected to face additional barriers in implementing ecosystem management. These barriers are mostly expressed as difficulties in coordination among varying levels of agencies (local, state, federal) with different incentives, authorities, and missions (GAO 1994).

Although not considered in the GAO report to be a primary federal land management agency, DOE has announced a policy of land stewardship based on the principles of ecosystem management (see Section A.1). Indeed, DOE has taken both the policy action identified by the GAO and the practical steps. The four practical steps outlined above are often best realized through the creation of field-level management plans. Across the DOE complex, such plans have been and are currently being written.

A.4 Natural Resource Management Planning at Other DOE Sites

The DOE has embraced the concept of ecosystem management as a means of managing its lands and resources, and though as a "non-resource management agency," it is proceeding cautiously with implementation, it is moving ahead with creating the building blocks necessary to implement the concept.[5] Individual DOE sites have achieved quite different levels of implementation in regard to ecosystem management let alone traditional natural resource management. A few case studies, and DOE's system of National Environmental Research Parks (NERP) are described below.

A.4.1 National Environmental Research Parks

The siting of many of the DOE facilities has resulted in a selection process that could have been used to select a network of ecological experimental research sites. Many of the sites contain lands that have been relatively undisturbed since they were set aside as security buffer zones and environmental monitoring areas at the beginning of the Manhattan Project. These sites serve as 50-year-old ecosystem baseline sites against which changes in environmental quality can be compared.[5]

The NERP Program was established by DOE in the 1970s to set aside land for ecosystem preservation and study and for environmental education (DOE 1994). Eventually a system of seven ecosystem sanctuaries was established; some of these land holdings represent the last remaining large remnants of the original surrounding ecosystem (DOE 1994). The seven NERPs are:

- Fermilab NERP
- Hanford NERP
- Idaho NERP
- Los Alamos NERP
- Nevada NERP
- Oak Ridge NERP
- Savannah River NERP.

One of DOE's broad mission goals is to provide the technical information and the scientific and educational foundation necessary to achieve improved environmental quality (DOE 1994). Environmental and ecological research at the seven NERP sites supports this mission goal as well as indirectly supporting other mission goals. Although execution of program missions of DOE sites must be ensured, ongoing environmental research projects and protected natural areas must be given careful consideration in any site-use decisions within a NERP (DOE 1994, Appendix: Charter for the National Environmental Research Parks).

A.4.2 Fernald Environmental Management Project

The Fernald Environmental Management Corporation is preparing a natural resource management plan for the Fernald Environmental Management Project (FEMP) site that was still in draft as of November 1994. In addition to supporting the FEMP site's environmental protection and resource management missions, the natural resource management plan also is intended to be a support document for future CERCLA, NEPA, and natural resource trusteeship activities.

The natural resource management plan is part of an overall resource management strategy for the FEMP site. The strategy includes: (1) establishing and maintaining natural resource characterization data, (2) developing and implementing the plan, (3) recommending avoidance/mitigation measures, (4) monitoring resource conditions, and (5) ensuring actions are taken to protect or enhance natural resources. The natural resource management plan

5 W. S. Osburn, Jr., U.S. DOE, Office of Energy Research, personal communication, 1996.

itself includes one section for each of the major categories of natural resources to be managed at the FEMP site. Each of these sections includes (1) a discussion of the regulatory drivers applicable to the management of the resource, (2) a detailed description of the natural resource, (3) overall management objectives applicable to each natural resource, and (4) the specific management plan to be implemented to meet the management objectives.

A.4.3 Nevada Test Site

The Nevada Test Site (NTS) is in the early stages of preparing a resource management plan in response to the Secretary's policy statement. The resource management plan is the first step toward improving land-use and resource management planning on the NTS. The primary goal of the resource management plan is to develop a land-use planning process for the NTS that will ensure long-term diversity and productivity of ecosystems and sustainable use of NTS land and facilities. This goal will be pursued through applying the principles of ecosystem management.

As part of developing and implementing the resource management plan, DOE's Nevada Operations Office is considering the following eight steps:

1. Review existing information and identify resources.
2. Develop management goals for resources. This step includes identifying management issues and constraints associated with each resource.
3. Identify management actions that will be undertaken during land-use planning and resource management to meet the goals established in step two.
4. Collect, analyze, and summarize data needed to implement the management actions identified in step three.
5. Focus on developing land-use planning tools for spatial analysis of resource data. These tools will include GIS models, other mapping tools, and land-use classification systems.
6. Use the resource management plan in the selection and design of new projects to evaluate the impacts of those activities on the ecosystems and resources of the NTS. This step will involve consideration of mitigation measures and alternatives to proposed actions.
7. Focus on resource monitoring and adaptive management.
8. Update the resource management plan every several years.

A.4.4 Oak Ridge Reservation

The DOE's Oak Ridge Reservation (ORR) has developed a resource management plan to assist planners in the resource management decision-making process (ORNL 1984–1992). Resources under the plan are viewed broadly and, thus, are not limited to natural resources. The resource management plan evolved as the mechanism for reviewing proposed activities within a framework that balances the preservation, conservation, consumption, and enhancement of the Reservation's resources.

The planning framework underlying the resource management plan is intended to: (1) develop and maintain a resource information database, (2) establish and use a problem-solving system to handle conflicts between resources and their uses while maintaining multiple-use criteria for resources, and (3) develop a means for assessing planned actions with the aim of ensuring protection of vulnerable or irreplaceable resources.

The resource management plan was organized by identifying individual resource categories. A resource plan was prepared for each category. In general, each individual resource plan includes (1) an inventory and characterization of the resource, (2) specific management plans for the resource, and (3) an identification and description of any interrelationships with other resources. It is intended that each of the resource plans would be reviewed and updated annually and the overall reviewed and revised every five years.

Through its 28 volumes, the ORR resource management plan contains information on all ORR resources, as well as recommendations for their continued management. The plan also describes the establishment of a permanent resource management structure that can respond quickly to administrative needs and coordinate and integrate the functions of individual resource management groups.

A.4.5 Savannah River Site

The Savannah River Site (SRS) natural resources management program began as a massive reforestation effort in the early 1950s that ultimately converted 80,000 acres of abandoned fields and fallow farmlands into pine forests. Over the years, management attention expanded to include such activities as wildlife management, fire suppression, boundary maintenance, soil stabilization, timber management, and cultural and ecological research. A Natural Resources Coordinating Committee, composed of federal and state agencies, contractors, and other entities, provide information and management recommendations to DOE Savannah River Operations Office (DOE-SR). Some of the organizations that sit on the committee share some of the operational responsibility for various aspects of natural resource management at SRS.[6]

In 1991 DOE prepared and implemented a natural resource management plan for the SRS to foster environmental protection and responsible stewardship of the SRS's resources (DOE 1991). The natural resource management plan provides the strategy and policy framework for natural resource management activities on the SRS. As such, it is an umbrella document under which other management and research program plans are prepared. The natural resource management plan is the strategic guidance that ensures compliance with (then) DOE Orders 4300.1C, "Real Property and Site Development Planning" and 5400.1, "General Environmental Protection" (DOE-SR 1993).

Within the natural resource management plan is a description of the individual resource management programs in place on the SRS. Following the policy theme of the management plan as a whole, the sections describing the individual resource programs provide the objectives, strategies, and policies pertaining to each resource. Under this policy direction, management plans are prepared for each resource (e.g., a fish and wildlife management operations plan). The SRS natural resource management plan integrates soils, water, plant conservation, fish, wildlife, threatened and endangered species, and forest management and reforestation needs in the development and uses of the SRS (DOE-SR 1993).

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The Secretary of Energy
Washington, DC 20585

December 21, 1994

MEMORANDUM FOR SECRETARIAL OFFICERS AND OPERATIONS OFFICE MANAGERS

FROM: HAZEL R. O'LEARY

SUBJECT: Land and Facility Use Policy

Today, I issued an innovative Departmental policy that strengthens the stewardship of our vast lands and facilities and encourages the return of some of these national resources to their rightful owners -- the American public. The policy will stimulate local economies, cut costs and redtape, and ensure public participation in our planning processes. The new policy states:

> It is Department of Energy policy to manage all of its land and facilities as valuable national resources. Our stewardship will be based on the principles of ecosystem management and sustainable development. We will integrate mission, economic, ecologic, social and cultural factors in a comprehensive plan for each site that will guide land and facility use decisions. Each comprehensive plan will consider the site's larger regional context and be developed with stakeholder participation. This policy will result in land and facility uses which support the Department's critical missions, stimulate the economy, and protect the environment.

The new policy is highlighted in the attached book, *DEPARTMENT OF ENERGY - STEWARDS OF A NATIONAL RESOURCE.* The book describes how we are changing the way we manage our lands and facilities. It also describes some of our recent successes in finding new uses for our surplus land and facilities. These successes range from new leases at the former Mound facility and the use of an idle reactor for brain cancer treatment at the Idaho National Engineering Laboratory to the creation of an urban park adjacent to our headquarters and the development of the National Wind Technology Center at the Rocky Flats plant. The book provides information about our major sites and contact numbers for each public affairs office. It encourages businesspeople, public officials, citizen organizations, and our site neighbors to provide their ideas for new site and facility uses.

This new policy has already undergone the initial directives review process and will be incorporated in the Department's broader Corporate Facilities Management Directive initiative that I have commissioned to respond to the National Performance Review.

I know you share my excitement about the opportunities we have in finding new uses for our lands and facilities. I look forward to working with you to fulfill the responsibility entrusted to us by the citizens of the United States for managing these valuable national resources.

Attachment 2

MEMORANDUM OF UNDERSTANDING
TO FOSTER THE ECOSYSTEM APPROACH

between the

COUNCIL ON ENVIRONMENTAL QUALITY
DEPARTMENT OF AGRICULTURE
DEPARTMENT OF THE ARMY
DEPARTMENT OF COMMERCE
DEPARTMENT OF DEFENSE
DEPARTMENT OF ENERGY
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
DEPARTMENT OF THE INTERIOR
DEPARTMENT OF JUSTICE
DEPARTMENT OF LABOR
DEPARTMENT OF STATE
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

I. DEFINITIONS

An *ecosystem* is an interconnected community of living things, including humans, and the physical environment within which they interact.

The ecosystem approach is a method for sustaining or restoring ecological systems and their functions and values. It is goal driven, and it is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic, and social factors. It is applied within a geographic framework defined primarily by ecological boundaries.

The goal of the ecosystem approach is to restore and sustain the health, productivity, and biological diversity of ecosystems and the overall quality of life through a natural resource management approach that is fully integrated with social and economic goals.

II. POLICY

The federal government should provide leadership in and cooperate with activities that foster the ecosystem approach to natural resource management, protection, and assistance. Federal agencies should ensure that they utilize their authorities in a way that facilitates, and does not pose barriers to, the ecosystem approach. Consistent with their assigned missions, federal agencies should administer their programs in a manner that is sensitive to the needs and rights of landowners, local communities, and the public, and should work with them to achieve common goals.

III. BACKGROUND

In its June 1995, report entitled, *The Ecosystem Approach: Healthy Ecosystems and Sustainable Economies*, the Interagency Ecosystem Management Task Force set forth specific recommendations with respect to how federal agencies could better implement the ecosystem approach. The Task Force recommended that member agency representatives sign a memorandum of understanding affirming their intent to implement the recommendations.

IV. THE ECOSYSTEM APPROACH

Healthy and well functioning ecosystems are vital to the protection of our nation's biodiversity, to the achievement of quality of life objectives, and to the support of economies and communities. The ecosystem approach recognizes the interrelationship between healthy ecosystems and sustainable economies. It is a common sense way for federal agencies to carry out their mandates with greater efficiency and effectiveness. The approach emphasizes:

- Striving to consider all relevant and identifiable ecological and economic consequences (long term as well as short term).
- Improving coordination among federal agencies.
- Forming partnerships between federal, state, and local governments, Indian tribes, landowners, foreign governments, international organizations, and other stakeholders.
- Improving communication with the general public.
- Carrying out federal responsibilities more efficiently and cost-effectively.
- Basing decisions on the best science.
- Improving information and data management.
- Adjusting management direction as new information becomes available.

V. THE COOPERATORS AGREE TO THE FOLLOWING:

A. Each federal agency that is a party to this Memorandum of Understanding shall designate an individual who will be responsible for coordinating the agency's internal and interagency activities in support of this Memorandum of Understanding to implement the recommendations of the Task Force report as appropriate. Such designation shall be reported to the Interagency Ecosystem Management Task Force within 30 days of signature. The collective agency designees will serve as an Implementation Committee. The Committee will meet regularly to share information on progress in implementing this Memorandum of Understanding, problems encountered, and solutions proposed in resolving them. The Committee shall provide reports at meetings of the Interagency Ecosystem Management Task Force. Such reports should include any unresolved issues that may require the attention of the Task Force.

B. Each signatory agency shall examine the specific recommendations made in the report of the Interagency Ecosystem Management Task Force in light of its authorities, policies and procedures, and identify recommendations that may apply to its programs. Based on this review, agencies shall determine what changes or interagency actions are necessary or desirable, undertake appropriate actions, monitor accomplishments, and report their findings and actions through the Implementation Committee to the Interagency Ecosystem Management Task Force, on a schedule to be determined by the Task Force.

C. The Interagency Ecosystem Management Task Force shall encourage regional directors or comparable executives of the federal agencies in the various regions to have regular and systematic exchanges of information about plans, priorities, and problems. The purposes are to eliminate inefficiencies and duplication of effort, to keep executives informed about federal government activities outside of their agencies, to clarify the respective contributions to ecosystem activities of federal agencies with varying missions (such as land management, resource management, regulatory, research, infrastructure, technical assistance, and funding), and to strengthen executive-level support for the interagency ecosystem activities of field personnel.

D. Each signatory agency shall participate, as appropriate to its mandates, in ecosystem management efforts initiated by other federal agencies, by state, local or tribal governments, or as a result of local grass-roots efforts. Members of the Implementation Committee shall identify their ongoing ecosystem efforts and other efforts that come to their attention, share information about those efforts, discuss appropriate agency actions with regard to participating in those efforts, and identify successful and unsuccessful components of those efforts. Signatory agencies shall also look for opportunities in new geographic areas for federal efforts in collaboration with stakeholders.

E. The Interagency Ecosystem Management Task Force will propose, as appropriate, new regional ecosystem demonstration initiatives. These initiatives will build upon the knowledge gained from evaluating the seven ecosystems that were the subject of the Task Force reports.

F. The Interagency Ecosystem Management Task Force will evaluate the potential for joint training programs for the ecosystem approach, in which all signatory agencies could participate, and in which personnel from all signatory parties could receive training. The Implementation Committee members will share information on agency training programs related to the ecosystem approach, and signatory agencies are encouraged to accommodate trainees from other agencies in such courses as appropriate.

VI. IT IS MUTUALLY AGREED AND UNDERSTOOD BY AND AMONG THE COOPERATORS THAT:

A. Specific work projects or activities that involve the transfer of funds, services, or property among the Cooperators will require the execution of separate interagency agreements, contingent upon the availability of funds as appropriated by Congress. Each subsequent agreement or arrangement involving the transfer of funds, services, or property among the Cooperators must comply with all applicable statutes and regulations, including those statutes and regulations applicable to procurement activities, and must be independently authorized by appropriate statutory authority.

B. This Memorandum of Understanding in no way restricts the Cooperators from participating in similar activities or arrangements with other public or private agencies, organizations, or individuals.

C. Nothing in this Memorandum of Understanding shall obligate the Cooperators to expend appropriations or enter into any contract or other obligations.

D. This Memorandum of Understanding may be modified or amended upon written request of any party hereto and the subsequent written concurrence of all of the Cooperators. Cooperator participation in this Memorandum of Understanding may be terminated with the 60-day written notice of any party to the other Cooperators. Unless terminated under the terms of this paragraph, this Memorandum of Understanding will remain in full force and in effect until September 30, 1999.

E. This Memorandum of Understanding is intended only to improve the internal management of the executive branch and is not intended to, nor does it create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, it officers, or any person.

F. The terms of this Memorandum of Understanding are not intended to be enforceable by any party other than the signatories hereto.

Attachment 2

VII. SIGNATURES

KATIE MCGINTY, Chair,
Council on Environmental Quality

JOHN ZIRSCHKY, Assistant Secretary for
Civil Works,
Department of the Army

SHERRI W. GOODMAN, Deputy Under
Secretary for Environmental Security,
Department of Defense

ANDREW M. CUOMO, Assistant Secretary
for Community Planning and Development,
Department of Housing and Urban
Development

LOIS SCHIFFER, Assistant Attorney General
for Environment and Natural Resources,
Department of Justice

JAMES R. LYONS, Undersecretary for
Natural Resources and Environment,
Department of Agriculture

DOUGLAS HALL, Assistant Secretary for
Oceans and Atmosphere,
Department of Commerce

DAN W. REICHER, Acting Assistant
Secretary for Policy, Planning and Program
Evaluation,
Department of Energy

BONNIE COHEN, Assistant Secretary for
Policy, Management and Budget,
Department of the Interior

JOSEPH A. DEAR, Assistant Secretary for
Occupational Safety and Health,
Department of Labor

5

DAVID A. COLSON, , Acting Assistant Secretary for Oceans and International Environmental and Scientific Affairs, Department of State

Deputy FRANK KRUESI, Assistant Secretary for Transportation Policy, Department of Transportation

FRED HANSEN, Deputy Administrator Environmental Protection Agency

JACK GIBBONS, Director, Office of Science and Technology Policy

Dated: December 15, 1995

6

Attachment 3

DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE

BIOLOGICAL RESOURCES PROTECTION POLICY

It is the policy of the U.S. Department of Energy, Richland Operations Office to be responsible stewards of the natural environment on the Hanford Site. The Richland Operations Office will work with its contractors, resource agencies, stakeholders, and the Indian Tribes to preserve or enhance the biological resources under its stewardship in a manner that is consistent with the principles of ecosystem management and sustainable development.

To carry out this policy:

The Richland Operations Office (RL) will ensure that biological resource values and ecosystem management principles are considered by all programs in all actions conducted on behalf of this Office. The Office will endeavor to enhance an awareness of, and appreciation for, biological resource values and their preservation, restoration, and enhancement. RL will work together with its contractors to integrate biological resource management goals and administrative procedures into program and project activities to ensure potential adverse impacts to biological resources are avoided or minimized.

Consistent with this policy, it is expected that:

Richland Operations Office Program and Project Managers will ensure that operations conducted under their programs and projects are carried out in accordance with ecosystem management principles and that biological resource management goals and administrative procedures are integrated into their program and project plans.

Richland Operations Office Contractors will carry out the work that they are responsible for in a cost effective manner consistent with this policy. They will incorporate ecosystem management principles and tools into the program and project planning process to facilitate meeting biological resource management goals and objectives.

All Richland Operations Office and Contractor employees will integrate environmental considerations, including biological resources preservation and enhancement, into their daily work, look for opportunities to improve management of human impacts to the environment, and promptly report environmental incidents and deficiencies that they observe.

Appendix B

Laws, Regulations, Executive Orders, and Policies that Potentially Affect the Management of Biological Resources at Hanford

This appendix lists the major laws, regulations, and Executive Orders that might apply to biological resources management at Hanford.

The following major federal laws, regulations, and Executive Orders might apply to biological resources management at Hanford. For a description of specific laws see DOE (1999).

B.1 Federal Laws and Regulations

- American Indian Religious Freedom Act of 1978
- Bald and Golden Eagle Protection Act of 1972
- Endangered Species Act
- Federal Land Policy and Management Act of 1976
- Fish and Wildlife Conservation Act of 1980
- Fish and Wildlife Coordination Act of 1934
- National Environmental Policy Act (NEPA) of 1969
- National Wildlife Refuge System Administration Act of 1966 (as amended by the National Wildlife Refuge System Improvement Act of 1997)
- Migratory Bird Treaty Act of 1918
- Sikes Act
- U.S. Fish and Wildlife Service Mitigation Policy
- Executive Order 11987 (Exotic Organisms)
- Executive Order 11988 (Floodplain Management)
- Executive Order 11990 (Protection of Wetlands)
- Executive Order 13112 (Invasive Species)
- Presidential Proclamation 7319 (Establishment of the Hanford Reach National Monument).

B.2 State Laws and Regulations

- State Environmental Policy Act of 1971.

Appendix C

Hanford's Biological Resources in a Regional Context

The purpose of Appendix C is to place Hanford Site biological resources into a regional context and, within that context, to describe the significance of Hanford's resources. Section C.1 introduces the concept of an ecoregion and briefly describes how the concept has been applied to the Columbia Basin. Section C.2 describes the characteristic physical and biological features of the Columbia Basin Ecoregion. Section C.3 provides a similar description of the Hanford Site. Within the framework established by Sections C.2 and C.3, Section C.4 then discusses Hanford's regionally and nationally significant biological resources.

Contents

Figures

Tables

C.1 Ecoregion Concept and Historic Depictions of the Columbia Basin Area

The ecoregion concept is a special method of regionalization[1] for subdividing a geographic area into regions of relative homogeneity with respect to ecological systems or the relationships between organisms and their environments (SAB 1991; Omernick 1987). The subdivisions that result can provide a valuable framework for environmental resource managers to use for monitoring, impact assessment, and resource management (SAB 1991). Also, the framework enables an evaluation of the relative significance of the characteristics that define geographic subdivisions. Although subdivision can occur at a variety of scales, as a particular level of geographic subdivision an ecoregion may be defined as a continuous geographic area within which the environment resulting from the interplay of variables such as climate, topography, and soils is sufficiently uniform to develop characteristic potential major vegetative communities. The interplay of environmental variables determine which biota can exist in an ecoregion (SAB 1991). Extreme changes in the characteristic vegetative communities define ecoregion boundaries.

Formulating definitions of geographic areas based on ecological characteristics has been an evolving process. A number of different approaches have been used in the past that have a bearing on determining Hanford's regional ecological context. Some methods for defining ecoregions have been applied across the entire United States. These are ecoregions as defined by Bailey (1976, 1980, 1995), Bailey et al. (1994), and Omernick (1987). The portions of the resultant maps produced from these methods applicable to the Pacific Northwest (in their latest versions) are portrayed in Figures C.1 (Omernick 1987) and C.2 (Bailey et al. 1994), respectively.

C.1.1 A First Attempt: Bailey 1976

Bailey's (1976, 1980) earlier framework for ecological classification was prepared as an aid for the U.S. Fish and Wildlife Service and its National Wetlands Inventory effort (Bailey 1980). The classification used a hierarchy of four levels. The broadest levels of the classification (i.e., domain and division) were based on climate. Based on the classification scheme, the Hanford Site is located within the dry domain and steppe division. Such an area is characterized by cold winters, rainfall less than 50 cm/yr (about 20 in./yr), and shrubs or sparse grasses. The next two levels, province and section, were defined by macro-features of the potential vegetation. The Hanford Site is located within the intermountain sagebrush (*Artemisia*) province, an area that encompasses southcentral Washington, a strip through central Oregon, southeastern Oregon, southern Idaho, northeastern California, most of Nevada, and western Utah. At the section level of Bailey's classification, Hanford is within the sagebrush/ (bluebunch) wheatgrass [*Agropyron* (= *Pseudoroegneria*) *spicatum*] section. The area covered was a subset of the province that excludes a western strip of Ponderosa shrub forest and most of the Nevada and Utah portions of the province. Thus, in Bailey's 1976 map Hanford maintained ecological continuity with the Snake River Plain and the high elevation shrub-steppe (i.e., steppe containing conspicuous shrubs; see below) of central Oregon. Such a depiction implied a close ecological association between shrub-steppe of the Columbia Basin and shrub-steppe of the Great Basin.

C.1.2 A Different Perspective: Omernick 1987

Omernick's (1987) framework was developed in response to a need to assess existing and attainable surface water quality (Omernick and Griffith 1991). Because surface waters generally reflect the characteristics of areas they drain, Omernick based his approach on patterns of terrestrial characteristics (Omernick 1987; Omernick and Griffith 1991). For Omernick's purposes, Bailey's (1976, 1980) ecoregion sections were inadequate at most locations, because at this level of classification Bailey relied on a single mapped characteristic [i.e., potential natural vegetation from Küchler (1970)] to define an area (Omernick 1987). Omernick's approach was to instead simultaneously analyze a combination of causal factors, that included climate, soils and geology, vegetation, and physiography, to define different ecoregions. Omernick also considered integrative factors, such as land use, to discern regional patterns.

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1 Regionalization is a mapping procedure by which a portion of the landscape is recognized as having a degree of internal homogeneity as well as features that contrast with those of an adjacent area (Bailey et al. 1978).

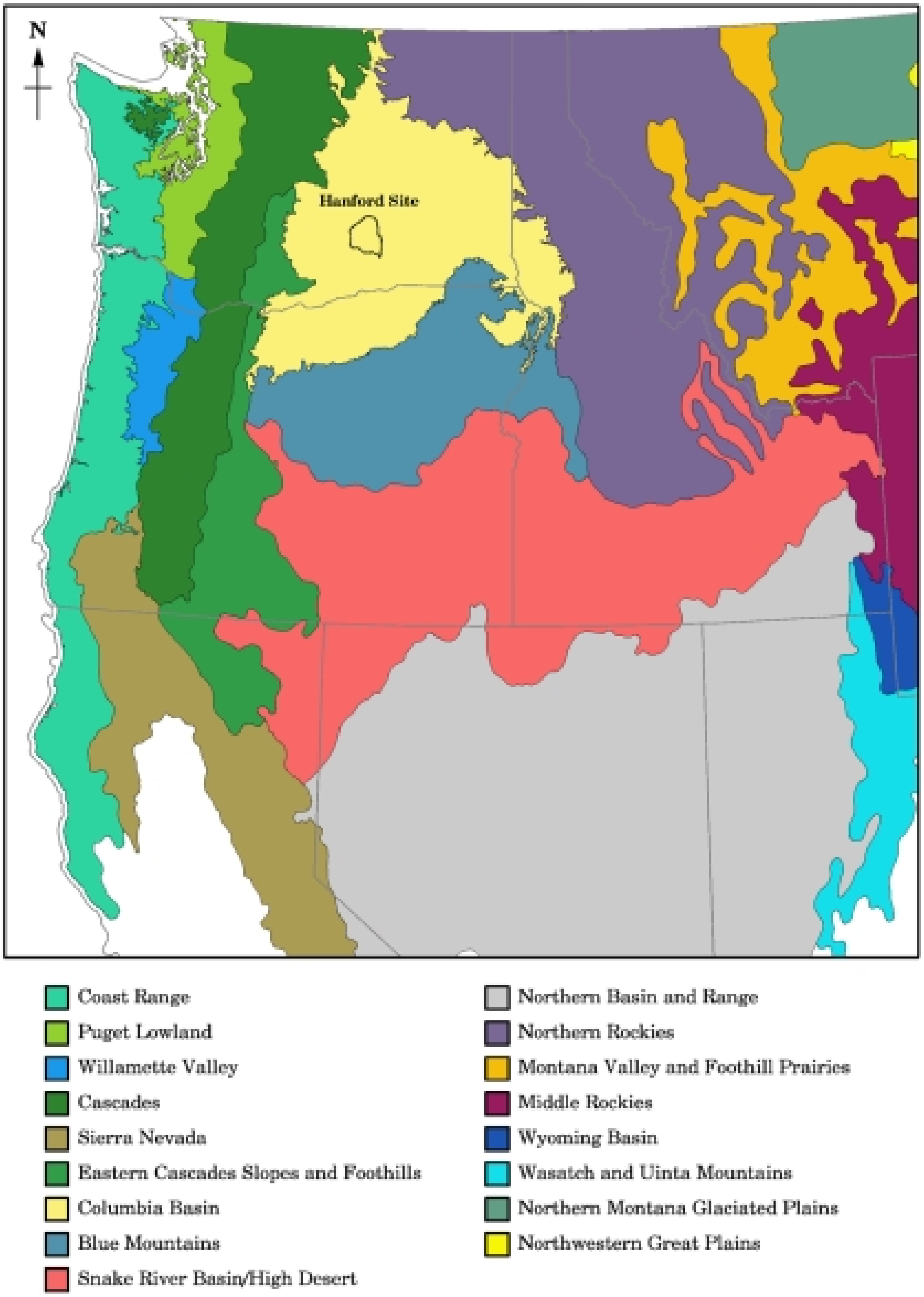
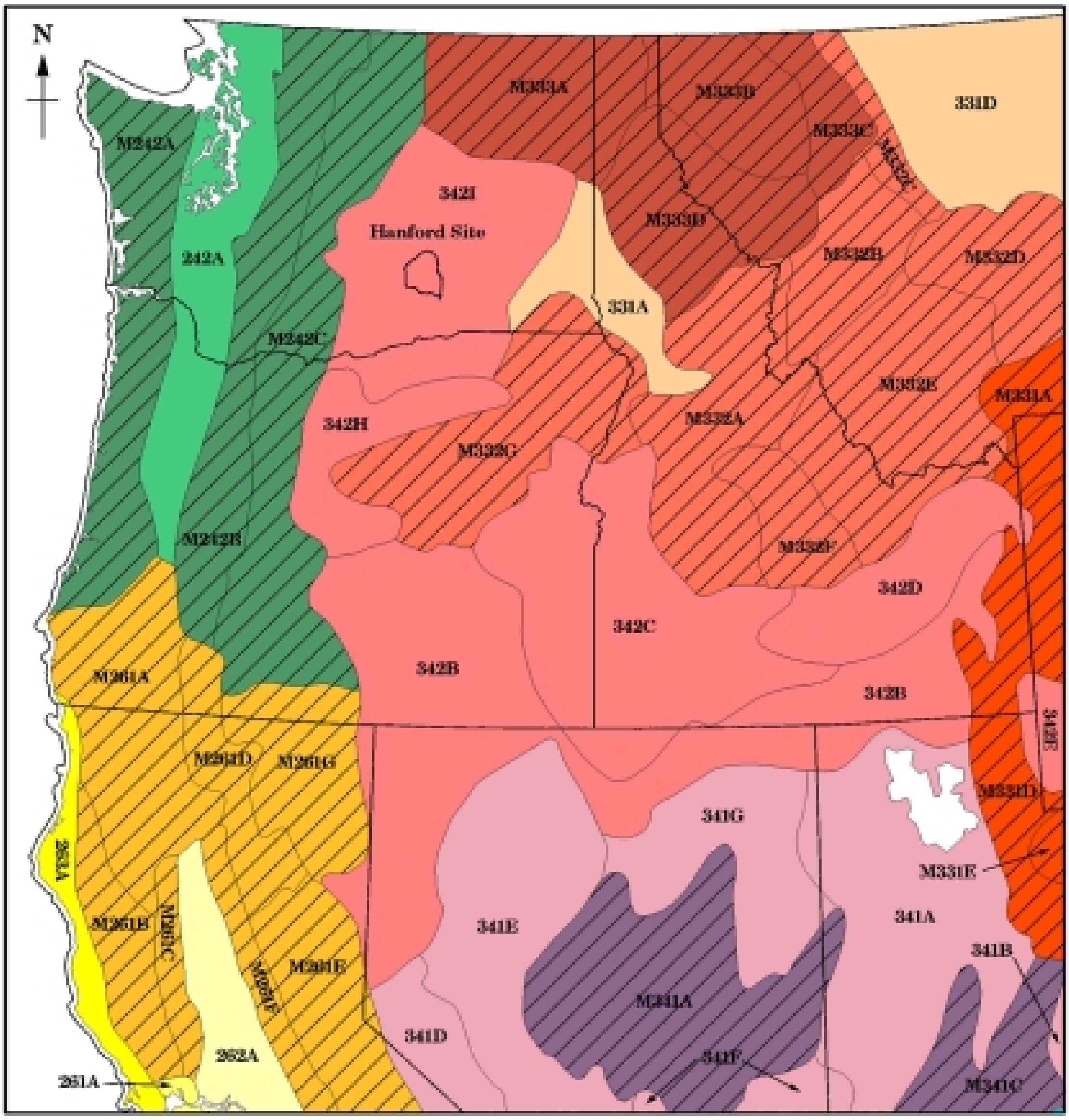


Figure C.1 Omernick's Ecoregions for the Northwest Portion of the United States (Original source: Omernick 1987. Electronic version obtained from the Interior Columbia Basin Ecosystem Management Project.)



331A Palouse Prairie Section
342B Northwestern Basin and Range Section
342C Owyhee Uplands Section
342D Snake River Basalts Section
342H High Lava Plains Section
342I Columbia Basin Section

M242C Eastern Cascades Section
M332A Idaho Batholith Section
M332G Blue Mountains Section
M333A Okanogan Highlands Section
M333D Bitterroot Mountains Section

Figure C.2 Bailey's Ecoregions for the Northwest Portion of the United States (Original source: Bailey et al. 1994. Electronic version obtained from the Interior Columbia Basin Ecosystem Management Project.)

Omernick's (1987) resulting map (Figure C.1) also used a hierarchical approach. At the broadest levels of classification, Omernick divided the United States into regions and sections (these classifications encompass areas that are not necessarily contiguous). The most detailed level, essentially equivalent to Bailey's (1976, 1980) section level and what is shown in Figure C.1, identified specific, integral geographic areas. The Hanford Site is located within Omernick's (1987) western xeric region, semi-arid section, and Columbia Basin Ecoregion. The major differences between Omernick's 1987 depiction and Bailey's 1976 map were Omernick's inclusion of Bailey's Palouse grassland province as part of the Columbia Basin Ecoregion and his limiting of the southern extent of the ecoregion to include only northcentral Oregon. Thus, in Omernick's depiction the Columbia Basin shrub-steppe was not in ecological continuity with Great Basin shrub-steppe, including the Snake River Plain. Of lesser importance, Omernick included portions of the Methow and Okanogan River drainages within the Columbia Basin Ecoregion.

C.1.3 A Modification of Earlier Efforts: Bailey and Others 1994

Subsequent to the efforts described in the preceding paragraphs, the U.S. Forest Service developed a hierarchical framework of ecological units as a means to provide a consistent framework for agency implementation of ecosystem management at different planning levels (ECOMAP 1993). Thus, for the Forest Service the primary purpose for delineating ecological units was to identify land and water areas at different levels of resolution that have similar capabilities and potentials for management (ECOMAP 1993). The different mapping units are differentiated by considering multiple factors, such as climate, physiography, geology, soils, water, and potential natural communities (animal as well as vegetation).

The resultant classification has hierarchies of scale, as well as levels within scales (ECOMAP 1993). At the ecoregion scale, the three ecological units included are adapted from Bailey (1976, 1980): domains, divisions, and provinces. At the subregion scale, two ecological units are included: sections and subsections. Two other scales complete the hierarchy: landscape scale and land unit scale. At coarse scales, abiotic factors dominate the basis of delineation; whereas, at finer scales of resolution both biotic and abiotic factors are important. The section ecological unit best approximates Omernick's (1987) ecoregion level of classification and Bailey's (1976, 1980) section level; whereas, the Hanford Site (or significant portions of it) approximates the landscape scale and project-level activities at Hanford approximate the land unit scale.

Bailey's latest revision of his ecoregion framework for the United States (Bailey 1995) retains the first three levels of the hierarchy (i.e., domain, division, and province) but, in some cases, redefines their geographic representation. At the division level, the Hanford Site is now considered to be in an area defined as temperate desert. At the province level, to the east Bailey's Great Plains-Palouse Dry Steppe Province is now restricted to extreme southeastern Washington and portions of westcentral Idaho (In Bailey's 1976 map the Palouse extended northwest to central Washington and southwest to Oregon.). The Hanford Site is located within the Intermountain Semi-Desert Province, a province that still includes the Snake River Plain area as contiguous ecologically with the Columbia Basin.

If Bailey's revision had stopped at the province level, there still would remain significant differences between Omernick (1987) and Bailey's (1995) ecoregion depictions; however, Bailey et al. (1994) further modified Bailey's 1995 map. (The discrepancy in dates is probably due to differences in publication schedules.) These authors subdivided the provinces into subregions (again referred to as sections) in accordance with the Forest Service's hierarchical framework (ECOMAP 1993). The resultant map is shown in Figure C.2. At the higher levels of the classification hierarchy, climate (domain and division) and macro-features of the vegetation (province) dominate the basis for subdivision. Because physiography exerts the major influence over ecosystem characteristics within climatic-vegetation zones, physiography is used as the basis for defining sections (Bailey et al. 1994). Of note is that now at the section level, the Hanford Site, located within the Columbia Basin Section, is identified separately from the remainder of the Great Basin.

C.1.4 Contributions of a More Regional Focus: Franklin and Dyrness 1973

A final source of information that can be useful for defining Hanford's ecological context is Franklin and Dyrness (1973). This work is a regional effort that covered ecological characteristics, principally major vegetation types, within the states of Washington and Oregon. Franklin and Dyrness attempted to outline the major phytogeographic units of the two-state region and to suggest how these units related to each other and to environmental factors. As a basis for discussion, they subdivided the region into relatively homogeneous areas (i.e., provinces) based on physiography (similar to the Bailey et al. 1994 section level designation criterion) (Figure C.3). Their Columbia Basin Province compares favorably with Omernick's (1987) Columbia Basin Ecoregion and Bailey et al.'s (1994) Columbia Basin Section.

C.1.5 A Synthesis of Available Information: Hanford's Relevant Ecological Context—The Columbia Basin Ecoregion Defined

Although the three depictions of the Columbia Basin area (i.e., Bailey et al. 1994; Franklin and Dyrness 1973; Omernick 1987; Figures C.2, C.1, and C.3, respectively) are not congruent, they overlap sufficiently to enable defining an area that provides the appropriate ecological context for Hanford's biological resources. First, it does seem necessary to define a southern ecological boundary that separates the Columbia Basin from the Great Basin, though the community dominants are often similar. Franklin and Dyrness (1973) offer several reasons to contrast the Columbia Basin steppes from the steppes of the southeastern Oregon portion of the Great Basin.[2] As compared with the Columbia Basin area:

1. Southeastern Oregon shrub-steppes average much higher in elevation.
2. Deep, loamy soils are not common in southeastern Oregon.
3. Desert or salt desert shrub communities are common enough in southeastern Oregon to show up on regional vegetation maps.
4. Western juniper (*Juniperus occidentalis*) and curl-leaf mountain mahogany (*Cercocarpus ledifolius*) occur in association with shrub-steppe in southeastern Oregon.
5. Meadow-steppes of sod-forming grasses and dicotyledonous herbs, which ring much of the Columbia Basin Province, are nearly absent in southeastern Oregon (Franklin and Dyrness 1973).

Based on a recent vegetation mapping of Oregon (O'Neil et al. 1995), the most appropriate southern boundary seems to be that of Omernick (1987). South of this boundary, western juniper becomes a community dominant (O'Neil et al. 1995). Franklin and Dyrness (1973) did not show western juniper as the dominant vegetation type until south of the Blue Mountains (High Lava Plains Province), and thus, extended the Columbia Basin Province south along the Deschutes River corridor. Omernick's boundary represents this vegetation transition better than do Bailey et al. (1994). Another reason for choosing Omernick's southern boundary is that the dominant land use within this portion of Oregon is agriculture, just as it is in the Columbia Basin portion of eastern Washington.

How to address the transition between the meadow-steppe of the Palouse and the remainder of the steppe region of eastern Washington is more problematic. Omernick (1987) did not differentiate the two and included the Bailey et al. (1994) Palouse Prairie within his Columbia Basin Ecoregion. Conversely, Bailey (1976, 1980, 1995) and Bailey et al.

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[2] The following discussion on steppe and shrub-steppe is taken from Daubenmire (1970). In contrast to a desert, steppe has moisture relations adequate to support an appreciable cover of perennial grasses on zonal soils (i.e., deep loams on gentle upland slopes), yet not enough to support arborescent vegetation (i.e., trees). Thus, Daubenmire considered eastern Washington to be better classified as steppe rather than desert. Steppe includes a physiognomic subdivision—shrub-steppe—and two ecological subdivisions: meadow-steppe and true-steppe. Shrub-steppe communities are plant communities consisting of one or more layers of perennial grass above which there rises a conspicuous but discontinuous layer of shrubs. Communities with bitterbrush (*Purshia tridentata*), big sagebrush (*Artemisia tridentata*), and perhaps threetip sagebrush (*A. tripartita*) illustrate shrub-steppe physiognomy in Washington. Meadow-steppe communities always reflect maximal water supplies for steppe vegetation as compared with true-steppe in which conditions are drier. Although not a physiognomic classification, meadow-steppe has a substantial measure of physiognomic homogeneity (i.e., a very dense plant cover with a rich component of broad-leaved forbs). Thus, meadow-steppe can be distinguished from true-steppe communities in which the grass cover is sparser, more narrow-leaved, and accompanied by few broad-leaved forbs.

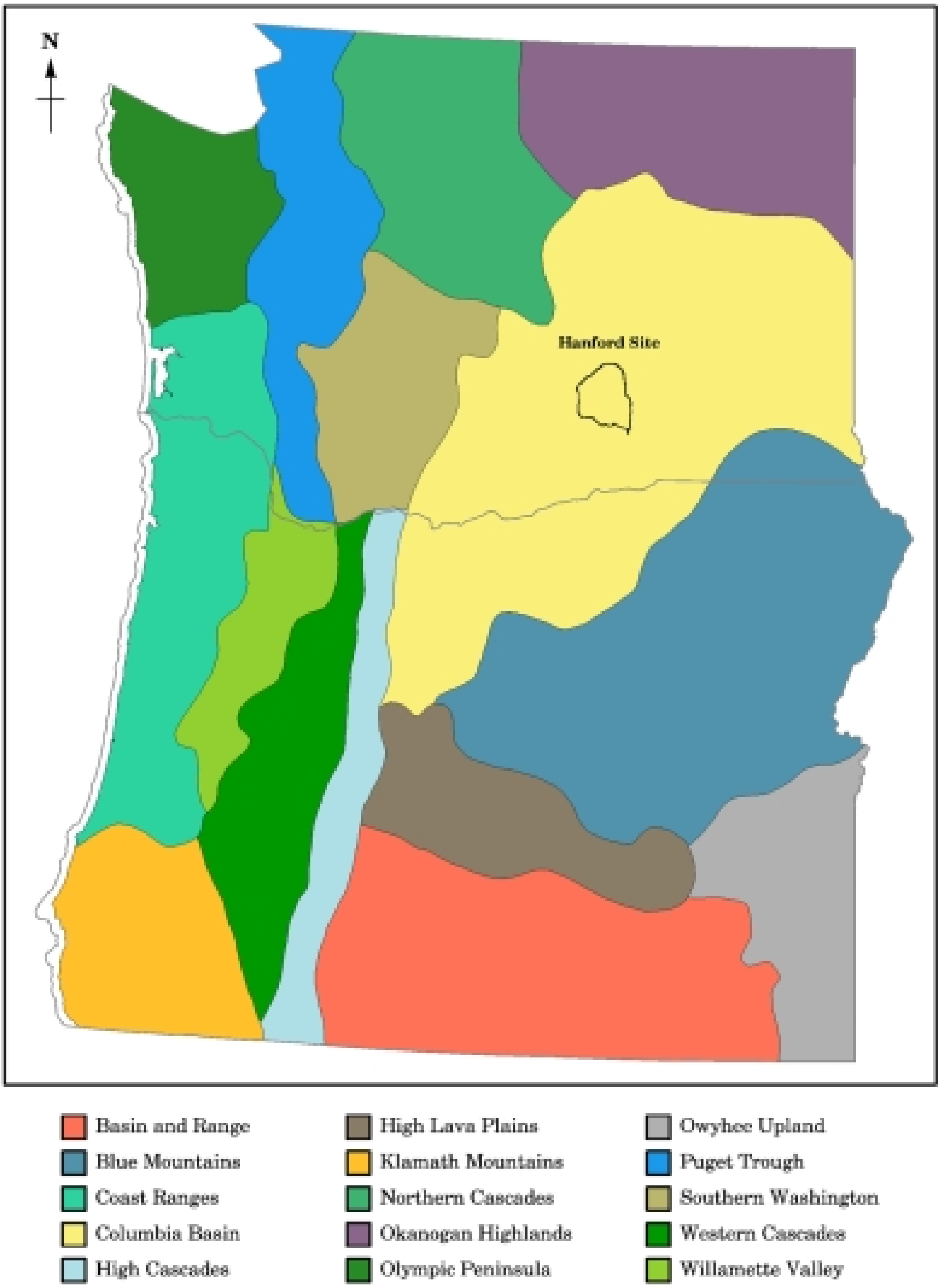

Figure C.3 Physiographic Provinces of Oregon and Washington (Original source: Franklin and Dyrness 1973. Electronic version obtained from the Interior Columbia Basin Ecosystem Management Project.)

(1994) separated the meadow-steppe of the Palouse Prairie of eastern Washington and westcentral Idaho from the drier, sagebrush-dominated areas to the west at as high a level of classification as the division.[3] Recent vegetation mapping of the state of Washington indicates, however, that similar to Franklin and Dyrness (1973) suggested, meadow-steppe rims the Columbia Basin and is not just restricted to the Palouse.[4] Additionally, there is no major physiographic break between the Palouse and the steppe regions to the west (Franklin and Dyrness 1973; Omernick 1987).

Currently, the Palouse Prairie is only a remnant ecosystem. Since European settlement, it has experienced greater than a 98% decline (Noss et al. 1995). The only remaining connection of steppe areas between Washington and Idaho is along the Snake River drainage. For all practical purposes, there remains little ecological connection between Washington and Idaho steppe areas (and through Idaho, extreme northeastern Oregon). Thus, based on the preceding discussion, the choice of an ecological boundary for the eastern portion of the Columbia Basin is somewhat arbitrary.

Bailey et al.'s (1994) suggested boundary does not accurately depict the ecological transition in steppe vegetation zones. Instead, Daubenmire's (1970) vegetation zone map for eastern Washington will be used to set the eastern boundary (Figure C.4). The Idaho fescue/snowberry (*Festuca idahoensis*/*Symphoricarpos albus*) and Idaho fescue/rose (*Festuca idahoensis*/*Rosa nutkana*) vegetation zones are considered here to be ecologically distinct from the remainder of the Columbia Basin steppe vegetation zones. The remaining meadow-steppe communities of eastern Washington—those that contain threetip sagebrush or bluebunch wheatgrass as ecological dominants—are conspicuous components of the remainder of the steppe region of Washington. Thus, these vegetation zones are considered here to be ecologically allied with the big sagebrush-dominated vegetation zones. Also, unlike the other zonal steppe communities, the fescue-dominated vegetation zones are not subject to invasion by cheatgrass (*Bromus tectorum*) when they are grazed excessively or when they are abandoned after cultivation (Daubenmire 1970). It follows that the eastern boundary will be delineated by what was the historic edge of the *festuca*-dominated vegetation zones. The Snake River corridor up to the Idaho border, as it includes bluebunch wheatgrass as a dominant, also is considered here to be ecologically connected to the drier portions of the Washington steppe.

The final major difference between the different depictions of the Columbia Basin area concerns the northern boundary. Both Bailey et al. (1994) and Franklin and Dyrness (1973) make the Columbia River the northern boundary. Conversely, Omernick (1987) includes both the Methow and Okanogan River corridors. The Okanogan River corridor, especially, provides a connection with steppe areas of southern British Columbia. This is not well represented by either the Bailey et al. (1994) or Franklin and Dyrness (1973) portrayals.

In summary, the Omernick (1987) ecoregion map, with the exception of the eastern boundary, provides the best ecological context for the Columbia Basin area at a scale appropriate for management decisions. As described above, Daubenmire's (1970) vegetation zone map is used to establish the eastern boundary. Thus, with the one modification, the regional ecological context for Hanford Site will reflect the Omernick (1987) boundaries and will be referred to, henceforth, as the Columbia Basin Ecoregion. Figure C.5 shows an outline of this area and its relationship to the Hanford Site.

C.2 Columbia Basin Ecoregion

The Columbia Basin Ecoregion occupies an extensive area south of the Columbia River between the Cascade Range and Blue Mountains in Oregon and roughly two-thirds of the area east of the Cascades in Washington State (Figure C.5). Although the

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[3] Bailey et al. (1994) do not show northeastern Oregon as containing characteristic Palouse (i.e., meadow-steppe) vegetation (Figure C.2). In contrast, Omernick (1987) includes this area (Figure C.1).

[4] Washington State GAP Analysis, Land Cover Map, Version 4. 1996. Prepared by the Washington Cooperative Fish and Wildlife Research Unit at the University of Washington. Although these marginal areas of the Basin can be classified as meadow-steppe because of moisture regimes, to the north and west they also represent shrub-steppe because they include threetip sagebrush (*Artemisia tripartita*) as a dominant (Daubenmire 1970). This overlap in steppe characteristics makes it difficult to draw distinctions between the Palouse Prairie (meadow-steppe) and the remainder of the steppe regions of Oregon and Washington.

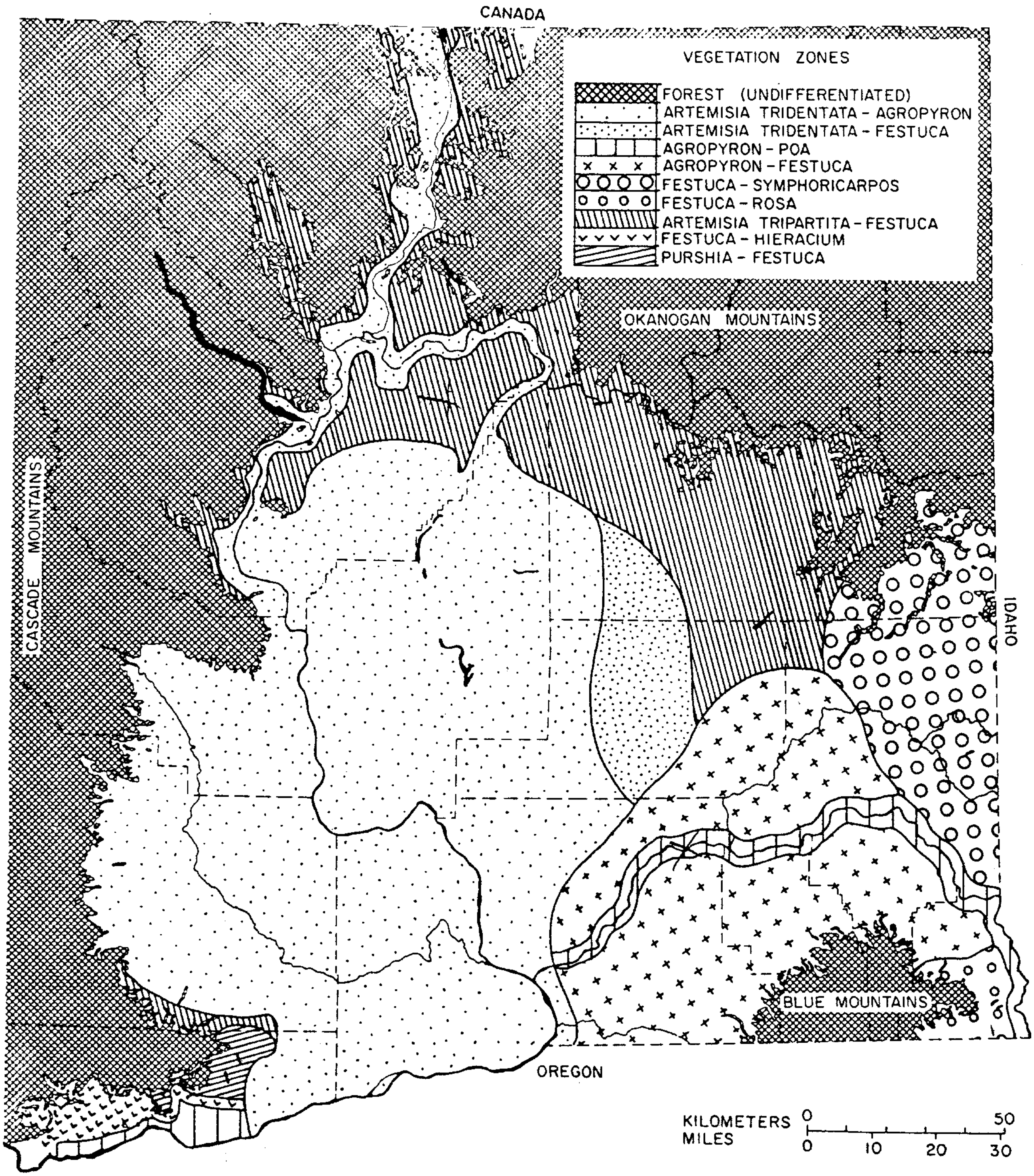

Figure C.4 Vegetation Zones of the Steppe Region of Eastern Washington (Source: Daubenmire 1970)

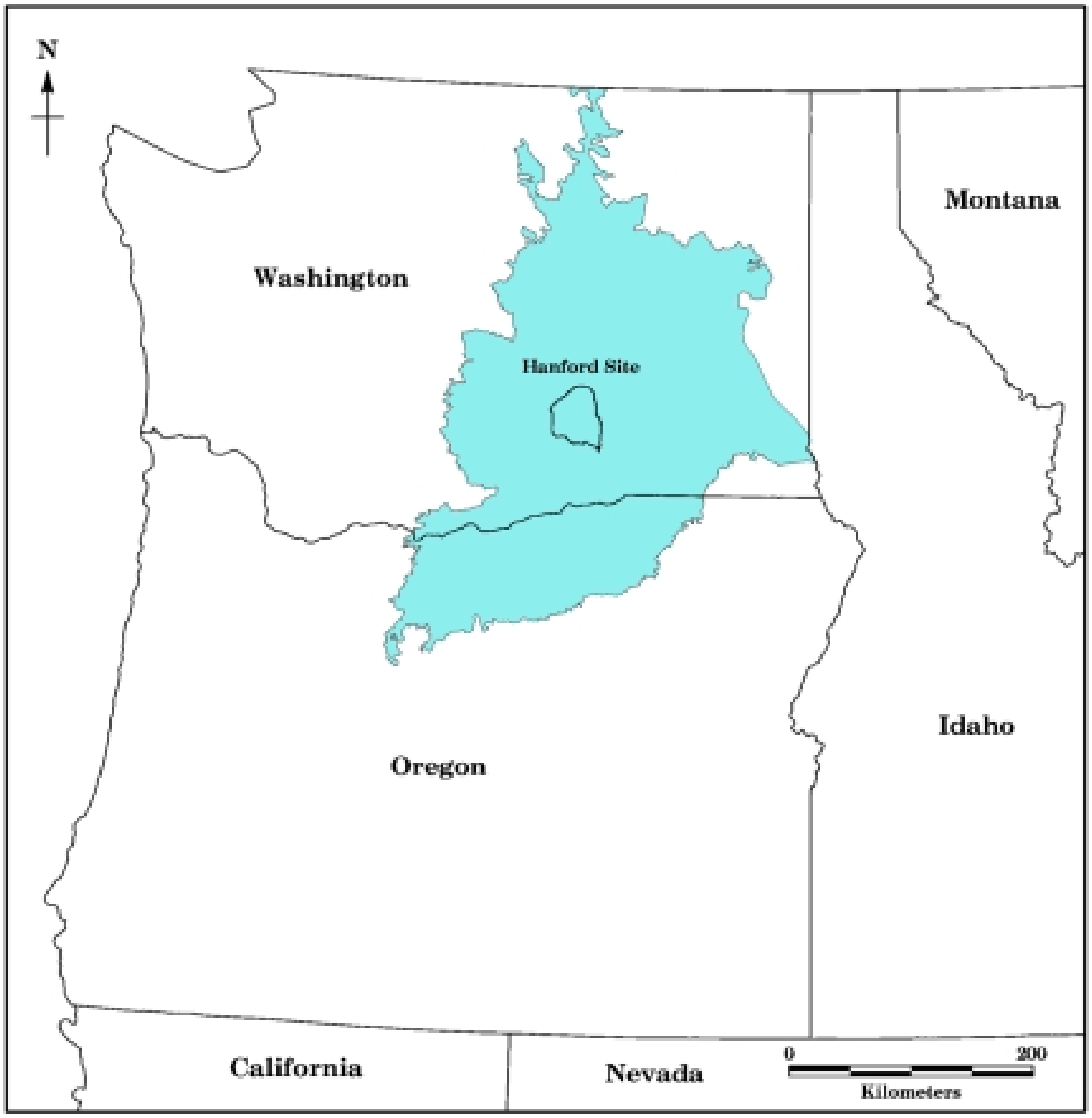

Figure C.5 Hanford's Ecological Context—The Columbia Basin Ecoregion precise boundaries offered by Franklin and Dyrness (1973) are not used to define the Columbia Basin Ecoregion, these authors still provide the best reference for general information about the topography, geology, climate, and soils for the area. These characteristics are described in Section C.2.1 using Franklin and Dyrness (1973) as the source of information, unless otherwise indicated. This section also includes a description of the Columbia River watershed. Vegetation characteristic of the ecoregion is described in Section C.2.2 and characteristic fauna is covered in Section C.2.3. Section C.2.2 also includes a comparative analysis of historic and current ecoregion vegetation.

C.2.1 Abiotic Characteristics

Topography—Topography within the Columbia Basin Ecoregion varies from gently undulating to moderately hilly land. Steep slopes are limited and are largely restricted to isolated basaltic buttes or canyons, such as those cut by major rivers. Over most of the area, elevations range from 300 to 600 m (about 1000 to 2000 ft) above sea level, though adjacent to the Columbia River they are less than 150 meters (about 500 ft).

Geology—The important geologic event in the Columbia Basin Ecoregion began during the Miocene epoch with the vast outpouring of lavas that constitute the Columbia River Basalt formation. This enormous basalt layer underlies virtually the entire ecoregion. The Columbia River Basalt formation ranges in total thickness from 600 to over 1500 m (about 2000 to 5000 ft) and is made up of numerous individual flows about 8 to 30 m (about 25 to 100 ft) thick. Within the past 15,000 years glacial action also has shaped the ecoregion by creating the Methow and Okanogan valleys. Flooding from Lake Missoula scoured lava beds creating the Channeled Scablands over 12,000 years ago. This flooding also created islands of deep soil as the water receded, the location of much of today's agriculture in the region (Bretz 1959).

Climate—Climatically, the Columbia Basin Ecoregion can be typified as arid to semi-arid with low precipitation, warm-to-hot dry summers, and relatively cold winters. Some marine influences are present; however, continental-type climatic conditions prevail. Precipitation is heaviest along the margins of the ecoregion [40 to 60 cm annually (about 16 to 24 in./yr)] and gradually decreases toward the central portion [10 to 23 cm annually (about 4 to 9 in./yr)].

Soils—A wide variety of soils occurs in the Columbia Basin Ecoregion. Most of the broad soil differences correlate with annual precipitation. Table C.1 depicts a zonal sequence of four soil regions that correspond to a gradient from the hottest, driest sites in the central portion of the ecoregion to the coolest, wettest sites along the periphery of the ecoregion. The regions form a roughly concentric circular pattern. Only the dominant soil group within a region is described.

In general, these great soil groups range from relatively poorly developed soils with lightly colored, thin A (surface) horizons and low organic matter, in which calcium carbonate accumulations are high in the profile (Camborthids), to well developed soils with thick, very dark-brown to black A horizons and high organic matter, in which calcium accumulations may be deep in the profile or absent (Argixerolls).

Columbia River Watershed—The Columbia River originates in the mountains of eastern British Columbia, Canada, and drains a total area of approximately 668,000 km^2 (258,000 mi^2) (van der Leen et al. 1990). The Hanford Site is located within the Pasco Basin portion of the Columbia River's watershed. The Columbia River enters the Pasco Basin at Sentinel Gap in the Saddle Mountains and leaves via the Wallula Gap upstream of McNary Dam. There are no perennial streams that feed the Columbia River and originate within the Pasco Basin. The Yakima, Snake, and Walla Walla rivers join the Columbia River downstream of the Hanford Site. Beginning with Bonneville Dam in 1938 and ending with John Day Dam in 1967, 11 hydroelectric dams have been constructed on the Columbia River within the United States. Operation of these dams has affected seasonal and daily flow regimes and eliminated most of the lotic habitat formerly present within the Columbia River system.

C.2.2 Vegetation

General Description—Information on vegetation characteristic of the Columbia Basin Ecoregion is taken from Daubenmire (1970) and Franklin and Dyrness (1973). In general, no single sequence of zonal belts of vegetation applies throughout the Columbia Basin Ecoregion. The following seven

Table C.1 Soil Regions of the Columbia Basin Ecoregion

Order	Suborder	Great Soil Group	Characteristics	Remarks
			Hot, dry	
Aridisol	Orthid	Camborthids (Region 1)	Pedogenic horizons low in organic matter; surface horizons are thin; no large accumulations of calcium carbonate or gypsum, though when a carbonate-enriched horizon occurs it may be cemented; no horizon of significant clay accumulation, though clay content may be higher in subsurface horizons.	Soils never moist for as long as three months; arid climate; used mostly for range and some irrigated crops.
Mollisol	Xeroll	Haploxerolls (Region 2)[a]	Soils derived from loess; poorly developed; moderately thick, dark grayish-brown, loam-textured surface horizons containing low amounts of organic matter; subsurface horizons high in bases but lacking large accumulations of clay, calcium carbonate, or gypsum.	Formed in climates with rainy winters and dry summers; semiarid climate; used for wheat, range, and irrigated crops.
Mollisol	Xeroll	Haploxerolls (Region 3)	Soils derived from loess but with less sandier windblown materials than region 2; moderately thick, brown silt loam surface horizons containing moderate amounts of organic matter over a light-brown silt loam horizons; zone of calcium carbonate accumulation commonly present.	Formed in climates with rainy winters and dry summers; semiarid climate; used for wheat, range, and irrigated crops.
Mollisol	Xeroll	Argixerolls (Region 4)	Soils with nearly black, friable (i.e., silt loam texture), organic-rich surface horizons high in bases; subsurface horizon of clay accumulation that is relatively thin or brownish.	Absent in the western part of the basin; formed in climates with rainy winters and dry summers; subhumid climate; used for wheat, range, and irrigated crops.
			Wet	
[a]Lithosols (i.e.,well drained, shallow, generally stony soils over bedrockÑazonal soil) also are common in Region 2 because it encompasses a large portion of the Channeled Scablands.				

zonal plant associations, which can occur as climatic climaxes, occur in the Columbia Basin Ecoregion within Washington (Figure C.4):[5]

1. Big sagebrush/bluebunch wheatgrass
2. Big sagebrush/Idaho fescue
3. Bluebunch wheatgrass-Sandberg's bluegrass [*Poa sandbergii* (=*P. secunda*)]
4. Bluebunch wheatgrass-Idaho fescue
5. Threetip sagebrush/Idaho fescue
6. Idaho fescue/tongue hawkweed (*Hieracium cynoglossoides*)
7. Bitterbrush/Idaho fescue.

These seven associations have differentiated in response to differences in temperature and total and seasonal distribution of precipitation in the ecoregion. The last three associations are found on the periphery of the ecoregion near its contact with

[5] Daubenmire (1970) recognizes two additional zonal plant associations as occurring in the steppes of eastern Washington: Idaho fescue/snowberry and Idaho fescue/rose. As discussed previously, these zones are considered outside the Columbia Basin Ecoregion.

forest vegetation. These tend to be lush, meadow-like communities with conspicuous amounts of large perennial grasses and broad-leaved forbs. The other four zonal associations lie in the more arid interior of the ecoregion where vegetation is more sparse and forbs are less conspicuous.

The driest and largest of these four zones [approximately 3.3 million ha (8.2 million acres)] has as a climatic climax the big sagebrush/bluebunch wheatgrass association. This association occupies the center of the Columbia Basin Ecoregion, extends west to the Cascade Mountains, north into the Okanogan Valley, south into portions of northcentral Oregon, and also encompasses all of the Hanford Site (Figure C.4 illustrates the Washington portion of this zone). In general, the big sagebrush/bluebunch wheatgrass association is characterized by four canopy layers that include an overstory layer composed mostly of big sagebrush, a tall understory layer of bluebunch wheatgrass, a short understory layer dominated by Sandberg's bluegrass, and a cryptogam layer of crustose lichens and acrocarpous mosses. Other shrub dominants include gray rabbitbrush (*Chrysothamnus nauseosus*), green rabbitbrush (*C. viscidiflorus*), bitterbrush, spiny hopsage (*Grayia spinosa*), threetip sagebrush, and horsebrush (*Tetradymia canescens*). Additional locally abundant bunchgrasses include needle-and-thread grass (*Stipa comata*), Indian ricegrass (*Oryzopsis hymenoides*), Cusick's bluegrass (*Poa cusickii*), and Idaho fescue.

The other three zonal associations: big sagebrush/Idaho fescue, bluebunch wheatgrass/Sandberg's bluegrass, and bluebunch wheatgrass/Idaho fescue, can occur as topographic climaxes on moister sites within the big sagebrush/bluebunch wheatgrass association. Conversely, the big sagebrush/bluebunch wheatgrass association may occur as a topographic climax on drier sites within these three adjacent zones.

Certain edaphic (soil-related) and zootic (animal-related) plant associations are of ecological importance within the ecoregion. On deep soils dominated by gravel, sand, or strongly weathered volcanic ash, needle-and-thread grass replaces bluebunch wheatgrass as the dominant grass in several associations. This shift seems to be related to needle-and-thread grass's ability to tolerate lower fertility soils than bluebunch wheatgrass. The dominant shrub in these associations can be either big or threetip sagebrush, or bitterbrush. On stony soils or extremely shallow soils over bedrock (lithosols), various species of buckwheat (*Eriogonum*) and/or stiff sage (*Artemisia rigida*) dominate the shrub layer, and Sandberg's bluegrass dominates the understory.

Within the hottest, driest, and elevationally lowest part of the ecoregion (e.g., the Hanford Site) is a series of three associations found on reasonably deep, loamy soils that are drier than those found on associated zonal associations. These are the big sagebrush/Sandberg's bluegrass, spiny hopsage/Sandberg's bluegrass, and winterfat [*Ceratoides* (=*Eurotia*) *lanata*]/Sandberg's bluegrass associations. Each of these associations is characterized by the lack of large perennial grasses and low overall plant species diversity. At one time, the big sagebrush/Sandberg's bluegrass plant association was thought to have been derived from the effects of livestock overgrazing within big sagebrush/bluebunch wheatgrass communities. Daubenmire (1970), however, provides persuasive evidence that this community exists as a natural community. Big sagebrush has a higher density (average cover, 24%; range, 8–35%) in this association than in any other type of undisturbed vegetation in the Columbia Basin Ecoregion.

Cheatgrass, introduced to Washington about 1890, is the most important invading species in the drier areas of the Columbia Basin Ecoregion following overgrazing or cultivation. On abandoned fields, a brief 1-2 year stage of dominance by the non-native annuals Russian thistle (*Salsoa kali*) and tumble mustard (*Sisymbrium altissimum*) is followed by cheatgrass dominance. Once established, there is no strong evidence that cheatgrass ever relinquishes an area to native grasses and forbs. Partial invasion by gray rabbitbrush into a mostly pure cheatgrass stand may occur as a result of grazing and represents another stage of degradation of the community.

Communities dominated by cheatgrass are a permanent and widespread feature of the Columbia Basin landscape. Wherever a major shrub dominant is removed by cultivation, fire, or gazing, a shrub-cheatgrass community may result. Indeed, the high flammability of cheatgrass increases the likelihood of fire in cheatgrass-dominated communities and replacement by cheatgrass in adjacent burned communities. Although a non-native species, in small quantities cheatgrass also must be considered an element of most climax steppe communities even on undisturbed sites (see also Brandt and Rickard 1994).

Response of Steppe Vegetation to Grazing—The Columbia Basin Ecoregion's shrub-steppe and meadow-steppe communities developed over the past several thousand years without the influence of large herds of ungulates (Daubenmire 1970; Mack and Thompson 1982). Before European settlement, grazing was limited to small numbers of deer, wapiti (elk), and antelope; buffalo were never a factor in grazing. Cattle and sheep were introduced in the Columbia Basin in 1834 (Daubenmire 1970) and about 1860, respectively, with peak numbers occurring from 1860–1900. Their introduction drastically altered much of the native shrub-steppe vegetation. The ecoregion's range was likely in its poorest condition around 1900 and has improved since (Daubenmire 1970; Franklin and Dyrness 1973) by a reduction in livestock grazing pressure. The native bunchgrass understory of shrub-steppe is easily damaged by heavy grazing and often is unable to recover; such conditions accelerate the invasion of non-native Eurasian annual plant species, such as cheatgrass and tumble mustard. Livestock trampling, which frequently occurs near water, and plowing, or any other severe mechanical disturbance of the soil, tends to eradicate native vegetation, opening the soil to invasion by these non-native annuals.

Response of Steppe Vegetation to Fire—Wildfire has played a relatively minor role in the ecology of the Columbia Basin Ecoregion. Wildfires are naturally recurring historic components of steppe plant communities. Natural wildfires are typically initiated by lightning and occur primarily during the summer months when most plants are mature and dried from summer drought (Uresk et al. 1980). Most shrub species (e.g., big sagebrush, bitterbrush, and spiny hopsage) are easily killed by burning. Shrubs may recolonize fire-scarred areas in the following ways: (1) by resprouting following burning [illustrated by greasewood (*Sarcobatus vermiculatus*) and threetip sagebrush], (2) from buried seed, and (3) by seed dispersal from unburned shrubs.

The understory comprises primarily grasses and forbs, is generally resistant to fire damage, and resumes vegetative growth during the following growing season (Uresk et al. 1980). In general, the dominant understory species on a site before burning, whether native or non-native, dominate the site following a fire; however, if the site is occupied by a native understory that is both burned and grazed, it may be colonized by non-native species, such as cheatgrass, tumble mustard, and Russian thistle, after a fire. Figure C.6 shows the major pathways of succession in sagebrush-steppe plant communities that may experience fire and grazing in the presence of non-native species. The successional model applies to sagebrush-steppe communities both within and outside of the Columbia Basin Ecoregion (West 1983a, b).

Comparison of Historic and Current Ecoregion Vegetation—The preceding sections provided both a description of the native and non-native vegetation that characterizes the Columbia Basin Ecoregion and an overview of some of the natural and human-related processes that affect the vegetation. This section provides a coarse-scale analysis of changes in the vegetation patterns that have occurred within the ecoregion since European settlement. Such an analysis is useful for two reasons it: (1) provides an indication of how ecological conditions have changed in the ecoregion, and (2) enables resource managers and land administrators to better plan resource conservation strategies for the future.

The data used to depict historic and current Columbia Basin Ecoregion vegetation were obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP)[6]. The ICBEMP has collected and developed large amounts of spatial data that cover a large portion of the Columbia Basin watershed east of the crest of the Cascade Mountains. Depicted and analyzed here are only those data that fall within the boundaries of the Columbia Basin Ecoregion. Two ICBEMP data sets are used here: "Historical Potential Vegetation Types" (September 8, 1995) and "Current Vegetation Cover Types" (as of April 14, 1995). Both ICBEMP data sets rely on successional models as an aid to their classification of vegetation in specific areas. The scale of resolution (i.e., pixel size) is 1 km^2 for both data sets.

The historic potential vegetation type classes are composed of broad groups of plant associations and habitat types that regional ecologists judged to

[6] The ICBEMP is a joint venture of the U.S. Forest Service and Bureau of Land Management. Together they are attempting to develop, through an open public process, a new management strategy for public land administered by the two agencies in eastern Oregon and Washington, Idaho, western Wyoming, and portions of northern Utah and northern Nevada.

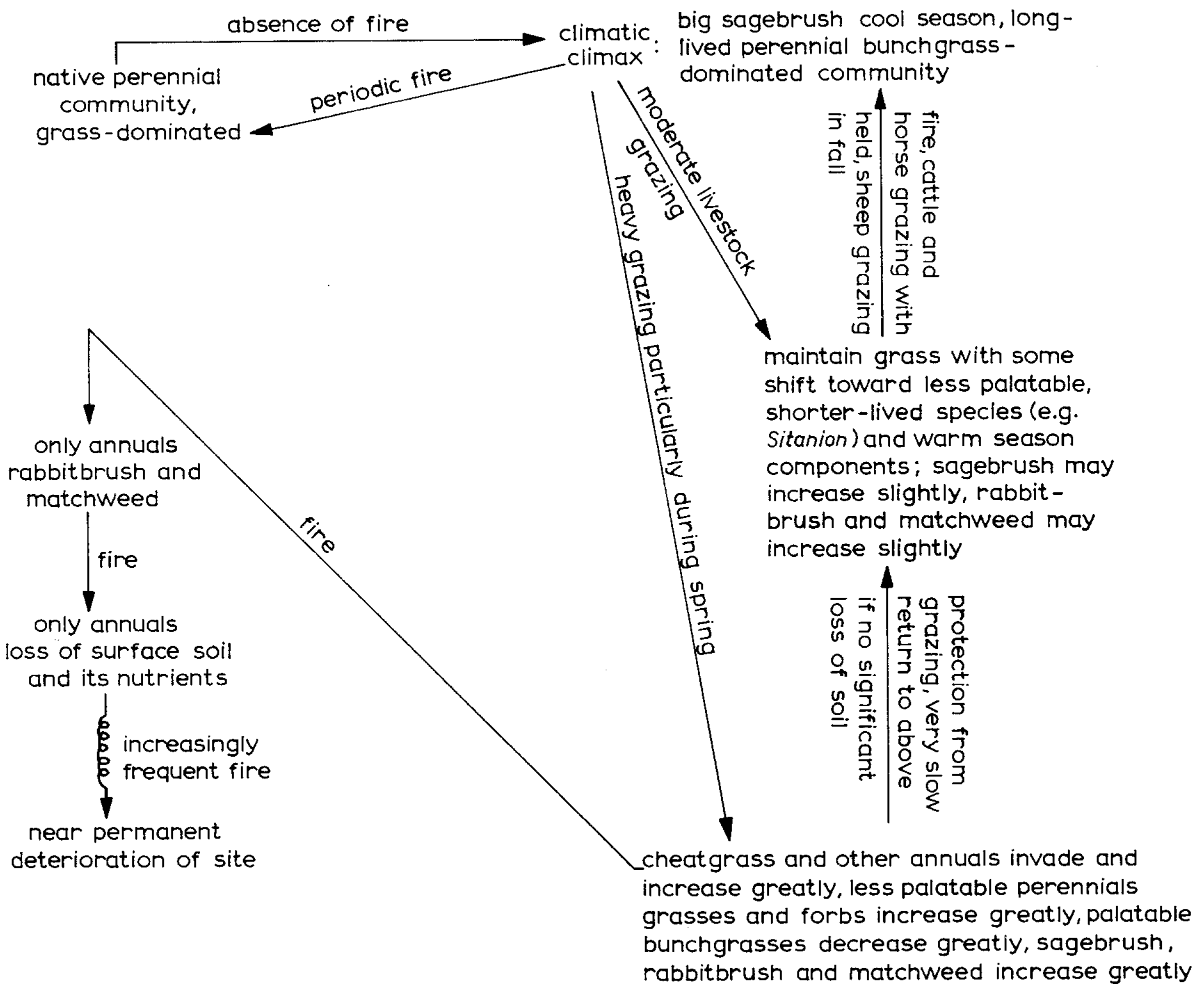

Figure C.6 Major Pathways of Succession in Sagebrush-Steppe Plant Communities (Source: West 1983a. Matchweed: *Xanthocephalum* spp.)

be present at a coarse scale of vegetation mapping. The mapped potential vegetation types were derived from overlaying current and earlier existing cover type base maps and a map depicting regional biophysical settings. Inconsistencies were corrected and the resultant map reclassified to match the successional models.

The current cover type classes are a classification of existing vegetation by broad vegetative communities that regional ecologists judged to be present at a coarse scale of vegetation mapping. For the Columbia Basin Ecoregion area the cover type classes were selected in accordance with Shiflet (1994); however, additional cover types were created for unique types. The mapped cover types were derived in a manner similar to the historic potential vegetation type map through the use of cover type base maps, a biophysical settings map, and the successional models. The current cover type base map is taken from the conterminous U.S. Land Cover Characteristics (LCC) map developed in 1991 by the Engineering and Remote Sensing Data Center of the U.S. Geological Survey.

Although the LCC map is itself a continuous layer of spatial information data for the entire United States, it is based on several remotely sensed image scenes. The data were obtained near the end of 1990 from the Advanced High Resolution Radiometer (AVHRR) sensor on the National Oceanographic and Atmospheric Administration's TIROS series satellites. The spectral data obtained were classified into 159 land-cover classes (without ground-truthing) that the ICBEMP's assembled regional ecologists merged or split to arrive at the cover type classes used in the current vegetation cover type map. A general overview of some remote sensing image sources and their characteristics is provided in the box below.

Not all the cover classes used for the ICBEMP historic potential vegetation type and current vegetation cover type data sets occur within the Columbia Basin Ecoregion. Moreover, a generalized cover class, such as *Agropyron* steppe, can be reclassified as bluebunch wheatgrass steppe to reflect that this is the only wheatgrass species that will occur as a dominant within the Columbia Basin Ecoregion. Thus, to make the cover class classifications more useful at the ecoregion level, the original ICBEMP cover classes were reclassified (Table C.2). An added advantage to reclassification was that it enables, at least, a coarse comparison between the historic and current vegetation data sets (i.e., ICBEMP did not use consistent cover class delineations for their two data sets).

Figures C.7 and C.8 provide depictions of the historic and current distribution and extent of land cover classes within the Columbia Basin Ecoregion, respectively. Table C.3 provides data on absolute area covered and percentage area covered within the ecoregion for each cover class. The Hanford Site data will be discussed in Section C.4.2.

To keep the relevance of the data presented in Figures C.7 and C.8 and Table C.3 in the proper perspective, several considerations bear mentioning before proceeding with further discussion of the data. These are:

- The historic vegetation data are based on potential vegetation (i.e., that vegetation predicted to be present at the end of plant succession in the absence of human-induced change). The current vegetation data are based on what actually is present, not what potentially could be present were the effects of humans to be removed. The generalized reclassification scheme used here (Table C.2) should accommodate these differences. With respect to steppe vegetation, especially, there are only a few regionally dominant shrubs and bunchgrasses that could occur within the ecoregion. Moreover, at the scale of resolution used for mapping, it seems unlikely that the current vegetation mapping of steppe vegetation could reflect early successional stages.
- Because of the scale of resolution and the use of generalized cover classes, analysis should be attempted at only large regional scales. At the level of the Columbia Basin Ecoregion, this

Remote Sensing Image Sources

Remote sensing technologies provide images of land surfaces and existing vegetation cover that enable researchers to map land cover classes over large areas. Although several sources of remote sensing images exist, the two sources commonly used to classify vegetation are the Advanced Very High Resolution Radiometer (AVHRR) and the Landsat Thematic Mapper (TM). These two sources, which are described below, are used because they collect spectral data sensitive to vegetative properties such as chlorophyll or moisture content. To map vegetation using spectral data from remote sensing images, the spectral data must first be classified. In a supervised classification (i.e., in which previous knowledge of vegetation classes at known locations is used to calibrate the data), the spectral signature of areas of known vegetative classes are used to define the decision space for those classes. After each class has been defined, a computer program is used to classify all the remaining areas in a scene.

AVHRR. This multispectral scanner travels aboard polar orbiting satellites that are in sunsynchronous orbits. The satellites circle the earth 14 times daily and acquire complete coverage of the globe every 24 hours. Images are acquired in a swath of 2700 km with a ground resolution of approximately 1 km^2. There are 5 spectral bands with the following band widths: 1: 0.55-0.68 µm (red); 2: 0.73-1.10 (reflected IR); 3: 3.55-3.93 (thermal IR); 4: 10.50-11.50 (thermal IR); and 5: 11.50-12.50 (thermal IR).

TM. A Thematic Mapper imaging platform is carried aboard the Landsat satellites and is usually referred to as Landsat TM. Complete earth coverage requires 16 days. Coverage is 185 km in east-west direction and ground resolution is 30 m^2 (approx.). There are 7 TM bands with band widths of: 1: 0.45-0.52 µm (blue-green); 2: 0.52-0.60 (green); 3: 0.63-0.69 (red); 4: 0.76-0.90 (reflected IR); 5: 1.55-1.75 (reflected IR); 6: 10.40-12.50 (thermal IR); 7: 2.08-2.35 (reflected IR).

Table C.2 Comparison of Land Cover Classes Used for the Columbia Basin Ecoregion Maps Versus the Original Classifications Used by the Interior Columbia Basin Ecosystem Management Project

BRMaP Historic	ICBEMP Historic	BRMaP Current	ICBEMP Current
Bluebunch wheatgrass steppe	Agropyron steppe	Bluebunch wheatgrass steppe	Agropyron bunchgrass
Idaho fescue steppe	Fescue grassland	Idaho fescue steppe	Fescue bunchgrass
Bitterbrush steppe	Antelope bitterbrush	Bitterbrush steppe	Antelope bitterbrush/ bluebunch wheatgrass
Big sagebrush steppe	Big sage steppe Big sage - warm Big sage - cool Low sage - mesic Mountain big sage - mesic - East Mountain big sage - mesic - East with conifer Mountain big sage - mesic - West	Big sagebrush steppe	Big sagebrush Mountain big sagebrush
Juniper/sagebrush	Mountain big sage - mesic - West with juniper	Juniper/sagebrush	Juniper/sagebrush
Threetip sagebrush	Threetip sage		
Black greasewood	Saltbrush riparian[a]		
Conifers/Idaho fescue	Fescue grassland with conifer		
Ponderosa pine	Interior Ponderosa pine	Ponderosa pine	Interior Ponderosa pine
Water	Water	Water	Water
		Urban	Urban
		Crop/hay/pasture	Crop/hay/pasture
Other	All other clover classes that occur in low amounts in the Columbia Basin Ecoregion.	Other[b]	All other clover classes that occur in low amounts in the Columbia Basin Ecoregion (i.e., less than 1.5% by area and not occurring within Hanford's geographic location).

[a]Includes black greasewood/ryegrass and black greasewood/saltgrass.
[b]The ICBEMP data showed low sage (*Artemisia arbuscula*) as occurring on Hanford in the general area occupied by 200 East and 200 West Areas. Because low sage does not occur on Hanford, these areas were reclassified as other.

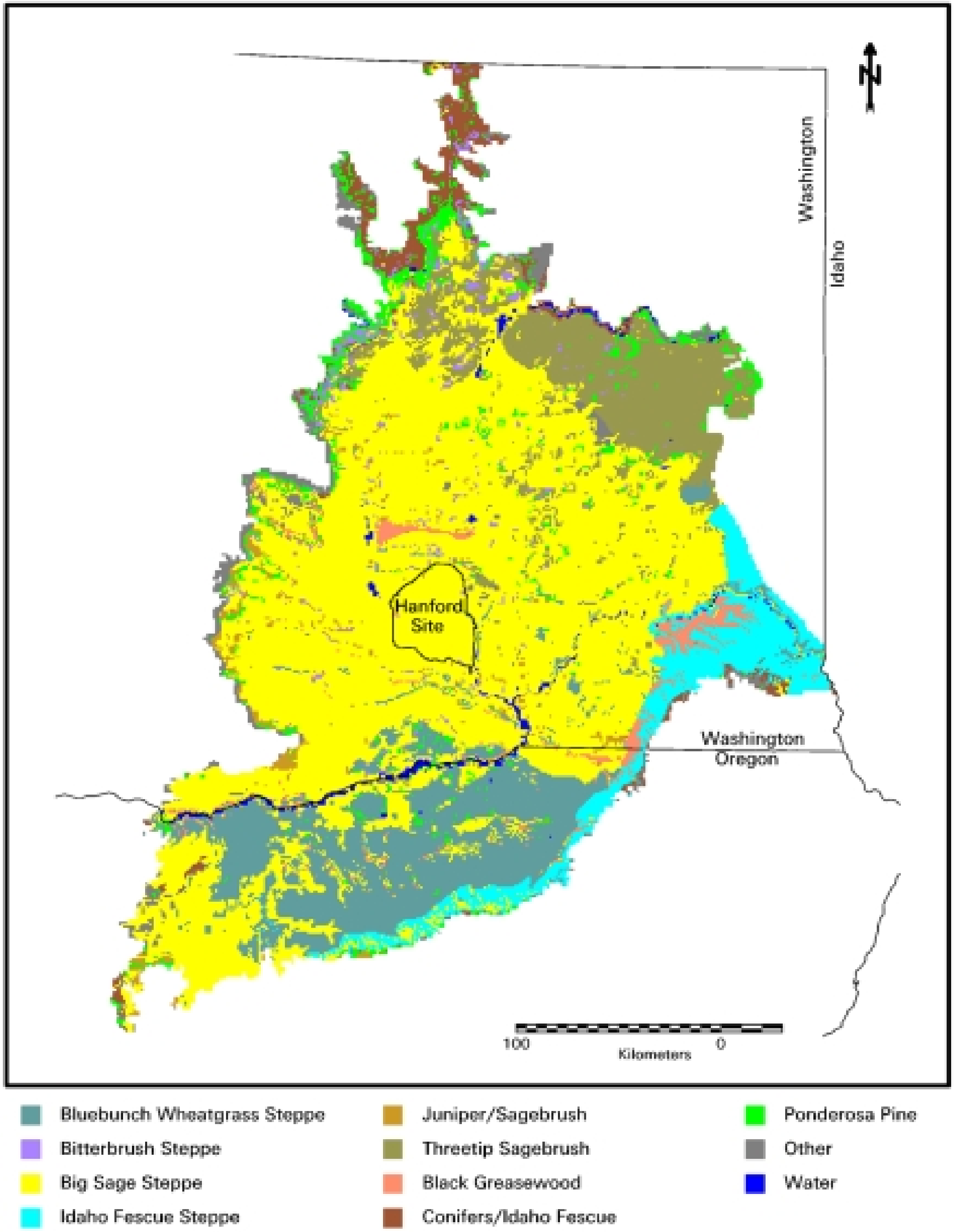

Figure C.7 Historic Distribution and Extent of Land Cover Classes Within the Columbia Basin Ecoregion (Source: Electronic version obtained from the Interior Columbia Basin Ecosystem Management Project.)

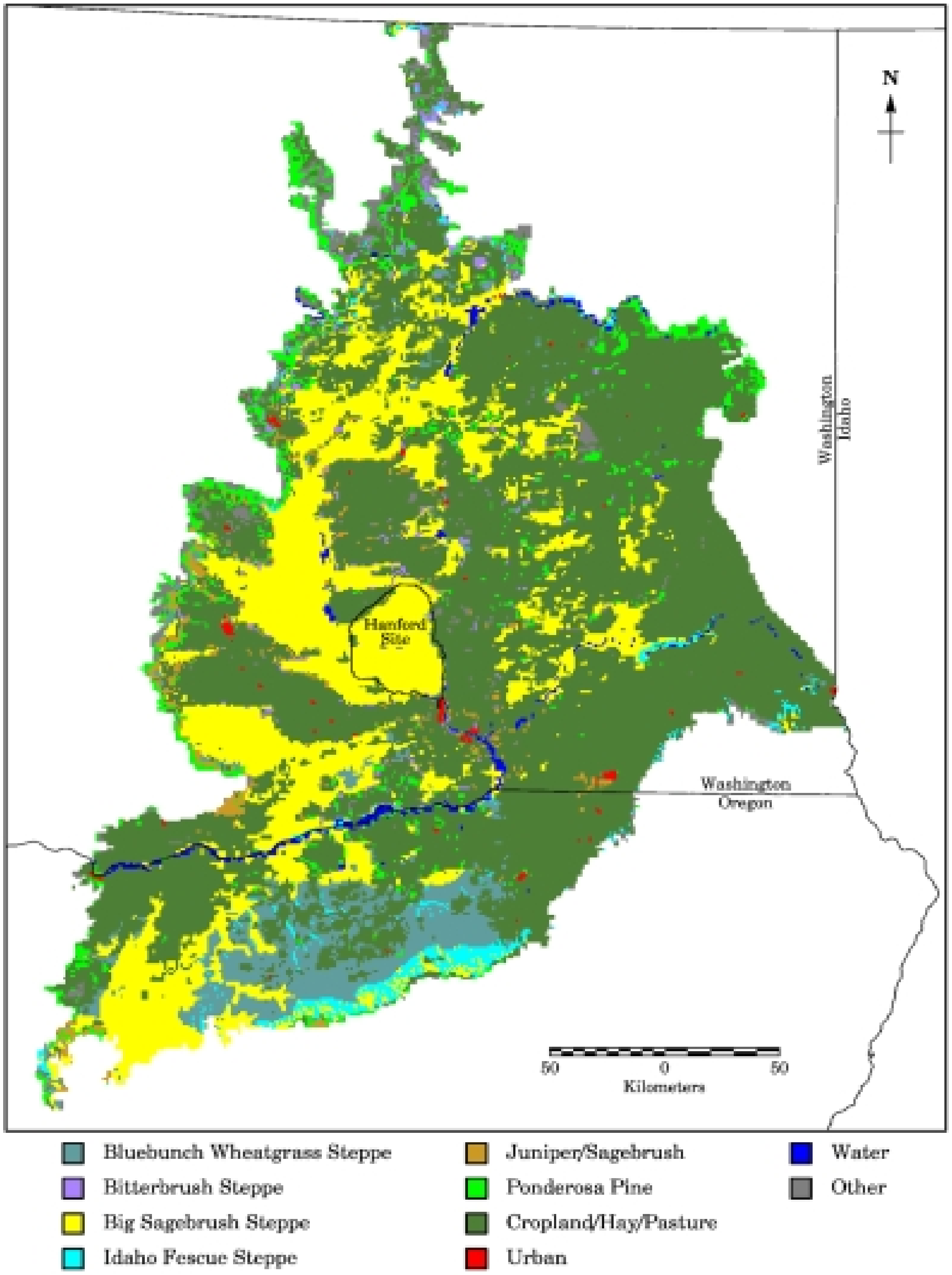

Figure C.8 Current Distribution and Extent of Land Cover Classes Within the Columbia Basin Ecoregion (Source: Electronic version obtained from the Interior Columbia Basin Ecosystem Management Project.)

Table C.3 Percentage of Area Covered and Actual Area Covered by the Different Land Cover Classes Within the Columbia Basin Ecoregion

Cover Class	Ecoregion Area (ha)	% Area of Ecoregion	Hanford Site Area (ha)	% of Cover Class by Area in Ecoregion at Hanford
Historic				
Bluebunch wheatgrass steppe	1,028,900	13.76	612	0.06
Idaho fescue steppe	436,700	5.84	0	0.00
Bitterbrush steppe	118,600	1.59	915	0.77
Big sagebrush steppe	4,096,900	54.79	148.902	3.63
Juniper/sagebrush	110,300	1.48	508	0.46
Threetip sagebrush	746,000	9.98	16	<0.01
Black greasewood	134,900	1.80	506	0.37
Conifers/Idaho fescue	225,000	3.01	0	0.00
Ponderosa pine	302,900	4.05	102	0.03
Water	71,100	0.95	25	0.04
Other	205,500	2.75	0	0.00
Total	7,476,800	100.00	151,585	2.03
Current				
Bluebunch wheatgrass steppe	431,400	5.77	1,602	0.37
Idaho fescue steppe	122,200	1.63	0	0.00
Bitterbrush steppe	78,100	1.04	904	1.16
Big sagebrush steppe	1,662,400	22.23	137,834	8.29
Juniper/sagebrush	109,100	1.46	508	0.47
Ponderosa pine	335,100	4.48	102	0.03
Water	71,100	0.95	25	0.04
Urban	22,200	0.30	156	0.70
Crop/hay/pasture	4,443,400	59.43	9,644	0.22
Other	201,800	2.70	812	0.40
Total	7,476,800	100.0	151,585	2.03

should not pose a problem; however, the Hanford data may need to be evaluated with caution (see Section C.4.2).

- Although both the historic and current vegetation data sets are modified by successional models, the current vegetation data set is, at least in part, based on real-time data (i.e., the LCC data base). Thus, there may be accuracy differences between the two data sets; however, again, provided the geographic scale of analysis is large, this should not be problematic.
- A complete matching of reclassified cover classes between the historic and current vegetation data sets was not possible. Ideally, other than human-activity derived cover classes there should be no differences in the types of cover classes used. Three reclassified cover classes that occur as a part of the historic vegetation data set—threetip sagebrush, black greasewood, and conifers/Idaho fescue—do not occur in the current vegetation data set. The areas occupied by the threetip sagebrush and black greasewood cover classes in the historic land cover map (Figure C.7) seem to have been replaced in the current cover class map (Figure C.8) by either human-altered areas or by being reclassified as big sagebrush steppe. At higher levels of analysis (i.e., combining cover classes to form even more generalized classifications), these potential overlap errors in classification should have minimal effect on the analysis. The conifers/Idaho fescue cover class occurs predominantly at the northern extent of the ecoregion and generally outside what either data set seems to classify as steppe vegetation. Thus, the lack of overlap here should have little effect on an analysis of changes in steppe vegetation.

Table C.4 provides comparison data associated with the historic and current vegetation data sets (The Columbia Basin Ecoregion data will be discussed here and the Hanford-specific data in Section C.4.2.). Whether looked at from the standpoint of big sagebrush steppe alone or when combined with other cover classes to form more generalized classifications (i.e., sagebrush steppe, shrub-steppe, or steppe with and without shrubs), about 35–40% of the steppe vegetation remains from what was present historically in the Columbia Basin Ecoregion. Historically, steppe vegetation accounted for about 89.2% of the ecoregion; today it occupies only about 32.1%. In its place, human-altered areas today occupy about 59.7% of the ecoregion. About 99.5% of this land use is related to agriculture.

The distribution of the loss in steppe vegetation is not uniform across the ecoregion. The most extensive losses of steppe vegetation are concentrated in the eastern portion of the ecoregion (Figure C.8) (A fate that also has befallen the Idaho fescue/snowberry plant associations east of the ecoregion in Washington.). Although more extensive amounts of steppe vegetation remain in the western and southern portions of the ecoregion, the distribution of what remains is fragmented. Also, much of the remaining large blocks are administered by federal agencies (e.g., DOE and DoD) that are not traditional resource management agencies.

C.2.3 Terrestrial Fauna

No single review publication or collection of studies focuses on characterizing the fauna of the Columbia Basin Ecoregion. Previous faunal characterizations have either treated the Columbia Basin area as a part of a larger biogeographic area [e.g., western intermountain sagebrush-steppe (West 1983b)] or have focused on a particular portion of the Columbia Basin Ecoregion [e.g., Fitzner/Eberhardt Arid Land Ecology Reserve Unit on Hanford (Rickard et al1988)]. Most studies have concentrated on the shrub-dominated aspects of the ecoregion's ecology and not on the significance, in regard to faunal diversity, of the mosaic of shrub-dominated and bunchgrass-dominated lands within the ecoregion. With respect to shrubs, big sagebrush communities are those that have received most of the attention.

In contrast to the general studies, certain taxa are fairly well-characterized for the ecoregion. For example, although they did not use exactly the same boundaries for the Columbia Basin Ecoregion as defined here, Nussbaum et al. (1983) provided information on the characteristic amphibians and reptiles found in the area. Also, as part of a larger study that examined non-game bird communities in northwestern rangelands (essentially encompassing the sagebrush-steppe communities of southeastern Washington, eastern Oregon, and southern Idaho), Rotenberry and Wiens (1978) provided evidence that distinct avian communities are present within the sagebrush-steppe. They identified one such distinct community as occurring within the Columbia Basin Ecoregion. As is probably true for other taxa, Rotenberry and Wiens's

Table C.4 Comparison of Historic and Current Land Cover Classes Within the Columbia Basin Ecoregion

Cover Class	Ecoregion Area (ha)		% Change in Area Covered in Ecoregion	% of Cover Class by Area in Ecoregion at Hanford		% Change in Area Covered at Hanford Relative to Ecoregion
	Historic	Current		Historic	Current	
Big sagebrush steppe	4,096,900	1,662,400	40.6	3.63	8.29	228.4
Sagebrush steppe[a]	4,953,200	1,771,500	35.8	3.02	7.81	258.6
Shrub-steppe[b]	5,206,700	1,849,600	35.5	2.90	7.53	259.7
Steppe without shrubs[c]	1,465,600	553,600	37.8	0.04	0.29	725.0
Steppe: with and without shrubs[d]	6,672,300	2,403,200	36.0	2.27	5.86	258.1
Conifers[e]	527,900	335,100	63.5	0.02	0.03	150.0
Human-altered areas[f]	0	4,465,600	--	--	0.22	--
Water	71,100	71,100	100.0	0.04	0.04	100.0
Other	205,500	201,800	98.2	0.00	0.40	--

[a]Includes *big sagebrush steppe, threetip sagebrush, and *juniper/sagebrush.
[b]Includes *big sagebrush steppe, threetip sagebrush, *juniper/sagebrush, *bitterbrush steppe, and black greasewood.
[c]Includes *bluebunch wheatgrass steppe and *Idaho fescue steppe.
[d]Includes *big sagebrush steppe, threetip sagebrush, *juniper/sagebrush, *bitterbrush steppe, black greasewood, *bluebunch wheatgrass steppe, and *Idaho fescue steppe.
[e]Includes *Ponderosa pine and conifers/Idaho fescue.
[f]Includes cropland/hay/pasture and urban.
*Indicates a cover class common to both historic and current land cover designations.

study indicates that, although individual bird species are not unique (i.e., endemic) to the Columbia Basin Ecoregion, what typifies the ecoregion are the characteristic species assemblages.[7] Finally, Rotenberry and Wiens is one of the few studies to examine changes in faunal species abundance (again for birds) between sagebrush-dominated areas and bunchgrass-dominated areas within the sagebrush-steppe.

The following sections provide an overview of those species considered dependent within the ecoregion on native steppe and shrub-steppe communities for continued population viability. An overview of species characteristic of the uplands within the Columbia Basin Ecoregion by taxa also is provided.

Steppe and Shrub-Steppe Obligate Species—Because much of the Columbia Basin Ecoregion is composed of sagebrush-dominated vegetation zones, much attention paid to species dependency has focused on identifying those species that are highly dependent (i.e., obligates) on sagebrush-dominated communities for at least portions of their life cycle. A more limited amount of information is available for non-sagebrush dependent species that are still

[7] Although endemic species as a rule do not characterize the Columbia Basin Ecoregion, plants and insects may be an exception; for example The Nature Conservancy biodiversity studies on Hanford have documented previously unknown plant and insect species not found elsewhere (TNC 1995, 1996, 1998, 1999).

generally confined to the Columbia Basin Ecoregion. Table C.5 provides a summary of steppe and shrub-steppe obligate species, their listing status, and their Hanford abundance with an emphasis on sagebrush-obligate species. Information as to what constitutes an obligate species is taken from Braun et al. (1976), Dobler (1992), Pyle (1989), and Rotenberry and Wiens (1978).

Other species, although perhaps found in other types of habitat, are generally associated with steppe and shrub-steppe habitats within the Columbia Basin Ecoregion. These species include sagebrush lizard (*Sceloporus graciosus*), burrowing owl (*Athene cunicularia*), loggerhead shrike (*Lanius ludovicianus*), lark sparrow, (*Chondestes grammacus*), vesper sparrow (*Pooecetes gramineus*), Townsend's ground squirrel (*Spermophilus townsendii*), northern grasshopper mouse, (*Onychomys leucogaster*), and Merriam's shrew (*Sorex merriami*). Additionally, species such as the Great Basin spadefoot toad (*Scaphiopus intermontanus*), though they rely on the proximity of at least ephemeral water supplies, also are highly characteristic of shrub-steppe habitats.

Invertebrates—Insects and their close invertebrate relatives, such as mites, spiders, and scorpions, are widely distributed in the steppe and shrub-steppe of the Columbia Basin, as well as in other arid land ecosystems throughout the world. Certain insect groups, such as locusts and beetles, are well known for their periodic population eruptions. Such eruptions often result in damage to range land vegetation and nearby croplands. Consequently, pest species such as Orthoptera (grasshoppers, crickets, and katydids) (Mulkern et al. 1964; Rogers

Table C.5 Steppe and Shrub-Steppe Obligate Species of the Columbia Basin Ecoregion

Scientific Name	Common Name	Federal Status	State Status	Sagebrush Obligate	Hanford Abundance
Insects					
Callophrys sheridanii neoperplexa	Sheridan's green hairstreak		Monitor		Rare
Reptiles					
Masticophis taeniatus	Striped whipsnake		Candidate	Yes	Rare
Birds					
Spizella breweri	Brewer's sparrow			Yes	Common
Centrocercus urophasianus	Sage grouse	Former candidate	Candidate	Yes	Rare
Oreoscoptes montanus	Sage thrasher		Candidate	Yes	Rare
Amphispiza belli	Sage sparrow		Candidate	Yes	Common
Mammals					
Brachylagus (=Sylvilagus) idahoensis	Pygmy rabbit	Former candidate	Endangered	Yes	Extirpated
Lagurus (=Lemmiscus) curtatus	Sagebrush vole		Monitor	Yes	Uncommon
Spermophilus (=Citellus) washingtoni	Washington ground squirrel		Monitor		Undocumented

and Uresk 1974); Hymenoptera (sawflies, parasitic wasps, ants, wasps, and bees) (Hewitt et al. 1974; Lavigne 1969); Coleoptera (beetles) (Graber et al. 1931; Rickard 1970); and Lepidoptera (butterflies and moths) (Wildermuth and Caffrey 1916; Walkden 1950) have been the focus of much research in the shrub-steppe.

The majority of insects in the shrub-steppe are primary consumers. Sometimes they may become so numerous as to completely defoliate sagebrush [e.g., the sagebrush moth (*Aroga websteri*)] or to compete with domestic livestock for forage, as do the migratory grasshopper (*Melanoplus sanguinipes*) and Mormon cricket (*Anabrus simplex*). Insects are an important food base for birds, especially horned larks, meadowlarks, sage sparrows (Rotenberry and Wiens 1978), and small raptors (Green et al. 1993).

Many insects in the shrub-steppe burrow in the soil during at least some part of their life cycle and, consequently, influence the development of shrub-steppe soils. These include various taxa such as ants, wasps, solitary bees, and beetles. In general, the activities of these groups are not well documented (Gano and Rogers 1983).

Herpetofauna—Information on the herpetofauna of the Columbia Basin Ecoregion is taken from Nusbaum et al. (1983). Amphibian diversity in the Columbia Basin Ecoregion is lower than in more mesic areas of the Pacific Northwest. Reptile diversity in the ecoregion is lower than in the southwestern United States. None of the herpetofauna in the ecoregion are endemic. Most species seem to have colonized the ecoregion relatively recently from the centers of their distributions to the south.

Several species are common throughout the ecoregion. The Great Basin spadefoot uses ephemeral habitats; the larvae are especially adapted to such conditions. Adult spadefoots also have numerous adaptations for life in a xeric environment. Painted turtles (*Chrysemys picta*) occur in marshy ponds or small lakes, as well as in the quiet backwaters of rivers. The sagebrush lizard (*Sceloporus graciosus*), side-blotched lizard (*Uta stansburiana*), and short-horned lizard (*Phrynosoma douglassii*) occur throughout the ecoregion. In appropriate habitat, sagebrush lizards and side-blotched lizards are locally common but seldom co-occur (Nussbaum et al. 1983). All three lizard species occur at lower elevations in the ecoregion than they do in the more southern portions of their ranges. Common snake species that occur in a variety of habitats throughout the ecoregion include the racer (*Coluber constrictor*), gopher snake (*Pituophis melanoleucus*), and western rattlesnake (*Crotalus viridis*).

Other herpetofauna, while characteristic of the ecoregion, are not so widely distributed. The pond-breeding tiger salamander (*Ambystoma tigrinum*), for example, is generally absent from drier areas of the ecoregion. Two ranid frogs, the bullfrog (*Rana catesbeiana*) and northern leopard frog (*R. pipiens*), occur in scattered locations throughout the ecoregion close to permanent ponds and lakes. The bullfrog was introduced to the Pacific Northwest in the late 1920s or early 1930s and has rapidly expanded its range. One bufonid species, Woodhouse's toad (*Bufo woodhousii*), occurs in the vicinity of the Snake and Columbia rivers. Both Woodhouse's toad and the northern leopard frog possibly recently colonized the ecoregion from the East by using the Snake and Columbia rivers as avenues of dispersal. Two snake species, the western terrestrial garter snake (*Thamnophis elegans*) and common garter snake (*T. sirtalis*), are widely distributed throughout the ecoregion, but generally occur near permanent water.

Other species such as the long-toed salamander (*Ambystoma macrodactylum*), Pacific treefrog [*Hyla* (=*Pseudacris*) *regilla*], and spotted frog (*R. pretiosa*) may be considered typical of the Pacific Northwest (i.e., 50% or more of their entire range occurs within the Pacific Northwest), but not of the ecoregion. These species tend to be more common and more widely distributed outside of the ecoregion than within it. Nonetheless, the Pacific treefrog is still considered one of the more common frogs of the ecoregion. Similar to the Great Basin spadefoot it will make use of empheral habitats. Both the long-toed salamander and spotted frog are absent from drier areas of the ecoregion.

Some species are relatively uncommon or occur only at specific locations within the ecoregion. The western skink (*Eumeces skiltonianus*) occurs mostly in the northern portion of the ecoregion where conditions are more mesic; it prefers rocky habitats with some moisture. Two snakes, the night snake (*Hypsiglena torquata*) and striped whipsnake (*Masticophis taeniatus*), are relatively uncommon. The northern extent of the striped whipsnake's range occurs in approximately the center of the ecoregion. The night snake tends to be found only in association with rocky outcrops and slopes. Several other amphibian and reptile species occur at the margins of the ecoregion or at isolated locations within the ecoregion. These include the western toad (*Bufo boreas*), southern alligator lizard [*Elgaria* (=*Gerrhonotus*) *multicarinata*], rubber boa (*Charina bottae*), sharptail snake (*Contia tenuis*), and ringneck snake (*Diadophis punctatus*).

Birds—Table C.6 provides a list of native birds that use steppe and/or shrub-steppe habitats within the Columbia Basin Ecoregion for at least a portion of their life cycle. The information in the table is taken from Andelman and Stock (1994a, 1994b), who draw heavily on U.S. Fish and Wildlife Service Breeding Bird Survey survey data on breeding neotropical migrants in various habitats in Washington and Oregon, and from Rotenberry and Wiens (1978).

Four sagebrush nesting birds, generally migratory, are characteristic of the shrub-steppe birds in the ecoregion in both Washington and Oregon. These are the loggerhead shrike, Brewer's sparrow, sage thrasher, and sage sparrow (Andelman and Stock 1994a, 1994b). The loggerhead shrike and Brewer's sparrow are habitat specialists (species that use only one or two habitats for nesting and foraging) that are considered to be declining significantly in the Oregon shrub-steppe (Andelman and Stock 1994b). Insufficient data exist to establish a trend for loggerhead shrike and Brewer's sparrow in Washington. The sage thrasher and sage sparrow are considered species of management concern in Washington because they are habitat specialists that have localized breeding distributions (Andelman and Stock 1994a). The sage grouse, a non-migrant, also is a sagebrush obligate. It is known to breed in two locations in the ecoregion, one on the Yakima Training Center (managed by the U.S. Department of the Army) and the other in Douglas County.

Most species that occur in shrub-steppe habitats also can be found in steppe habitats. Six species best characterize steppe habitats in both Washington and Oregon. These are the long-billed curlew, vesper sparrow, grasshopper sparrow, lark sparrow, savannah sparrow, and western meadowlark (Andelman and Stock 1994a, 1994b). The sharp-tailed grouse, a non-migrant resident of the ecoregion, also is a species that uses bunchgrass areas for nesting.

A number of raptors are characteristic of both shrub-steppe and steppe in the ecoregion. The most conspicuous of these are the American kestrel, prairie falcon, red-tailed hawk, ferruginous hawk, turkey vulture, northern harrier, and golden eagle.

Several introduced game species also use steppe and shrub-steppe habitats within the Columbia Basin Ecoregion. These include the chukar (*Alectoris chukar*), ring-necked pheasant (*Phasianus colchicus*), and gray partridge (*Perdix perdix*) (Rotenberry and Wiens 1978).

Rotenberry and Weins (1978) drew several conclusions from their analysis of non-game bird communities in northwestern rangelands (As described in the introductory paragraphs to Section C.2.3, these rangelands include more than the Columbia Basin Ecoregion.). They concluded:

1. Shrub-steppe avian communities are distinctly different from the surrounding forest communities. Only 3-6 species are recorded usually in any local area. This number ranges from 20-33% of that reported for various forest bird censuses.

2. Shrub-steppe is not avifaunally homogenous itself. There are different species assemblages in different areas. The Columbia Basin Ecoregion is one of these distinct areas.

3. There are indeed species that are characteristic of the shrub-steppe.

4. Wintering avifaunas are sparse, both in terms of species occurrence and abundance.

Mammals—Mammal diversity in the Columbia Basin Ecoregion is lower than in more mesic areas of the Pacific Northwest. Mammals in the Columbia Basin Ecoregion must either be adapted to the to semi-arid climate or live close to a permanent water source. The ecoregion has only one endemic species. Many species that occur in the ecoregion range far beyond the ecoregion's borders and most exist in greater numbers outside the ecoregion.

The Washington ground squirrel is the only mammal endemic to the Columbia Basin Ecoregion. It is found only in the grasslands, low sagebrush, wheat fields, and rocky hillsides of central Washington and northeastern Oregon. It seems to prefer steppe habitats with high grass and forb cover, deep and loose soil, and soil without a high clay content (Betts 1990).

Species within a number of groups might be considered typical of the ecoregion, as their ranges overlap it entirely. These include shrews, pocket gophers, rabbits, ground squirrels, mice, woodrats, bats,

Table C.6 Native Avian Species that Use Steppe and/or Shrub-Steppe Habitats for Some Portion of Their Life Cycle Within the Columbia Basin Ecoregion

Scientific Name	Species	Shrub-Steppe	Steppe[a]
Year-Round Residents (at least some members of the population)			
Corvus brachyrhynchos	American crow	X	X
Falco sparverius	American kestrel	X	X
Pica pica	Black-billed magpie	X	X
Athene cunicularia	Burrowing owl	X	X
Corvus corax	Common raven	X	
Eremophila alpestris	Horned lark	X	X
Lanius ludovicianus	Loggerhead shrike	X	X
Zenaida macroura	Mourning dove	X	X
Circus cyaneus	Northern harrier	X	X
Falco mexicanus	Prairie falcon	X	X
Buteo jamaicensis	Red-tailed hawk	X	X
Centrocercus urophasianus	Sage grouse	X	
Tympanuchus phasianellus	Sharp-tailed grouse	X	X
Asio flammeus	Short-eared owl		X
Sturnella neglecta	Western meadowlark	X	X
Summer Residents			
Hirundo rustica	Barn swallow	X	X
Dolichonyx oryzivorus	Bobolink		X
Euphagus cyanocephalus	Brewer's blackbird	X	
Spizella breweri	Brewer's sparrow	X	
Hirundo pyrrhonota	Cliff swallow	X	X
Chordeiles minor	Common nighthawk	X	X
Phalaenoptilus nuttallii	Common poorwill	X	X
Buteo regalis	Ferruginous hawk	X	X
Aquila chrysaetos	Golden eagle	X	X
Ammodramus savannarum	Grasshopper sparrow	X	X

[a]Steppe here refers not only to vegetation zones that are characteristically without sagebrush or bitterbrush, but also to areas within the shrub-steppe vegetation zones that are in a successional stage and lack a significant shrub cover.

Table C.6 Native Avian Species that Use Steppe and/or Shrub-Steppe Habitats for Some Portion of Their Life Cycle Within the Columbia Basin Ecoregion (continued)

Scientific Name	Species	Shrub-Steppe	Steppe[a]
Summer Residents (Continued)			
Empidonax wrightii	Gray flycatcher	X	
Chondestes grammacus	Lark sparrow	X	X
Numenius americanus	Long-billed curlew		X
Sialia currucoides	Mountain bluebird		X
Salpinctes obsoletus	Rock wren	X	X
Amphispiza belli	Sage sparrow	X	X
Oreoscoptes montanus	Sage thrasher	X	X
Passerculus sandwichensis	Savannah sparrow		X
Sayornis saya	Say's phoebe	X	X
Buteo swainsoni	Swainson's hawk	X	X
Cathartes aura	Turkey vulture	X	X
Pooecetes gramineus	Vesper sparrow	X	X
Tyrannus verticalis	Western kingbird	X	X
Aeronautes saxatalis	White-throated swift	X	X
Winter Residents			
Lanius excubitor	Northern shrike	X	X
Buteo lagopus	Rough-legged hawk	X	X

[a]Steppe here refers not only to vegetation zones that are characteristically without sagebrush or bitterbrush, but also to areas within the shrub-steppe vegetation zones that are in a successional stage and lack a significant shrub cover.

weasels, coyote (*Canis latrans*), bobcat (*Lynx rufous*), mule deer (*Odocoileus hemonionus*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethica*) (Burt and Grossenheider 1976).

Some of these species are widely distributed throughout the sagebrush-steppe. The Great Basin pocket mouse (*Perognathus parvus*), for example, is granivorous and likely obtains its water entirely from its food (Ingles 1965). Others that have a strong association with sagebrush-steppe are the northern pocket gopher (*Thomomys talpoides*), black-tailed jack rabbit (*Lepus californicus*), and northern grasshopper mouse. In contrast, other species, such as the long-tailed weasel (*Mustela frenata*), beaver, and muskrat, are found only in areas near a permanent water source, where they find much of their food. Other species typical of the ecoregion's shrub-steppe also occur in more mesic environments elsewhere outside the ecoregion. These mammals include Merriam shrew, Nuttall's cottontail (*Sylvilagus nuttalli*), deer mouse (*Peromyscus maniculatus*), striped skunk (*Mephitis mephitis*), bushy-tailed woodrat (*Neotoma cinerea*), and badger (*Taxidea taxus*). A number of bats species that are typical of the ecoregion, as well as more mesic environments elsewhere, include the little brown myotis (*Myotis lucifugus*), California myotis (*M. californicus*), Yuma myotis (*M. yumanensis*), silver-haired bat (*Lasionycteris noctivagans*), big brown bat (*Eptesicus fuscus*), pale Townsend's (=western) big-eared bat (*Plecotus townsendii pallescens*), and pallid bat (*Antrozous pallidus*). Riparian zones provide suitable foraging habitat for these insectivores.

Other species, while characteristic of the ecoregion, are not so widely distributed. Several rely on forested or riparian vegetation for food and cover. These include the vagrant shrew (*Sorex vagrans*), white-tailed jack rabbit (*Lepus townsendii*), long-eared myotis (*Myotis evotis*), long-legged myotis (*M. volans*), and small-footed myotis [*M. ciliolabrum* (split from *M. leibii*)]. Other species that are associated with sagebrush steppe, but are not common throughout the entire Columbia Basin Ecoregion, include the pygmy rabbit, Townsend's ground squirrel, least chipmunk (*Eutamias minimus*), sagebrush vole, western harvest *mouse (Reithrodontomys megalotis*), western pipistrel (*Pipistrellus hesperus*), and badger.

The pygmy rabbit, for example, is found in Washington only within the Columbia Basin Ecoregion. These Washington populations are disjunct from the core of the species's range to the south, and apparently, have been separated for thousands of years. The pygmy rabbit requires dense rabbitbrush or clumps of sagebrush to provide necessary cover from predators such as the coyote and long-eared owl (*Asio otus*). The pygmy rabbit is highly dependent on sagebrush, which composes up to 99% of its diet. It also requires relatively deep, loose soil for digging its burrows (WDFW 1993). Such habitat has largely been converted to agriculture and is now relatively scarce in the ecoregion. The pygmy rabbit's numbers are few in Washington. The sagebrush vole has a close association with big sagebrush (Rickard 1960).

A number of other species are less characteristic of the ecoregion, as they occur within the ecoregion but on its periphery. These peripheral species include the fringed myotis (*M. thysanodes*), hoary bat (*Lasiurus cinereus*), shorttail weasel (*Mustela erminea*), mink (*Mustela vison*), spotted skunk *(Spilogale putorius),* raccoon (*Procyon lotor*), river otter (*Lutra canadensis*), and red fox (*Vulpes fulva*), all of which are confined to locations with permanent water. The yellow-bellied marmot (*Marmota flaviventris*), mountain lion (*Felis concolor*), Columbian ground squirrel [*Spermophilus* (=*Citellus*) *columbianus*], Ord kangaroo rat (*Dipodomys ordi*), elk (*Cervus elaphus*), and porcupine (*Erethizon dorsatum*) require other habitat characteristics that limit their range within the ecoregion. Many of these are found primarily in forested areas at the margins of the ecoregion and at higher elevations. For example, the Columbian ground squirrel is found in grassland and open timber along the eastern edge of the ecoregion; the marmot is found primarily in talus slopes bordering alpine meadows; and the porcupine is largely arboreal, frequenting conifer forests along the eastern and western fringes of the ecoregion. The Ord kangaroo rat occurs in sagebrush steppe in open sandy areas; its range extends only into the extreme southern portion of Washington (Ingles 1965).

Response of Steppe Animals to Fire—The adverse effects of fire for shrub-nesting birds [e.g., loggerhead shrike, sage sparrow, sage thrasher, and Brewer's] are typically delayed until the following spring, as most wildfires occur after the nesting season. Ground-nesting birds are generally not greatly affected by burning [e.g., horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), and long-billed curlew (*Numenius americanus*)]. The sage grouse may be adversely affected because it forages largely on sagebrush foliage. Small mammals that burrow deeply are little affected by burning (e.g., Great Basin pocket mouse and Townsend's ground squirrel). Large, highly mobile mammals usually escape wildfires (e.g., coyote, mule deer, and elk).

C.2.4 Riverine/Riparian Communities Within the Ecoregion

The presence of dams has significantly altered the physical characteristics of the riverine environment of the Columbia Basin Ecoregion's major rivers the Columbia and Snake. What was once a free-flowing system with significant seasonal changes is now mostly slackwater confined within a reservoir system. These physical changes have altered the amount and diversity of habitats available to aquatic organisms. Slackwater-adapted species are now favored over those that rely on free-flow conditions. Resident fish species for different segments of the Columbia River are described in a number of sources (see Gray and Dauble 1977 for citations). Some of these may describe pre-dam populations. As one of the last free-flowing stretches of the Columbia/Snake River system, the Hanford Reach may retain remnants of the pre-dam native fish species assemblages for this system (see Section C.3.6).

During the 1970s, the U.S. Army Corps of Engineers undertook an inventory of riparian habitats and associated wildlife along the Columbia and Snake rivers as part of an effort to evaluate the impacts of river regulation for maximum power production (i.e., power peaking) on key riparian habitats and wildlife . Payne et al. (1976) inventoried the approximately 400-mile segment of the Columbia River from just north of Richland, Washington, to the Canadian border. The portion of the study conducted downstream of Chief Joseph Dam will be used to represent the riverine/riparian communities of the Columbia Basin Ecoregion, although it should be realized that many of these communities are still in a state of development following impoundment.

The main vegetation types identified by Payne et al. (1976) that occurred along the river shoreline included cobble and shoreline gravel, sand dune, shrub-steppe, steppe (without shrubs), riparian shrub [e.g., willow (*Salix* spp.)], and riparian tree [e.g., black cottonwood (*Populus trichocarpa*)]. Riparian shrub and tree communities were the most limited in occurrence, yet the most valuable in regard to wildlife usage. Before impoundment, narrow bands of willow may have typified the river floodplain where stream bank gradients were not steep.

Riparian habitat was important for passerine birds both for nesting and as resting areas during migration. Bird species diversity increased with vegetation type in the order: sand dune, cobble, shrub-steppe, riparian shrub, and riparian tree. The ranking probably reflects a similar increase in habitat complexity. Deer mice were the most abundant small mammal detected. When shrub-steppe occurred adjacent to the river, Great Basin pocket mice occupied as many transects as the deer mice; however, they were always at lower densities. Small mammal diversity never exceeded seven species at any particular location. Payne et al. (1976) had minimal sampling records for amphibians and reptiles, though they recorded nine different species along the Hanford Reach. Larger mammals and raptorial birds use the riparian habitat, but are not as tied to it as the smaller species.

C.3 Hanford Site and Immediate Surrounding Areas

C.3.1 Physical Features

The current Hanford Site occupies about 1450 km^2 (560 mi^2) of shrub-steppe in semi-arid south-central Washington. Figure C.9 shows the major physical features of the Hanford Site. Additional detail about the physical features of the Hanford Site can be found in Neitzel (1999).

A stretch of the Columbia River (the Hanford Reach) runs through the northern part of the Site and forms part of its eastern boundary. Specific abiotic characteristics of the Hanford Reach are described as part of Section C.3.6. Other than the Columbia River, little surface water is present on the Hanford Site—mostly a few spring and stream systems in the southwestern portion of the Site and irrigation runoff areas that have resulted in the formation of wetlands north of the Columbia River.

Hanford is located within the hottest and driest portion of the Columbia Basin Ecoregion. An almost 50-year record of climatological data is available for the central portion of the Site (Hoitink and Burk 1994). Average annual precipitation for this area is 16 cm (6.3 in.). Although the data from the central portion of the Site are representative of the general climate conditions for the region, differences in the topography of the Site contribute to relatively significant local changes in some aspects of climate (Neitzel 1999). For example, on the crest of Rattlesnake Mountain annual precipitation can reach up to 35 cm (13.8 in.) (Downs et al. 1993).

The Columbia River plain constitutes the majority of the Hanford Site and is its lowest and most arid region. The Columbia River plain differs somewhat from other areas of the Columbia Basin Ecoregion in that it was severely disturbed by a series of massive glacio-fluvial floods 10-20,000 years ago. As the floods subsided, the plain was newly colonized by terrestrial plant and animal populations from surrounding hills and ridges. Considering its relatively recent colonization and relatively extreme climate, it is not surprising that the native flora and fauna of the Columbia River plain differ from that of the surrounding shrub-steppe. The recent colonization of the plain also may be a factor in its vulnerability to invasion by non-native annuals (e.g., cheatgrass; see Section C.2.2 and Brandt and Rickard 1994).

Several basalt ridges traverse the Site and provide much of its topographic relief. Rattlesnake Mountain is the largest and highest ridge [1050 m (about 3450 ft)] and forms the southwestern border of the Site. Two ridges, Yakima and Umtanum, extend across Hanford's western boundary and terminate on the Site. Gable Butte and Gable Mountain, located north of the 200 Areas, are segmented extensions of Umtanum Ridge (Neitzel 1999). The Saddle Mountains form the northern border of the Site. The White Bluffs, which are formed from consolidated sediments, create a prominent cliff

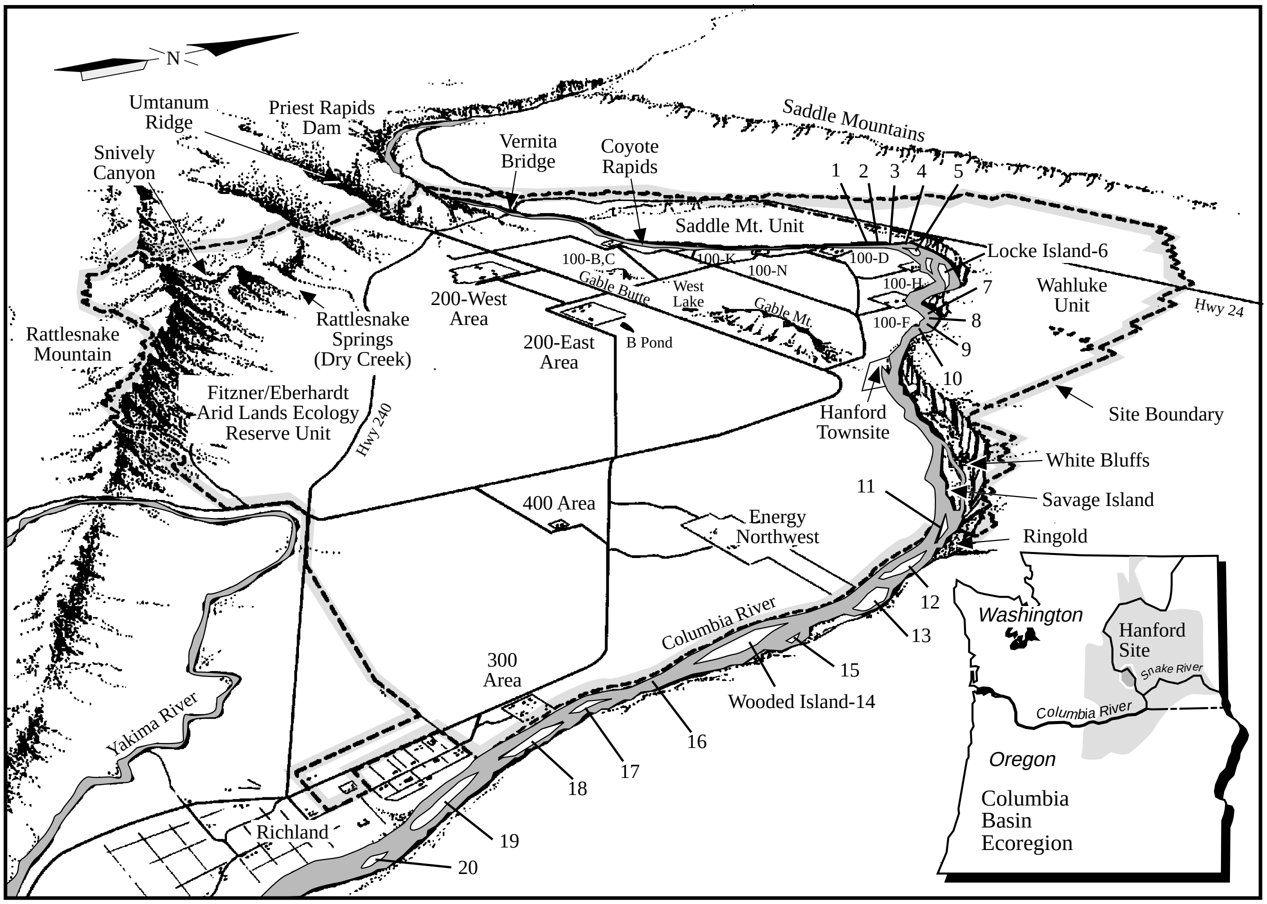

Figure C.9 Major Physical Features of the Hanford Site. Numbers refer to numbered river islands within the Hanford Reach.

along much of the eastern and northern shore of the Hanford Reach. The White Bluffs are subject to landslides as a result of irrigation activity east of the Columbia River (Neitzel 1999). The Cold Creek Valley (generally delineated by the route of state Highway 240 at the base of Rattlesnake Mountain) traverses the Site at roughly 150 m (about 500 ft) elevation.

Soils on the Hanford Site vary from sand to silty and sandy loam with 15 types in all described (Hajek 1966). The silt loam soils tend to found on the slopes and higher elevation areas of the Site; whereas, the sandier soils are found at the lower elevations of the Columbia River plain (see Figure 1 in Hajek 1966). Active and stabilized sand dunes are present in the eastern portion of Hanford (south and west of the Columbia River) and north of the Columbia River on the North Slope. Soil classification schemes have evolved since Hajek (1966); however, until such time the Site is resurveyed, Hajek's classification serves as the best available information (Neitzel 1999).

C.3.2 Hanford Site Operations and Land Uses

Before 1943, the recent land-use history of the Hanford Site related principally to livestock ranching, farm homesteads, and small supply and grain shipment towns (Gerber 1992). The consequences of some of these land uses are still apparent today as, for example, the abandoned town sites and old fields along the Columbia River. These areas today are composed mostly of non-native plant species that will probably not recover to a native composition without manipulation. Other areas that were grazed either retain a mix of native and non-native plant species or, if not intensively grazed, still closely resemble the original native plant communities. Even the Fitzner/Eberhardt Arid Lands Ecology (ALE) Reserve Unit experienced historic land uses (i.e., 1880–1940), such as homesteading, winter/spring sheep grazing, gas wells, and road building (Hinds and Rogers 1991). These historic non-DOE land uses also must be considered in understanding the ecological context of the Hanford Site.

The Hanford Site was established in 1943 in response to the nation's defense needs during World War II. Hanford's initial mission was to produce plutonium for use in the fabrication of nuclear weapons. Over most of its over 50 years of operation, Hanford's mission has been a combination of energy-related research and military-related material production, the apportionment of which depended on the nation's changing defense needs (Becker 1990). In the late 1980s the Site's mission changed to environmental cleanup and economic transition.

Plutonium production involved construction and operation of eight single-pass nuclear reactors, one dual-purpose nuclear reactor, and associated auxiliary facilities along the Columbia River (100 Areas); fuel reprocessing and waste management facilities in the central plateau region of the Site, all of which were at least 8 km (5 mi) from the Columbia River (200 Areas); fuel fabrication and research facilities north of the city of Richland along the Columbia River (300 Area); and support facilities north of the city of Richland inland from the Columbia River (1100 Area) (Figure C.10). Throughout much of their early operating history the 100 and 300 Areas also were used for waste management. All combined, the 100, 200, and 300 Areas occupy about 28.5 km^2 (11 mi^2) (Area estimates here and below are from Neitzel 1999.). A concise and informative summary of Hanford's history is provided by Gray and Becker (1993). Gerber (1992) provides a more detailed overview.

The Site today also contains several other facilities and land areas that are mostly unrelated to Hanford's former defense mission. The Fast Flux Test Facility (currently deactivated) is located in the 400 Area inland from the Columbia River about 8 km (5 mi) north of the 300 Area. The 600 Area includes all other land areas not previously described. These lands are mostly undeveloped; however, they do include:

- an active commercial nuclear reactor and two unfinished commercial reactor complexes, which occupy about 4.4 km^2 (1.7 mi^2) of land and are operated by Energy Northwest (formerly the Washington Public Power Supply System), located east of the 400 Area, west of the Columbia River, and about 19 km (11.8 mi) north of the city of Richland
- a commercial, low-level radioactive-waste burial facility operated by U.S. Ecology on 0.4 km^2 (0.15 mi^2) of land leased by the state of Washington that is located south of the 200 Areas
- the Laser Interferometer Gravitational-Wave Observatory (LIGO) located west of Route 10
- the Environmental Restoration Disposal Facility (ERDF) located southeast of the 200 West Area. The ERDF receives waste resulting from the environmental cleanup of Hanford.
- an area in the southeast portion of the Site dedicated to the Hanford Patrol for training purposes.

The state also owns 2.6 km^2 (1.0 mi^2) of land just north of State Highway 240 and southeast of the 200 Areas that was acquired as a potential site for disposal of nonradioactive hazardous waste. A few hazardous and mixed waste burial sites are scattered throughout the 600 Area. A network of roads, railroads, and electrical transmission lines connect the above building complexes on Hanford.

Recently, two new facilities were built in the southeastern corner of the Site. A training facility for hazardous materials handling [Hazardous Materials Management and Emergency Response Training Center (HAMMER)] and the Environmental Molecular Sciences Laboratory (EMSL). A nuclear fuel fabrication facility, which is operated by the Siemens Nuclear Power Corporation, is located adjacent to the Hanford Site near the 1100 Area and just south of HAMMER.

Scattered parcels throughout much of the Hanford Site are Bureau of Land Management-withdrawn lands that have been transferred to the control of DOE-RL. Additionally, there are Bureau of Reclamation parcels on the North Slope that DOE-RL uses under a Memorandum of Agreement with Reclamation.[8] Reclamation retains the right to construct, operate, and maintain the irrigation infrastructure on these parcels.

Much of the land surrounding Hanford is used for agriculture. Ironically, use of Hanford for the production of defense nuclear materials protected much of the Site from industrial development, agriculture, and livestock grazing (Gray and Becker 1993; Gray and Rickard 1989).

8 Memorandum of Agreement between the Bureau of Reclamation and the then Atomic Energy Commission in regard to the transfer of rights for certain acquired and withdrawn lands on the Wahluke (North) Slope, dated February 27, 1957.

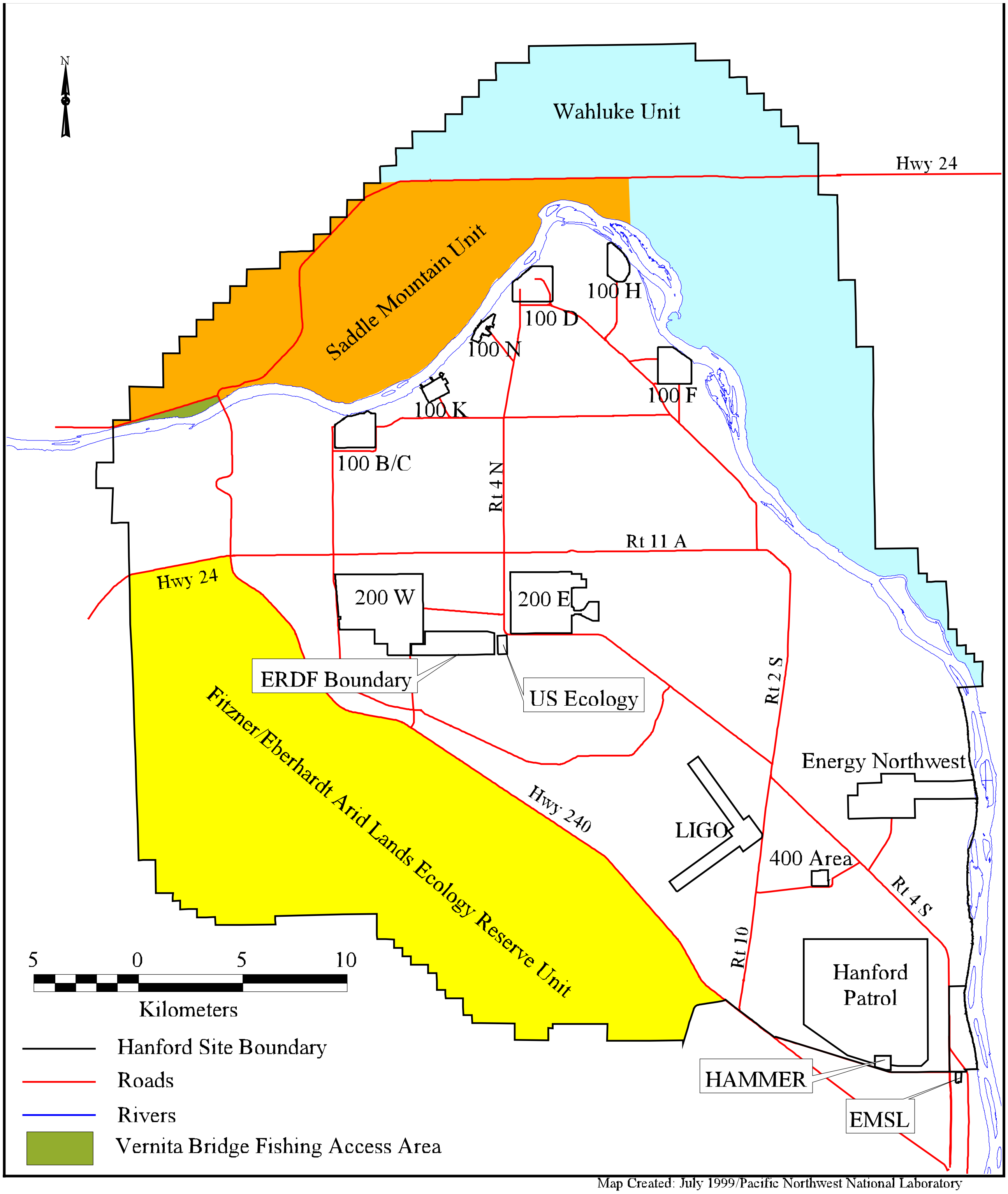

Figure C.10 Hanford Site Facilities and Land Use Areas

C.3.3 Areas Managed Principally for Their Biological Resource Values

Three land areas within the 600 Area are managed principally for their biological resource values (Figure C.10). The former ALE Reserve, now named the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit of the Hanford Reach National Monument/ Saddle Mountain National Wildlife Refuge, is a 312-km^2 (120-mi^2) area of relatively undisturbed shrub-steppe habitat southwest of State Highway 240. It is managed by the U.S. Fish and Wildlife Service, by condition of permit issued by DOE-RL, as a Research Natural Area. Property north of the Columbia River is managed by two different agencies under revocable use permits (Neitzel 1999). The DOE land north of the Columbia River and east of State Highway 24, which constitutes approximately 355 km^2 (137 mi^2), is managed by the U.S. Fish and Wildlife Service as a national wildlife refuge.

A smaller property (approximately 1.65 km^2) that lies north of the Columbia River, west of State Highway 24 and south of State Highway 223 is casually referred to as the Vernita Bridge Fishing Access Area and is currently managed by permit from DOE-RL to the Washington Department of Fish and Wildlife for recreational use. However, the long-term management of this land area, which also has biological resource value is, at the time of this writing, being negotiated among the DOE-RL, USFWS, and WDFW.

Two other wildlife areas border the Hanford Site: the Rattlesnake Slope Wildlife Area (managed by the WDFW) and the McNary National Wildlife Refuge (managed by the USFWS), which includes some islands of the Columbia River north of the city of Richland (Neitzel 1999).

C.3.4 Hanford Vegetation

The Hanford Site is located in the lowest and most arid portion of the Columbia Basin Ecoregion. The Site is located within the big sagebrush/bluebunch wheatgrass association, one of seven vegetation zones within the ecoregion (see Section C.2.2). Vegetation at higher elevations on Hanford largely typifies this association. For example, on Rattlesnake Mountain, Gable Mountain, Umtanum Ridge, and Yakima Ridge, communities with a big sagebrush overstory and a bluebunch wheatgrass understory are prevalent. In contrast, on the Columbia River plain, communities with a big sagebrush overstory and a Sandberg's bluegrass understory are prevalent. Spiny hopsage frequently co-occurs with big sagebrush on the plain and in a few areas occurs in monotypic stands. Winterfat replaces big sagebrush and spiny hopsage in some areas, as does bitterbrush in mostly sandy soils. Appendix D provides land cover maps that delineate Hanford's vegetation. Sackschewsky et al. (1992) provides a listing of vascular plants present on the Hanford Site. Recent work by The Nature Conservancy (Caplow and Beck 1996; TNC 1995, 1996, and 1998) has added to the number of documented plant species on the Site.

The Hanford Site is unique within the Columbia Basin Ecoregion because it is the only area where irrigated agricultural fields have been permitted to naturally recolonize for as long as 50 years. After 50 years, abandoned fields in the vicinity of White Bluffs and the old Hanford Townsite remain dominated by non-native annuals [e.g., cheatgrass, tumble mustard, and jagged chickweed (*Holosteum umbellatum*)] with little evidence of recolonization by native shrubs and herbs. The persistent dominance of these species reflects the vulnerability of shrub-steppe to invasions by introduced Eurasian species and the competitive ability of these non-native species. The abandoned old fields provide nesting habitat for western meadowlarks, horned larks, and long-billed curlews, and foraging habitat for Canada geese (*Branta canadensis*), California quail (*Callipela californica*), and ring-necked pheasants, as well as for mule deer.

The Hanford populus was relocated offsite in the early 1940s. Residents' shade trees were allowed to remain. Those trees located near the Columbia River provide critical day perches and night roosts for wintering bald eagles (Eisner 1991) and nest sites for great blue herons (*Ardea herodias*). Riparian vegetation is further described in Section C.3.7. Trees located away from the river provide nest sites for Bullock's (formerly northern) orioles (*Icterus bullockii*), western kingbirds, Swainson's hawks, red-tailed hawks, American kestrels, and other tree-nesting species.

Hanson and Eberhardt (1971) provide maps of the vegetation characteristic of the islands within the Hanford Reach for areas above the littoral zone. Dominant species included northern buckwheat (*Eriogonum compositum*), absinthe (*Artemisia absinthium*), lupine (*Lupinus* sp.), and thick-spiked wheatgrass (*Agropyron dasystachyum*) (see Table 3 in Hanson and Eberhardt 1971). In a more recent study, Salstrom and Easterly (1995), describe three different island upland communities (may be seasonally flooded). Plant dominants differed from those reported by Hanson and Eberhardt (1971). Differences could be due to different seasons of sampling or actual changes in composition during the intervening years.

C.3.5 Hanford Terrestrial Fauna

Several reviews on Hanford terrestrial fauna have been published (e.g., Downs et al. 1993; Fitzner and Gray 1991; Rickard and Poole 1989) as well as extensive treatments on particular portions of the Site (e.g., Rickard et al. 1988 on the ALE Unit). An overview of Hanford's fauna in relation to the rest of the Columbia Basin Ecoregion is provided in the paragraphs below.

Invertebrates—More than 1100 terrestrial and aquatic insect species are found on the Hanford Site (TNC 1995, 1996, 1998, 1999). In general, bunchgrass, rabbitbrush, and sagebrush communities seem to be preferred more by insects than cheatgrass communities. The major taxonomic groupings, as indicated by biomass estimates, are Coleoptera (beetles), Hymenoptera (ants, bees, and wasps), and Lepidoptera (moths and butterflies). Darkling beetles (Tenebrionidae) and ground beetles (Carabidae) are the most common beetles. Ants (Formicidae) are the most common family of the Hymenoptera, and moths are the most common lepidopterans (Downs et al. 1993). The above insects are an important food source for higher level consumers.

Herpetofauna—At least 9 species of reptiles and three species of amphibians have been documented on the Hanford Site (Table C.7) (TNC 1998). Payne et al. (1976) reported the presence of common garter snakes within a segment of the Columbia River between Priest Rapids Dam and River Mile 345.5 (i.e., just north of Richland, Washington); however, they did not provide a precise sampling location. Compared to other taxa, amphibians and reptiles have been little studied on the Hanford Site. The side-blotched lizard is by far the most abundant reptile and can occur over the entire Site (Downs et al. 1993; Marr et al. 1988); however, in a study by Marr et al. (1988), no lizards were captured in the hopsage/Sandberg's bluegrass community. Racers and gopher snakes are the most common snakes at Hanford (Fitzner and Gray 1991). Amphibians are found primarily in close association with riparian and wetland habitats.

Birds—Various publications have estimated the number of bird species that have been observed on Hanford. Fitzner and Gray (1991) reported 187 species, Landeen et al. (1992) 238 species, and most recently for the ALE Unit, the North Slope, and central Hanford combined The Nature Conservancy reported 154 species for the ALE Unit, 152 for central Hanford, and 195 for the North Slope (TNC 1998). The shrub-steppe-dependent species that occur on the Site include virtually all of those listed in Section C.2.3 as species typical of shrub-steppe in the ecoregion. Sage thrashers occur in low numbers and sage grouse have not been seen in recent years. Brewer's sparrows tend to be found only at high elevations on the ALE Unit within the threetip sagebrush communities. Sage sparrows and loggerhead shrikes are common. Other significant components of Hanford's upland avifauna include ferruginous hawks, bald eagles (*Haliaeetus leucocephalus*), burrowing owls, vesper sparrows, lark sparrows, grasshopper sparrows, long-billed curlews, and Swainson's hawks.

The 1997 bird survey of Central Hanford yielded 152 species, 57 of which were unique to Central Hanford in comparison to the ALE Unit (with 26 unique species) and the North Slope (with 77 unique species). The higher numbers of unique species on Central Hanford and the North Slope were attributed to the presence of the abundant riparian and wetland habitats. It was also noted that the Central Hanford surveys were of shorter overall duration and may have missed some of the winter resident species.

Additional bird survey data have been recorded from the Hanford Site Ecosystem Monitoring Project and from other occasional surveys and field studies. Those data are maintained in the Ecosystem Monitoring Project data files, but have not yet (September 1999) been integrated for the purpose of revising the Hanford Site bird species list.

Many insectivorous and piscivorous riverine and riparian species are found in riparian areas and on the shoreline of the Columbia River. Some of these, such as the bald eagle and great blue heron, use trees planted by early settlers along the Columbia River, as these provide night roosts, perches, and nest sites. Some species, such as the meadowlark

Table C.7 Reptiles and Amphibians Potentially Occurring on the Hanford Site

Scientific Name	Common Name
Reptiles	
Sceloporus graciosus	Sagebrush lizard
Uta stansburiana	Side-blotched lizard
Phrynosoma douglassii	Short-horned lizard
Masticophis taeniatus	Striped whipsnake
Coluber constrictor	Racer
Pituophis melanoleucus	Gopher snake
Thamnophis elegans	Western terrestrial garter snake
Hypsiglena torquata	Night snake
Crotalus viridis	Western rattlesnake
Chrysemys picta	Painted turtle
Amphibians	
Scaphiopus intermontanus	Great Basin spadefoot
Bufo woodhousii	Woodhouse's toad
Pseudacris (=Hyla) regilla	Pacific chorus (=treefrog) frog
Rana catesbeiana	Bullfrog

and loggerhead shrike, though they occur along the river, are much more common in shrub-steppe habitats (Downs et al. 1993). Waterfowl are abundant along the Hanford Reach where hunting is prohibited. As the Hanford Site is located in the Pacific flyway, many migratory birds use the Hanford Reach as a resting place during fall and spring migrations.

Mammals—Over 40 species of mammals species, all of which are listed in Section C.2.3 as mammals of the ecoregion [with the addition of the montane vole (*Microtus montanus*), Norway rat (*Rattus norvegicus*), and house mouse (*Mus musculus*) and the exclusion of the red fox, spotted skunk, mountain lion, and Columbian ground squirrel), have either been documented as occurring at Hanford (Fitzner and Gray 1991; Fitzner et al. 1992) or are identified by BRMaP as potential residents of the Site. Most of these species are small and primarily nocturnal and provide an abundant food source for larger predatory mammals, such as coyotes, and raptors. Large mammalian species that occur on the Site include Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) and Rocky Mountain elk (*Cervus elaphus nelsoni*). Elk are a relatively recent addition to Hanford Site wildlife, first appearing on the ALE Unit in 1972 (Rickard et al. 1977). The resident herd increased from approximately eight animals in 1975 to approximately 850 in 1999 (www.pnl.gov/ecology/ecosystem). Pygmy rabbits have not been observed on Hanford since 1984 (Fitzner and Gray 1991). Ord's kangaroo rat and the Washington ground squirrel may occur on the Hanford Site (i.e., on the North Slope). Both have yet to be documented by validated sightings (Rickard and Poole 1989); however, Payne et al. (1976) reported observing the kangaroo rat's characteristic track three miles downstream from Priest Rapids Dam on the Grant County side of the Columbia River. Certain species, such as Merriam's shrew, white-tailed jack rabbit, least chipmunk, yellow-bellied marmot, and sagebrush vole seem to be restricted in their distribution to the higher elevations of the ALE Unit (Fitzner and Gray 1991); however, Payne et al. (1976) reported observing yellow-bellied marmots along the Hanford Reach.

C.3.6 The Hanford Reach

The Columbia River within the Hanford Site is atypical of the rest of the post-dam Columbia River system in the United States in that, here, the river runs through an approximately 76-km (47-mi) segment extending from the upper end of McNary Dam Reservoir to Priest Rapids Dam—known as the Hanford Reach—that remains essentially free-flowing. Except for the Columbia River estuary downstream of Bonneville Dam, this makes the Hanford Reach the only unimpounded stretch of the Columbia in the United States. As a result, the Hanford Reach provides remnant free-flowing habitat for aquatic organisms that were present before the remainder of the Columbia River system was converted to reservoir or slackwater habitat.

Although unimpounded, flows through the Hanford Reach are regulated by releases at Priest Rapids Dam and other upstream dams (primarily Grand Coulee Dam and Canadian water storage projects). Thus, the ranges of daily and seasonal flows differ from pre-dam conditions. Daily average discharges through the Hanford Reach vary seasonally and typically range from about 1140 to 7070 m^3/sec (40,000 to 250,000 cfs). Additionally, the Federal Energy Regulation Commission has established minimum licensed flows of 1020 m^3/sec (36,000 cfs) at Priest Rapids Dam.

The variability of water velocity and depth and substrate characteristics within the Reach has resulted in a diversity of riverine habitats. Some habitats may be used by a wide variety of aquatic species during all or part of their life cycles, whereas, others are species specific. The general kinds of habitat of importance are (1) main channel, (2) deepwater, and (3) backwater or slough. Within the main channel, there are areas with a relatively uniform vertical profile and flow, as well as braided sections with numerous islands, rock ledges, and gravel bars. Water velocities in the main channel vary with dam discharge and typically range from 0.6–3.0 m/s (2–10 ft/s). Reduced velocities occur near the shoreline and provide resting areas for many fish species. Maximum depth of the river channel rarely exceeds 10 m (about 33 ft) during average discharges; however, several deepwater sites [15-20 m (49–66 ft)] provide holding areas for white sturgeon and adult fall chinook salmon. Backwater areas are characterized by shallow depths and low velocities. The river bed typically consists of sand, gravel, cobble, and large rock (Chapman et al. 1983, 1986), with cobble the dominant substrate except in backwater areas.

Gray and Dauble (1977) identified 43 species of fish as occurring in the Hanford Reach. Neitzel (1999) added one more to the list: the brown bullhead [*Ameiurus* (= *Ictalurus*) nebulosis]. Several species of salmonids (i.e., salmon, trout, and whitefish) use the Reach as migration routes to and from upstream spawning areas. Both fall chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*O. mykiss*) spawn in the Reach (Downs et al. 1993). Additional information on the significance of the Hanford Reach's fisheries is provided in Section C.4.3.

The cobble substrate and free-flowing habitat of the Hanford Reach also supports a diverse benthic community. All major freshwater benthic taxa are represented in the Columbia River. The aquatic insect larvae of caddisflies (Trichoptera), midge flies (Chironomidae), and black flies (Simuliidae) are the dominant taxa. Other aquatic invertebrates include limpets, snails, sponges, and crayfish (Downs et al. 1993). The microfloral communities are composed mainly of diatoms, generally one or two taxa dominate, and benthic microfloral productivity may exceed that of the phytoplankton (Neitzel et al. 1982).

C.3.7 Riparian Communities

In general, two kinds of riparian habitats occur on the Hanford Site, the extensive narrow corridors along the Hanford Reach shoreline and the isolated, disjunct patches along the ALE Unit springs/streams. The important spring/stream communities on the ALE Unit include Rattlesnake (Dry Creek), Snively, and Bobcat. The ALE Unit springs/streams habitats consist primarily of native trees, such as black cottonwood (*Populus trichocarpa*) and chokecherry (*Prunus virginianus*); shrubs, such as willows (*Salix* spp.); and an herbaceous understory. In addition to the springs and streams on the ALE Unit, several ephemeral springs/seeps are located across the Hanford Site. For example, Cold Creek and its tributary, Dry Creek, are ephemeral springs within the Yakima River system. Such isolated springs contain small populations of land snails, including a previously undescribed species (Frest and Johannes 1993). Because surface water is rare on Hanford, all the above springs are an important source of water for wildlife.

The riparian community on the Hanford Reach shoreline consists primarily of introduced trees, such as mulberry (*Morus alba*), Siberian elm (*Ulmus pumila*), and black locust (*Robinia pseudo-acacia*); native shrubs, such as willows; and emergent vegetation, such as reed canary grass (*Phalaris arundinacea*). In addition, a rich assemblage of perennial forbs and grasses occurs along the Hanford Reach shoreline and islands (Becker 1985; Salstrom and Easterly 1995). Substrate in the Hanford Reach riparian communities consists primarily of cobblestone. This substrate and the associated riparian plant communities are unique in the Columbia River ecosystem (Fickeisen et al. 1980a).

In the Hanford Reach, riparian vegetation is limited near the river's edge (Rickard et al. 1982). Most riparian vegetation occurs above the average annual flow line because variable discharge levels in the Hanford Reach prevent it from becoming established. Thus, the amount of shading and/or cover for aquatic organisms in the river is minimal. Riparian plant community compositions have been dynamic, which could be a response to the changing water level fluctuations resulting from the operation of Priest Rapids Dam (Rickard et al. 1982).

The ALE Unit and Hanford Reach riparian areas serve as a corridors for wildlife daily and seasonal movements and provide nesting, cover, and foraging habitat. Avifauna in these riparian areas is more diverse than in the surrounding shrub-steppe habitats (Rotenberry et al. 1979). These are valuable bird habitats, as most such stands outside of Hanford have not been protected from livestock grazing and are thus relatively scarce elsewhere in the ecoregion. By removing cattle from Rattlesnake Springs in the 1960s (Rickard and Cushing 1982), woody riparian habitat quickly expanded and now provides nest sites for many bird species, as well as forage for elk and mule deer. Additional discussion of Hanford Reach riparian habitat usage by wildlife is provided in Downs et al. (1993), Fickeisen et al. (1980b), and Rickard et al. (1982).

C.4 Regional and National Significance of Hanford's Biological Resources

C.4.1 Administrative Designations

The entirety of Hanford is designated a NERP by DOE (DOE 1994). This designation reflects the importance of Hanford in providing a "protected area for research demonstrations and education in ecology" (PNL 1977). The ALE Unit, one component of the Hanford NERP, is also designated a Research Natural Area. The ALE Unit provides opportunities for researchers, students, and educators to study and observe a relatively large and undisturbed ecosystem in which natural processes are retained (PNL 1993). The Research Natural Area designation also supports the state of Washington's Natural Heritage Plan (e.g., by providing a protected area for rare plant communities) (WDNR 1995).

In June 2000, the Hanford Reach, ALE Unit, Saddle Mountain Unit, and Wahluke Unit were proclaimed the Hanford Reach National Monument by presidential proclamation (65 FR 37253). The USFWS manages the monument.

C.4.2 Stemming the Decline of Shrub-Steppe

Current Trends—Washington is rapidly losing much of its remaining steppe habitat and losses are projected to be high for the next 50 years (Andelman and Stock 1994a). Oregon also is losing its remaining steppe habitat, but at a slower rate (Andelman and Stock 1994b). Dobler (1992) estimates that approximately 60% of the original acreage [4.2 million ha (10.4 million acres)] of steppe vegetation in Washington has been lost, primarily to agriculture. Much of what remains is either already degraded and fragmented or is threatened by development and agricultural expansion (Noss et al. 1995). Moreover, Noss et al. (1995) recently concluded that:

- native shrub- and grassland-steppe (steppe in which the shrubs are not the most conspicuous part of the flora) within Washington and Oregon is an endangered ecosystem, in that it has experienced between an 85% to 98% decline since European settlement

- ungrazed sagebrush-steppe in the Intermountain West is a critically endangered ecosystem, in that it has experienced greater than a 98% decline since European settlement.

Dobler's (1992) estimate of steppe vegetation losses for Washington compares favorably with the ICBEMP data for vegetation losses across the entire Columbia Basin Ecoregion (see Section C.2.2 and Table C.4). Dobler's estimate is based on an analysis of Landsat Thematic Mapper (TM) data by the WDFW). The WDFW's unsupervised (i.e., ground-truthing was not used to calibrate the spectral data) land cover classification of the TM data is shown in Figure C.11. Non-potential shrub-steppe (SS) indicates that those areas classified as grass/bare are not likely shrub-steppe (WDFW's classification scheme does not distinguish areas of steppe which at the end of succession will contain large shrubs from those areas of steppe that will never contain large shrubs.).

The area shown in Figure C.11 covers only a portion of eastern Washington. To the west it includes some areas that are not part of the Columbia Basin Ecoregion and to the east, north, and south it omits some areas. The data represent portions of four satellite scenes: two scenes from June 9, 1986, and two scenes from July 18, 1986 (the latter scenes represent areas west of Hanford) (S. Snyder, WDFW, pers. comm., 1996). The advantage this data set has over the ICBEMP data is that TM data enable a mapping unit size of about 30 m^2 versus the 1 km^2 of the AVHRR data.

Where they overlap in coverage, the WDFW and ICBEMP data indicate a similar pattern of the current distribution and extent of steppe vegetation across eastern Washington (to the extent that 1986 and 1990 data are current). Overall, the WDFW data depict a higher degree of fragmentation of the remaining steppe vegetation; however, this is not unexpected given that it has a smaller mapping unit size. Both data sets (compare Figures C.8 and C.11) indicate that the Hanford Site and Yakima Training Center (located to the west of Hanford) combined contain the largest remaining remnant of steppe vegetation in the Columbia Basin Ecoregion. Moreover, the figures also indicate that these two sites still retain some degree of ecological continuity. If conversion and fragmentation of the remaining steppe outside these two sites continues unabated, the importance of this connectivity may increase over time.

The Role of Hanford—Ironically, use of Hanford for the production of defense nuclear materials has protected much of the Site from industrial development, agriculture, and livestock grazing (Gray and Becker 1993; Gray and Rickard 1989). The Hanford Site retains the largest remaining blocks of relatively undisturbed shrub-steppe in the Columbia Basin Ecoregion (Smith 1994) (Geographically, Hanford is in that portion of the Columbia Basin Ecoregion within which the potential steppe vegetation would be predominately shrub-steppe.). Shrub-steppe plant communities on Hanford that have a high regional significance are those that are (1) extensive on Hanford relative to their extent in the rest of the ecoregion, and/or (2) are of high quality on Hanford relative to their counterparts elsewhere in the ecoregion (Table C.8).

Figure C.11 shows that about 86% of Hanford can be classified as shrub-steppe. The perhaps less accurate ICBEMP data indicate that Hanford has lost only 7-8% of its historic shrub-steppe cover (Table C.3). Although at a finer scale of vegetation mapping it can be shown that significant portions of what these remotely sensed data sets identify as shrub-steppe contain extensively non-native species (e.g., cheatgrass), the estimates of remaining shrub-steppe at Hanford are reasonably accurate when only the developed portions (i.e., industrial and historic agricultural areas) are removed from the estimate. The ICBEMP data also can be used to illustrate, at least in a coarse manner, how Hanford's relative significance in regard to the presence of shrub-steppe has changed as the lands within much of the remainder of the Columbia Basin Ecoregion have been extensively converted to human use. Thus, the percentage that Hanford contributes to the existence of shrub-steppe within the ecoregion has increased by about 250% since European settlement (Table C.4).

Hanford's importance as a refuge for the shrub-steppe ecosystem is not based strictly on the ecosystem's rarity. In many places on Hanford, the shrub-steppe is relatively free of non-native plant species and/or is extensive enough to retain characteristic populations of shrub-steppe birds, mammals, and plants. In an analysis of avian diversity within eastern Washington, Smith (1994) predicted species distributions based on habitat associations.

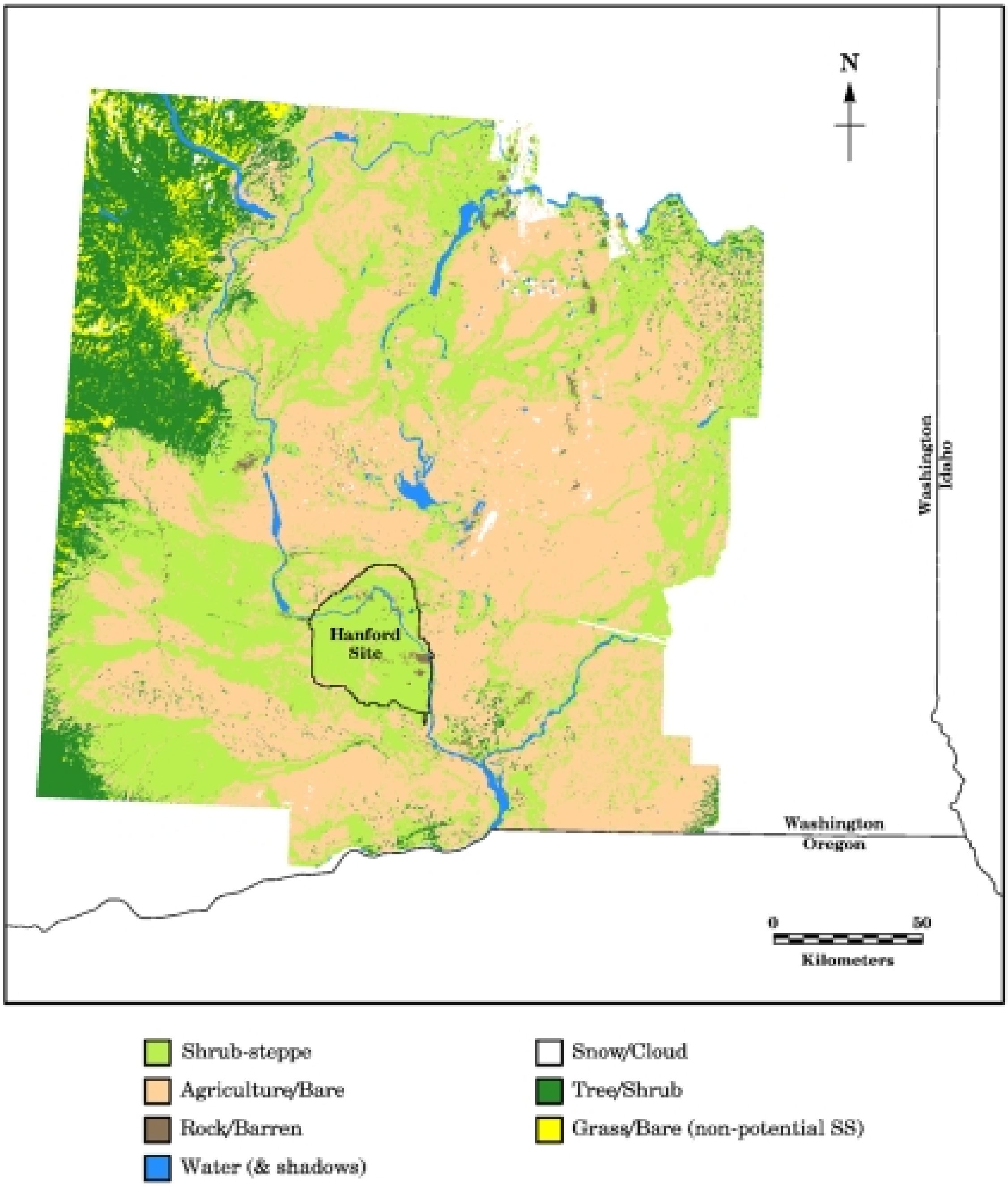

Figure C.11 Current Distribution and Extent of Land Cover Classes Within A Portion of the Columbia Basin Ecoregion (Source: Electronic version obtained from the Washington Department of Fish and Wildlife)

Table C.8 Shrub-Steppe Plant Communities on the Hanford Site in Relation to Their Status Elsewhere in the Shrub-Steppe of the Columbia Basin Ecoregion of Washington

Plant Community	Geographic Extent on Hanford	Stand Quality[a]	Regional Significance	Threat from Hanford Activities	Comments
Big sagebrush/ bluebunch wheatgrass	Major	High-Low	High	Low	Good quality stands on deep soil
Big sagebrush/ Sandberg's bluegrass	Major	High-Low	High	High	
Stiff sagebrush/ Sandberg's bluegrass	Minor	Mod.	Low	Low	Scarce on the Hanford Site
Threetip sagebrush/ bluebunch wheatgrass	Minor	High	High	Low	
Black greasewood/ alkali saltgrass (*Distichlis stricta*)	Minor	Mod	High	Low	Sodium accumu-lator; phreatophyte
Spiny hopsage/ Sandberg's bluegrass	Minor	Mod.	High	Mod	Potassium accumu-lator; relict stands
Winterfat/ Sandberg's bluegrass	Minor	Mod.	High	Low	
Rock buckwheat (*Eriogonum sphaerocephalum*)/ Sandberg's bluegrass	Minor	Mod.	High	Low	
Thyme buckwheat (*Eriogonum thymoides*)/ Sandberg's bluegrass	Minor	High	Mod.	Low	
Bitterbrush/ needle-and-thread	Major	Mod-Low	High	High	Bitterbrush is regarded as high quality forage for mule deer

[a]Stand quality judged by presence of non-natives (e.g., few non-natives = high quality).

His analysis indicates that Hanford possesses suitable habitat for the highest number of:

- species that breed within eastern Washington
- shrub-steppe species of concern (those that are listed or are candidates for listing by the federal government, Washington State, and or Oregon State governments)
- species that nest in big sagebrush.

Hanford's shrub-steppe also supports, or may potentially support, a number of obligate species (i.e., those that are dependent on a specific habitat type for at least a portion of their life cycle; for a discussion of avian obligates, see Section C.2.3), as well as other species that seem to be associated strongly with shrub-steppe. Notable examples of obligate species that have dramatically declined in Washington and Oregon, and that may occur on Hanford, but are either not currently known to occur or only rarely occur there, are the pygmy rabbit and sage grouse, respectively. The sage sparrow is also an obligate species; it is present in significant numbers on the Hanford Site. Examples of other species that seem to be associated strongly with shrub-steppe and that are known to occur on Hanford include the ferruginous hawk, loggerhead shrike, striped whipsnake, and Columbia milkvetch (*Astragalus columbianus*).

C.4.3 Last Free-Flowing Stretch of the Columbia River

The Hanford Site contains significant riparian, wetland, and riverine habitat associated with the Hanford Reach of the Columbia River. It contains riparian habitat, free-flowing riffles, gravel bars, oxbow ponds, and backwater sloughs, which are otherwise limited in occurrence in the Columbia River system (USFWS 1980; NPS 1994). In 1980, the USFWS inventoried exceptional fish and wildlife habitats within the state of Washington. Based on the USFWS criteria of nationally significant and unique ecosystems, the Hanford Reach section of the Columbia River ranked second in the state (USFWS 1980). Also, the ecological importance of the Hanford Reach and the DOE-administered (but leased) land north and of the Columbia River (Wahluke or North Slope) has contributed, in large measure, to a recent determination that these areas should be permanently protected (NPS 1994).

The river channel within much of the Hanford Reach contains islands (over 20), submerged rock ledges, and gravel bars. The resultant complex network of pools, riffles, and backwater areas supports an aquatic community unique to the Columbia River basin. For example, native species of cyprinids (i.e., carps and minnows), catostomids (i.e., suckers), and salmonids require higher velocity areas for spawning, while adjacent low-velocity areas provide essential rearing habitat. Thus, the increased habitat complexity within the Hanford Reach supports a wider range of life stages and greater species diversity than the more uniform habitat found within the reservoir complex. In contrast to backwater habitat within the reservoir complex that accumulate sediments and may be filled over time, reach backwater areas or sloughs are periodically flushed during high flow periods. The seasonal flushing action scours the substrate, exposing gravel/cobble beds important for fish spawning and invertebrate production.

Backwater areas within the Hanford Reach provide important spawning and rearing habitat for many aquatic species, including bass (*Micropterus* spp.), sunfish (*Lepomis* spp. and *Pomoxis* spp.), and catfish (mostly the brown bullhead) that migrate from downstream areas to the Hanford Reach each year for spawning (Page et al. 1982). These backwater areas also are important nursery areas for juvenile anadromous salmonids and resident native populations of cyprinids and catostomids. Backwater areas also are likely important breeding areas for amphibians, as well as important habitat for populations of mollusks (e.g., *Anadonta* spp.).

The Hanford Reach is regionally significant in that it provides important habitat for several species of anadromous salmonids. The Hanford Reach contains the last major mainstem spawning habitat in the Columbia River system for fall chinook salmon. Hanford Reach fall chinook represent a healthy population of the most inland fall chinook salmon stock in the Pacific Northwest and California (Huntington et al. 1996). Construction of 11 hydroelectric dams on the Columbia River and 6 dams on the Snake River between 1939 and 1975 blocked access or inundated most spawning sites used historically by fall chinook salmon. Up to 80% of the total run of adult fall chinook salmon returning to the mouth of the Columbia River spawn in the Hanford Reach (Dauble and Watson 1990). In recent years, nearly 60% of the return adult fall chinook salmon that pass McNary Dam spawn naturally in the Hanford Reach (NPS 1994). The Hanford Reach also serves as a migration corridor for other species/stocks of anadromous salmonids [i.e., sockeye salmon (*Oncorhynchus nerka*) and spring/summer chinook salmon] and provides important rearing habitat for juvenile steelhead trout and sockeye salmon from upstream production areas.

In addition, the Hanford Reach provides significant breeding habitat for several resident fish, such as the white sturgeon (*Acipenser transmontanus*). The white sturgeon is a long-lived species that requires flowing water to reproduce. White sturgeon spawning habitat downstream of the Hanford Reach is limited to small areas just below each hydroelectric project. Within the Hanford Reach, white sturgeon spawning has been recently documented just below Priest Rapids Dam and at a second location above Vernita Bridge (NPS 1994). Other locations are probable (Fickeisen 1980a). The Hanford Reach and the lower Columbia River downstream of Bonneville Dam support the largest white sturgeon populations in the Columbia River system. In addition to white sturgeon, mountain whitefish (*Prosopium williamsoni*), and sandroller (*Percopsis transmontana*) are two native species that may be present in much higher numbers in the Hanford Reach than in impounded areas (NPS 1992).

A number of non-fish, species of concern from a variety of taxa occupy the Hanford Reach. For example, the native molluscs Columbia pebblesnail (*Fluminicola columbiana*) and the shortface lanx

(*Fisherola nuttalli*), both state candidate species, can be found in the Reach. The distribution of the populations of these species may now be fragmented within the Columbia River basin, and populations are typically limited to headwater streams and unimpounded areas within larger rivers. The state endangered Columbia yellowcress (*Rorippa columbiae*) occurs in scattered locations along the wet shoreline of the Reach (Downs et al. 1993). The federal and state threatened bald eagle rests and forages along the Reach during its overwinter stay. Additionally, several species of recreational importance, such as the Canada goose and other waterfowl, also use this stretch of the river, its islands, and riparian corridor for portions of their life cycle.

Recent surveys by The Nature Conservancy (Salstrom and Easterly 1995; TNC 1996) identified six areas along the south shore and islands of the Hanford Reach that represent regionally significant occurrences of Columbia Basin low-elevation riparian wetlands. Most comparable sites have been permanently flooded by the existing reservoir system of the Columbia and Snake rivers. The six areas are: China Bar, Wahluke Bend Islands (2 and 3; see Figure C.9) and Point Bar, Locke Island, White Bluffs Slough, 100-F Area Slough, and the Hanford Townsite Slough.

Future regulatory actions associated with the listing of aquatic species under the Endangered Species Act may impact the management of aquatic species in the Hanford Reach. For example, upper Columbia River steelhead was recently listed as endangered and Snake River Basin steelhead was listed as threatened under the Endangered Species Act. Thus, any activity along the Hanford Reach that may adversely affect Snake River populations will need to be carefully scrutinized before implementation. Because the Hanford Reach may serve as migration corridors for other salmonids of regional importance [e.g., bull trout (*Salvelinus malma*) and steelhead], new listings of species in the Columbia River watershed, particularly those upstream of the Hanford Reach, may warrant similar scrutiny of Hanford activities.

C.4.4 Rare Habitats on the Hanford Site

Other riparian and wetland areas not directly associated with the Hanford Reach are scattered across the Hanford Site. These areas include a mix of small, naturally occurring, cold-desert springs and streams (see Section C.3.7), artificial wetlands created by irrigation runoff (north of the Columbia River), and a variety of other temporary water bodies that result from waste-water discharges (Neitzel 1999; Downs et al. 1993). The springs and streams and their riparian vegetation provide water, forage, cover, and breeding sites for wildlife within arid portions of the Hanford Site (Downs et al. 1993). The presence of riparian and wetland areas also is important because of the increased habitat diversity they provide. Because of their relative isolation, the springs and streams may contain previously unknown endemic species or unique genotypes (Frest and Johannes 1993).

The Hanford Site also contains a diversity of other rare terrestrial habitats such as riverine islands, bluffs/cliffs, basalt outcrops, and sand dunes (Downs et al. 1993). Sand dunes, especially, have received little investigation, and could contain several fauna and flora species of concern.

C.4.5 Endemic Plant Species

Several plant species grow on and around the Hanford Site that are not known to occur anywhere else. Most are confined to the basalt hills and ridges, such as rosy balsam root (*Balsamorhiza rosea*), Hoover's desert parsley (*Lomatium tuberosum*), Columbia milkvetch, basalt milkvetch (*Astragalus conjunctus* var. *rickardii*) and Umtanum desert buckwheat (*Eriogonum codium*). This last species does have other varieties that occur elsewhere. The Hanford population is a northern range extension for the species (TNC 1998). White bluffs bladderpod (*Lesguerella tuplahensis*) is apparently restricted to a narrow zone along the crest of the White Bluffs located on the east shoreline of the Columbia River. At least in some cases, the above plants seem to be uniquely adapted to the rooting substrates in the locations in which they occur (Caplow and Beck) 1996.

C.4.6 Hanford Biodiversity

One of the first steps toward conserving biodiversity is to conduct floral and faunal inventories at appropriate geographic scales (Knopf and Samson 1994). Effective biodiversity conservation relies on accurate information about species richness (i.e., the number of species), how species richness changes over different spatial scales, and the relative abundance of species. Recently, TNC, in cooperation with DOE-RL, implemented a detailed inventory of Hanford's biodiversity. The need for such a study was described by TNC as follows (TNC 1995):

> The DOE needs an accurate account of the rare species and ecosystems present on the Hanford Site in order to make informed decisions about future land uses. Biological studies undertaken in the past at Hanford have been primarily project- or species-specific. These studies have contributed enormously to the body of knowledge on Hanford, but have not included a large-scale, detailed inventory of the rare species and ecosystems present on the Site.

The results of TNC's 1994, 1995, and 1997 inventories (TNC 1995, 1996, 1998, 1999) are informative as to the nature of Hanford's biodiversity. Highlights of the inventories include documentation of the following:

- 48 plant community element occurrences of 17 terrestrial elements (community types)
- 6 element occurrences of wetland/aquatic communities
- 112 populations of 28 rare plant taxa, 2 species and 1 variety new to science
- 1121 taxa of invertebrates, 40 species and 2 subspecies new to science
- 368 butterfly and moth taxa
- 3 species of amphibians
- 9 species of reptiles
- approximately 200 species of birds
- 16 mammal species.

Because the inventories focused on specific taxa and geographic areas, these results provide only a partial picture of Hanford's potential biodiversity (TNC 1995, 1996, 1998, and 1999). In assessing the relevance of their findings TNC concluded (TNC 1996):

> From a conservation standpoint, the Hanford Site is a vital—and perhaps the single most important—link in preserving and sustaining the biodiversity of the Columbia Basin's shrub-steppe region.

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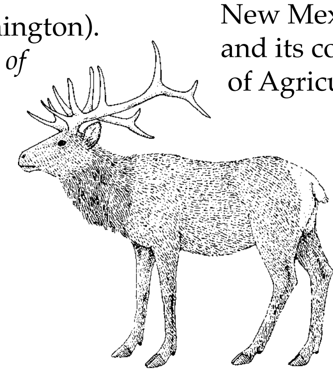


Appendix D

Hanford's Biological Resources: Geographic Information System-Based Resource Maps, Species of Concern Data Tables, and Their Technical Basis

This appendix provides detailed information about Hanford's biological resources. The best available data were used to prepare resource descriptions and to conduct data analyses. Resource data are depicted in two main ways: Geographic Information System (GIS)-based map layers that spatially depict resource occurrence and tabular information (principally associated with species of concern data).

These data represent a snapshot in time, and moreover, the degree of data accuracy differs across location and taxa; for example, although about 10% of the upland areas of the Hanford Site have been surveyed for rare plants, survey intensity varied across this area (Caplow and Beck 1996). Throughout Appendix D, there has been an attempt to identify missing data and assess the accuracy of available data. This information can be used to set priorities for future biological diversity inventory needs at the Hanford Site. For now, data gaps and the degree of data reliability must be accounted for when using and interpreting the available data as a basis for management decisions.

The information presented in this Appendix concentrates on Hanford habitats, plant communities, and species of concern. The presentation begins, however, with a brief description of the relevance of Hanford's relationship to the Columbia Basin Ecoregion and the availability of data to determine the significance of Hanford's role within this ecoregion.

Contents

Figures

Tables

D.1 Columbia Basin Ecoregion

The Hanford Site is located within the Columbia Basin Ecoregion. The boundaries of this ecoregion, and the character and condition of the natural resources contained therein, provide the relevant context for assessing management prescriptions affecting Hanford's biological resources. These boundaries are important because an ecosystem management approach requires that ecological (versus administrative) boundaries be used when identifying biological resources, their relative importance, and appropriate management goals and objectives.

To provide the ecological context for Hanford's biological resources, information on the ecoregion's current land cover, potential species diversity, and ownership/protection status is needed. At this level of regional analysis, use of satellite imagery is necessary to gain information about land cover at large geographic scales. The imagery is classified into corresponding land cover classes and depicted in a GIS-based map layer. Three sources of satellite imagery data were evaluated for their usefulness in defining Hanford's regional ecological context: Washington Department of Fish and Wildlife data that covered only a portion of eastern Washington, Interior Columbia Basin Ecosystem Management Project (ICBEMP) data for the entire ecoregion (only in part based on satellite imagery), and Washington Gap Analysis Project data for Washington.[1] There are advantages and disadvantages with each of the data sets.

The ICBEMP data were developed to support a project whose coverage was greater than the Columbia Basin Ecoregion. The satellite imagery data, collected in 1990, was modified by the use of successional models and other factors. The mapping unit size is crude and cover class delineation fairly broad. Besides current land cover information, the available ICBEMP data also included historic land cover data (i.e., pre-European).

The Washington State Gap Analysis Project, as part of a nationwide program administered by the U.S. Geological Survey's Biological Resources Division, has mapped existing land cover (Cassidy et al. 1997) for Washington State and breeding distributions of all terrestrial vertebrates. The information was used to identify ecosystems, species, and areas having high vertebrate diversity and that lack representation in the current network of reserves managed either entirely, or in part, for biodiversity.

The conclusions and management implications from the Washington Gap Analysis Project serve to focus regional concerns on steppe zones in the state and demonstrate the regional importance of Hanford lands to biological resource conservation. The three Washington vegetation zones with highest Conservation Priority Indices (CPIs) are located in the steppe, and seven of nine zones with high or moderately high CPIs are in steppe zones. The section on Conclusions and Management Implications of the Washington Gap Final Report (Cassidy et al. 1997) states that, "The buffer areas around Hanford that are currently managed as refuges are the Saddle Mountain Unit, the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit, and the Wahluke Unit. These three reserves combined comprise 35% of all Status 1 and Status 2 lands in the Columbia Basin, and their removal from the reserve system (which is under consideration) would have a considerable negative impact on the conservation status of the Columbia Basin and on most Basin-dependent species."

As better GIS data become available, use and interpretation will be improved. The data, whether its coverage is state or region wide, will hopefully enable the following determinations:

- extent of a particular cover type present state-/region-wide (as compared to prehistoric levels)
- percentage of the cover types state/region/wide that Hanford possesses
- landscape-level estimates of fragmentation, block sizes, and potential wildlife movement corridors
- centers of potential high native biodiversity and their protection status.

Appendix C contains an analysis of the available regional data (i.e., the WDFW and ICBEMP data). The ICBEMP data enabled a comparison of historic and current land cover class data.

[1] Gap analysis is a geographical approach to the protection of biodiversity that matches predictions of habitat association and distribution for many different species with the distribution of protected areas to assess where there are "gaps" in the protection of biodiversity (Scott et al. 1993). The Gap Analysis Project is operated out of the Washington Cooperative Fish and Wildlife Research Unit at the University of Washington. The project involves a number of agency, university, and institution cooperators.

D.2 Hanford Biological Resources

This section describes Hanford's biological resources in terms of land cover classes, habitat-based resources, plant communities, administrative areas, and species of concern. The resource information is grouped into these categories to facilitate presentation of data and associated technical basis concerning their derivation and use.

D.2.1 Land Cover Classes

The starting point for deriving most GIS-based map layers in the BRMaP is a land cover map. A land cover map identifies what actually exists on the surface at the time data are collected. The map is a combination of vegetation associations, land forms, and human structures and residuals. It differs from a potential vegetation map in that it portrays what currently exists and not what might be expected in the future. Potential vegetation, however, is still a useful piece of information for biological resource management planning; therefore, where possible, this information layer and others are retained in the GIS database in a manner that enables different geographic areas to be assigned multiple attributes.

D.2.1.1 Hanford Site Land Cover Classes

The Hanford land cover class map (Figure D.1) is a composite map of information drawn from 1987 and 1991 aerial photographs and field survey information and mapping obtained from The Nature Conservancy (TNC) of Washington.[2] The 1991 photographs were obtained from the Benton County Land Use Planning Office and, thus, only included the portion of the Hanford Site that falls within the Benton County boundaries. Field assessments and mapping were conducted in 1993 to refine the information obtained from the aerial photographs. TNC surveyed and mapped land cover on the ALE Unit, the North Slope, and central core of Hanford during 1994, 1995, and 1997. In general, mapping unit resolution for these portions of the cover map is about 0.8 ha.

To arrive at the BRMaP classification, the following four attributes of the data were considered important to retain:

1. The identity of individual TNC classes, though combined in many cases to form more inclusive classes within the land cover map, was retained within the GIS database for use in other resource mapping layers (see below)

2. Where raw data enabled, and class description was similar for each data source, classifications for the ALE Unit, the North Slope, and Central Hanford were standardized

3. Where possible, areas with understories dominated by native bunchgrasses were distinguished from areas dominated by non-native grasses. Also, where possible and relevant, a cover class attempted to include both the dominant shrub(s) and the dominant grass

4. Because much of the central core was mapped as mosaics of two to four cover types, the classification was based on the dominant shrubs and the relative percentage of each cover class in the mapped polygon. The understory component was most often classified as bunchgrasses.

TNC data generally included a finer spatial breakdown in what constituted the dominant grass within areas containing the same dominant shrub(s). To address this and to simplify the classification scheme BRMaP used three conventions:

1. For each dominant shrub class, where both appropriate and possible, areas with a dominant, native grass understory were distinguished in the classification from areas with a dominant, non-native grass understory (e.g., spiny hopsage/bunchgrasses and spiny hopsage/cheatgrass).

2. If data indicated the shrub was associated with only one species of native bunchgrass, the specific species was identified as part of the classification (e.g., black greasewood/Sandberg's bluegrass).

[2] The existing cover class data for each area were provided by TNC, digital data and correspondence, 1995, 1998, 1999); TNC's reports on the biodiversity of Hanford (TNC 1995, 1996, 1998) contain data on potential plant community types but not on existing cover classes.

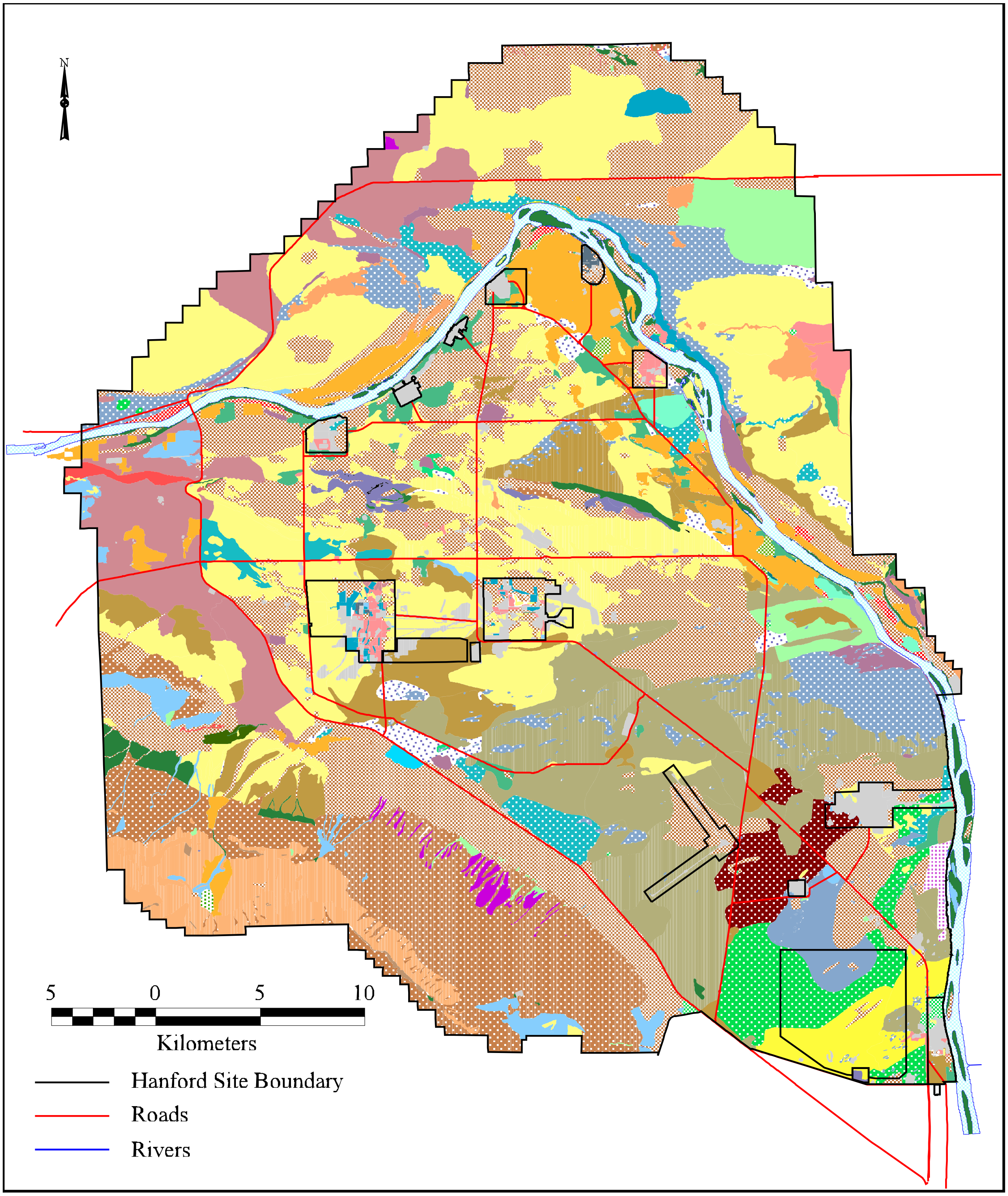


Figure D.1 Distribution and Extent of Land Cover Classes Across the Hanford Site (Map)

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 D.1 Distribution and Extent of Land Cover Classes Across the Hanford Site (Legend)

3. If the data indicated the shrub may be associated with more than one species of native bunchgrass (generally TNC data), the general classification of bunchgrasses was used (e.g., the spiny hopsage/bunchgrasses class actually consists of areas where understories are dominated by one of three different native bunchgrasses).

Again, as above, the identity of specific TNC map units was retained for use in other data layers, as needed. The BRMaP cover class map uses "rabbitbrush" as a generic category to refer to either species.

As noted above, accurate identification of the understory is limited with aerial photography. Moreover, the central core of Hanford is, in many areas, heterogeneous with respect to both dominant shrub and dominant grass. To address uncertainties about grasses, the grass composition for many areas on the land cover map was identified as bunchgrasses-cheatgrass to indicate the heterogeneity of the understory (i.e., at some locations within these particular land cover classes cheatgrass may predominate in the understory and at other locations a species of native bunchgrass may predominate). Shrub species heterogeneity occurs particularly in areas that are in ecological succession (mostly a result of the 1984 fire). These areas also contain a mosaic pattern of dominant grasses (Downs et al. 1993), and in many cases, areas are mapped as mosaics containing more than one distinguishable cover type.

Previous maps of the site (Downs et al. 1993) included two cover classes that were associated with open/flowing water and the immediately adjacent vegetation (i.e., that vegetation found in close association with permanent or at least seasonally intermittent surface water): water and riparian. The riparian cover class on these earlier maps was associated with both flowing and standing water; however, riparian vegetation is more traditionally associated with just flowing water. BRMaP reclassified the water and riparian cover classes in the following ways as shown in Figure D.1:

- portions of the original water cover class associated with flowing water are now classified as "Riverine Wetlands and Associated Deepwater Habitats"
- portions of the original riparian cover class associated with flowing water are retained as the new "Riparian" cover class
- the remaining areas of standing water and associated vegetation are now classified as "Non-riverine Wetlands and Associated Deepwater Habitats."

This reclassification facilitates comparisons with WDFW and USFWS wetland/riparian habitat classifications (see Sections D.2.2.2 and D.2.2.4). The identification of flowing water was based on the water data layer associated with the United States Geological Survey's topographic maps.

D.2.1.2 Industrial Areas

As a result of recent environmental restoration and site development activities, the pace of human-related disturbances that alter the cover class characteristics of the land has quickened at Hanford. The future portends the continuation of this trend, at least in certain areas of the site. The industrial areas of Hanford include the 100, 200, 300, 400, and 1100 Areas (see Figure D.2). These areas are shown (unlabeled) on Figure D.1. Because of the potential for rapid alteration of the landscape within these areas, the Ecological Compliance Assessment Project (now the Hanford Biological Resources Laboratory) has mapped changes in the land cover classes for each area annually since 1994.

Figures D.3 through D.11 depict the land cover classes and species of concern sightings within Hanford's industrial areas (except the 1100 Area) as mapped by the Hanford Biological Resources Laboratory's 1995 baseline surveys. Cover classes are essentially the same as used in Figure D.1 with minor exceptions. Areas dominated by Russian thistle are mapped separately from the other disturbance categories (i.e., buildings, parking lots, etc.). The boundaries of individual cover class occurrences were mapped by a Global Positioning System (GPS) to an accuracy of 2 m (6.6 ft). The smallest mapped area was about 0.09 ha (900 m^2).

D.2.2 Habitat-Based Resources

One of DOE-RL's program-wide biological resource management goals is to expand the focus of biological resource management from threatened and endangered species and their critical habitat needs to include a broader array of fish, wildlife, plants, and habitats (see Chapter 2.0). The focus

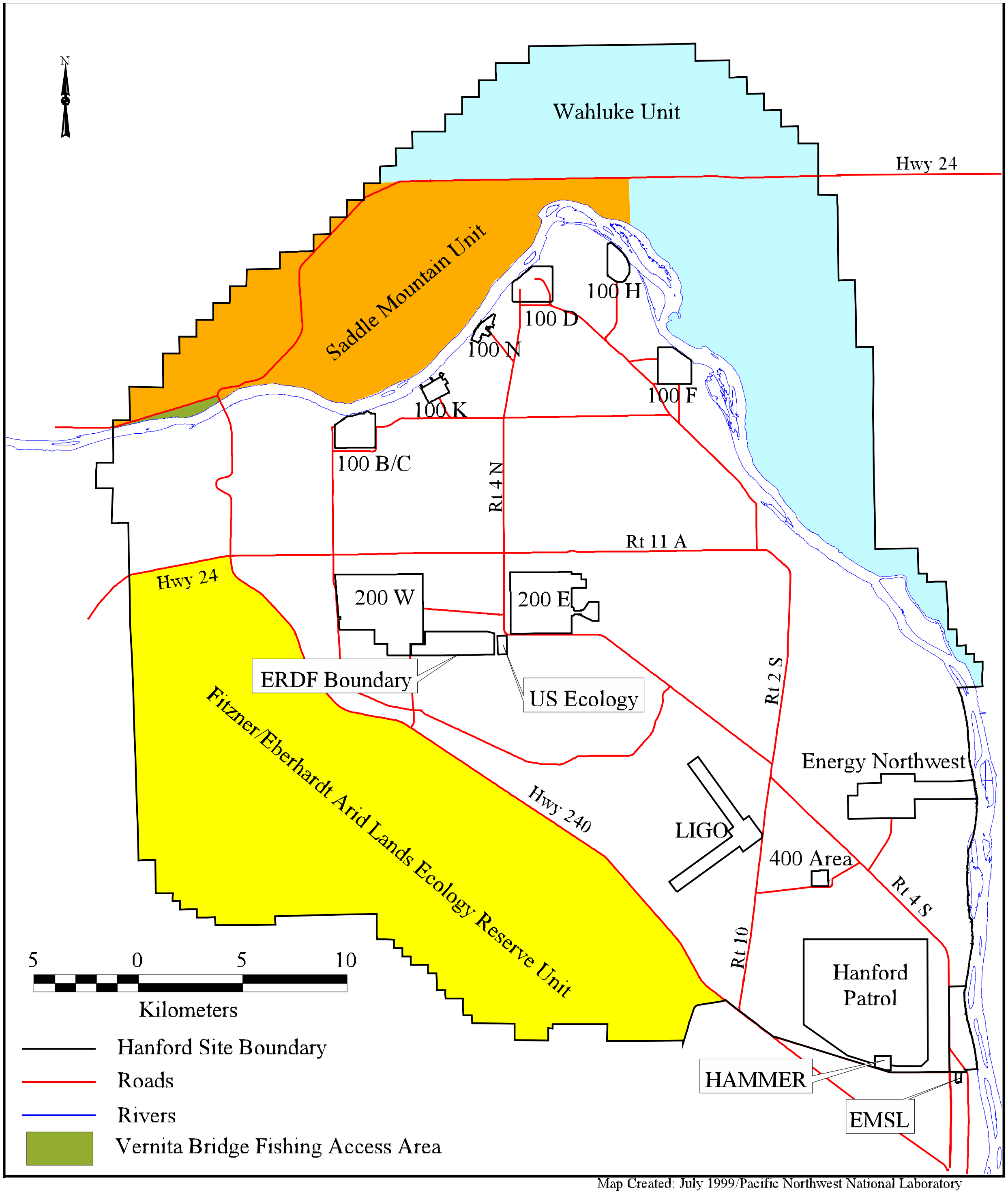


Figure D.2 Hanford Site Facilities and Land Use Areas (ERDF = Environmental Restoration Disposal Facility, LIGO = Laser Interferometer Gravitational-Wave Observatory, HAMMER = Hazardous Materials Management and Emergency Response Training Center, EMSL = Environmental Molecular Sciences Laboratory; *Energy Northwest formerly was the Washington Public Power Supply System)

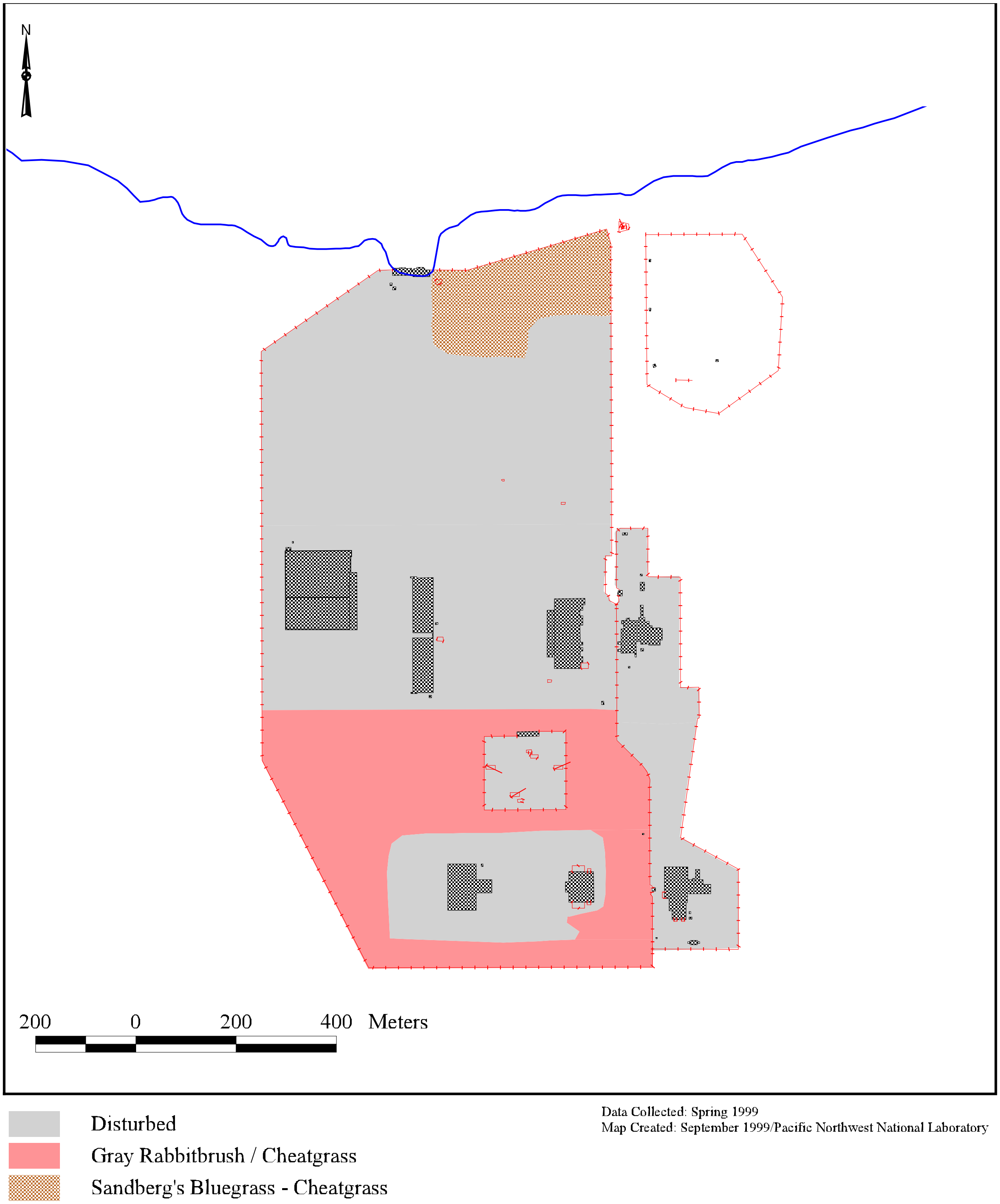


Figure D.3 100 B/C Area Land Cover Classes

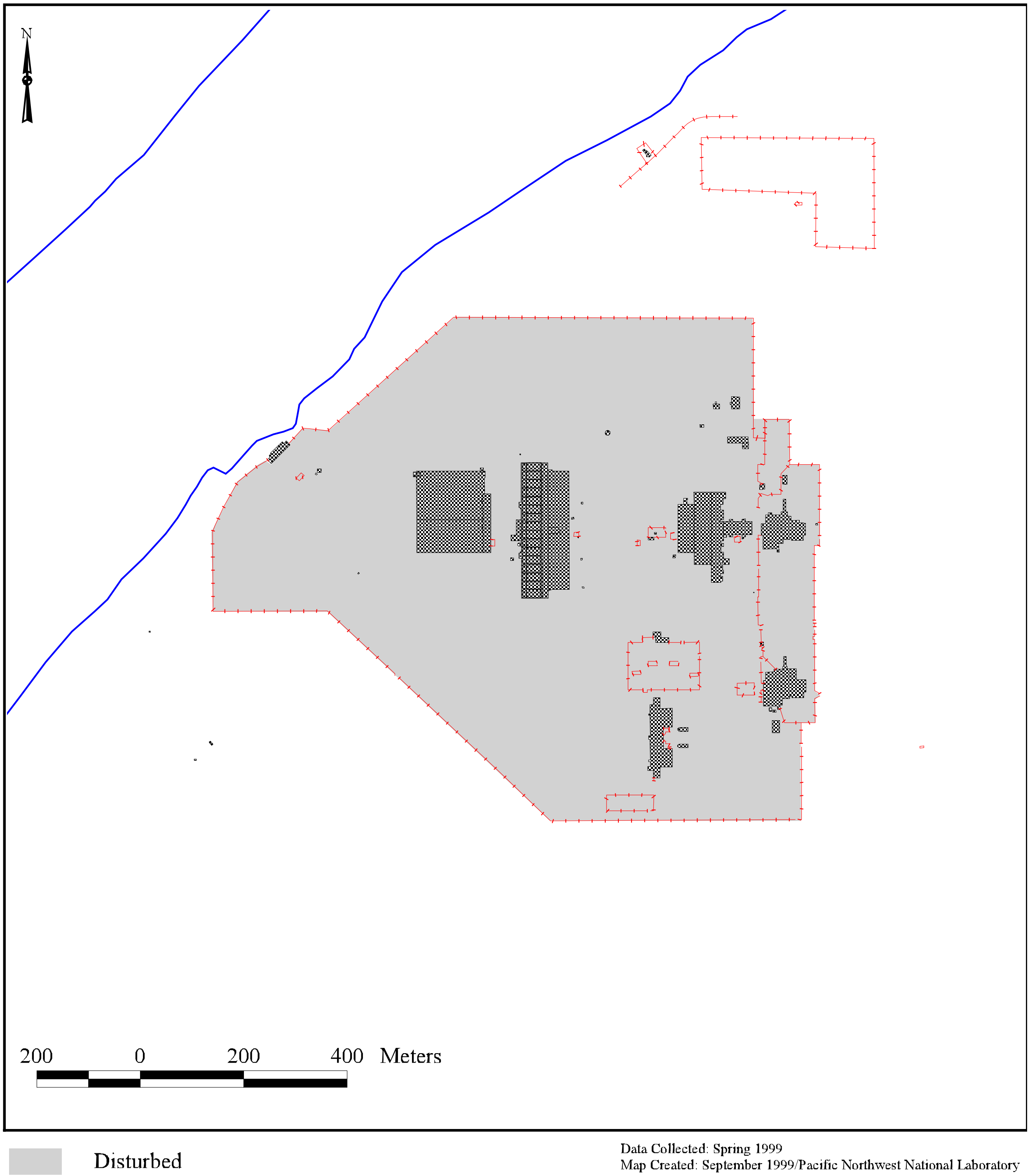


Figure D.4 100 D Area Land Cover Classes

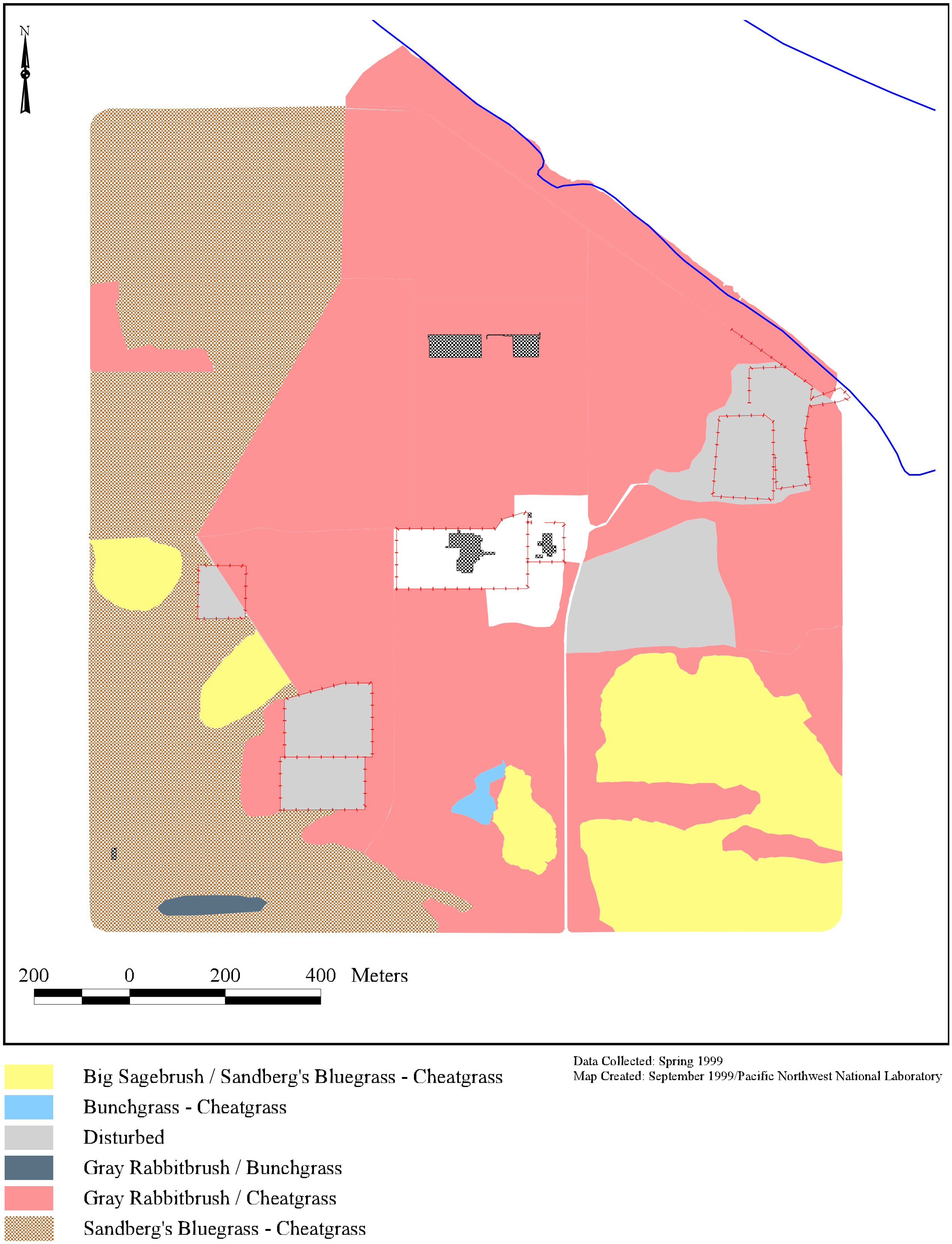


Figure D.5 100 F Area Land Cover Classes

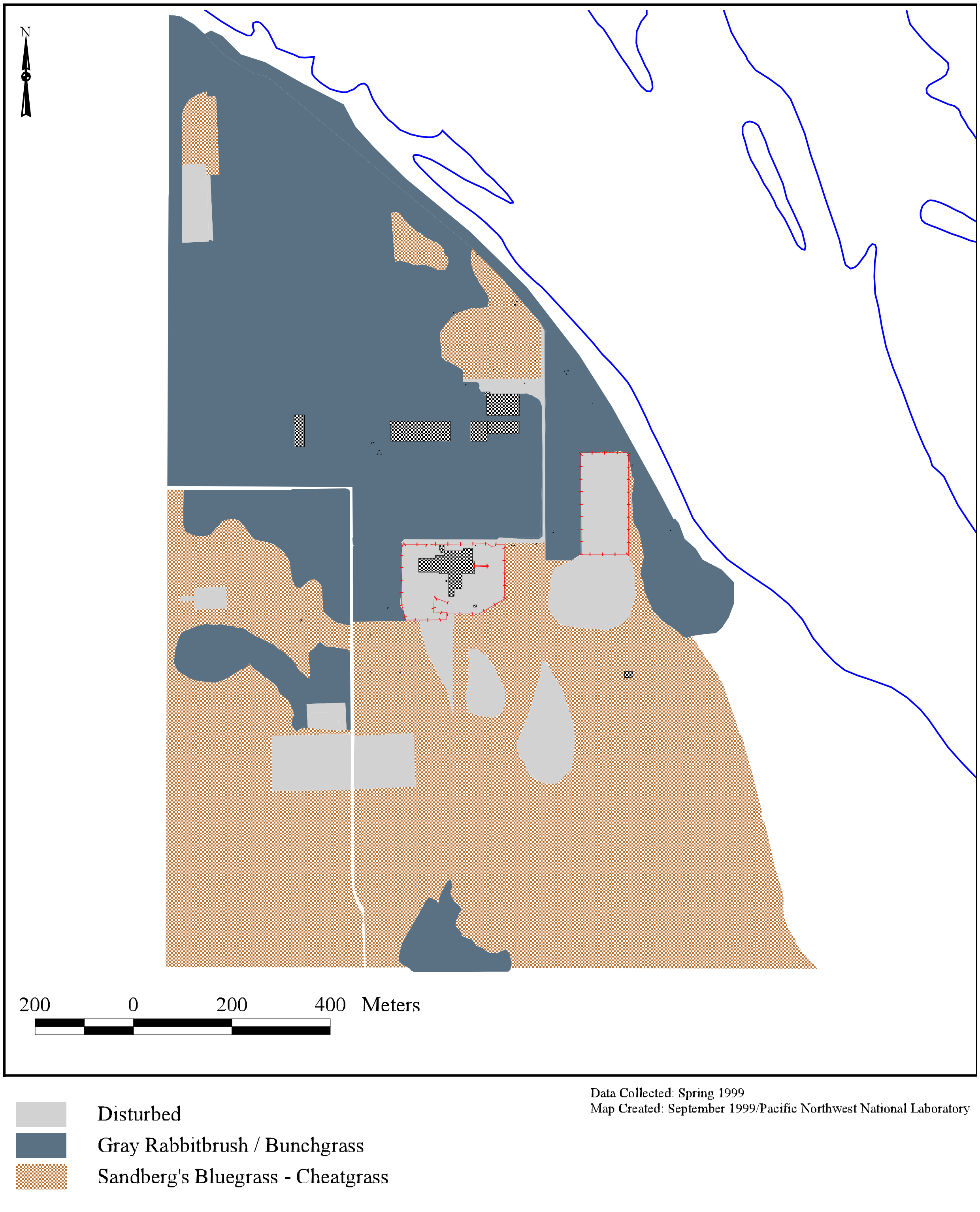


Figure D.6 100 H Area Land Cover Classes

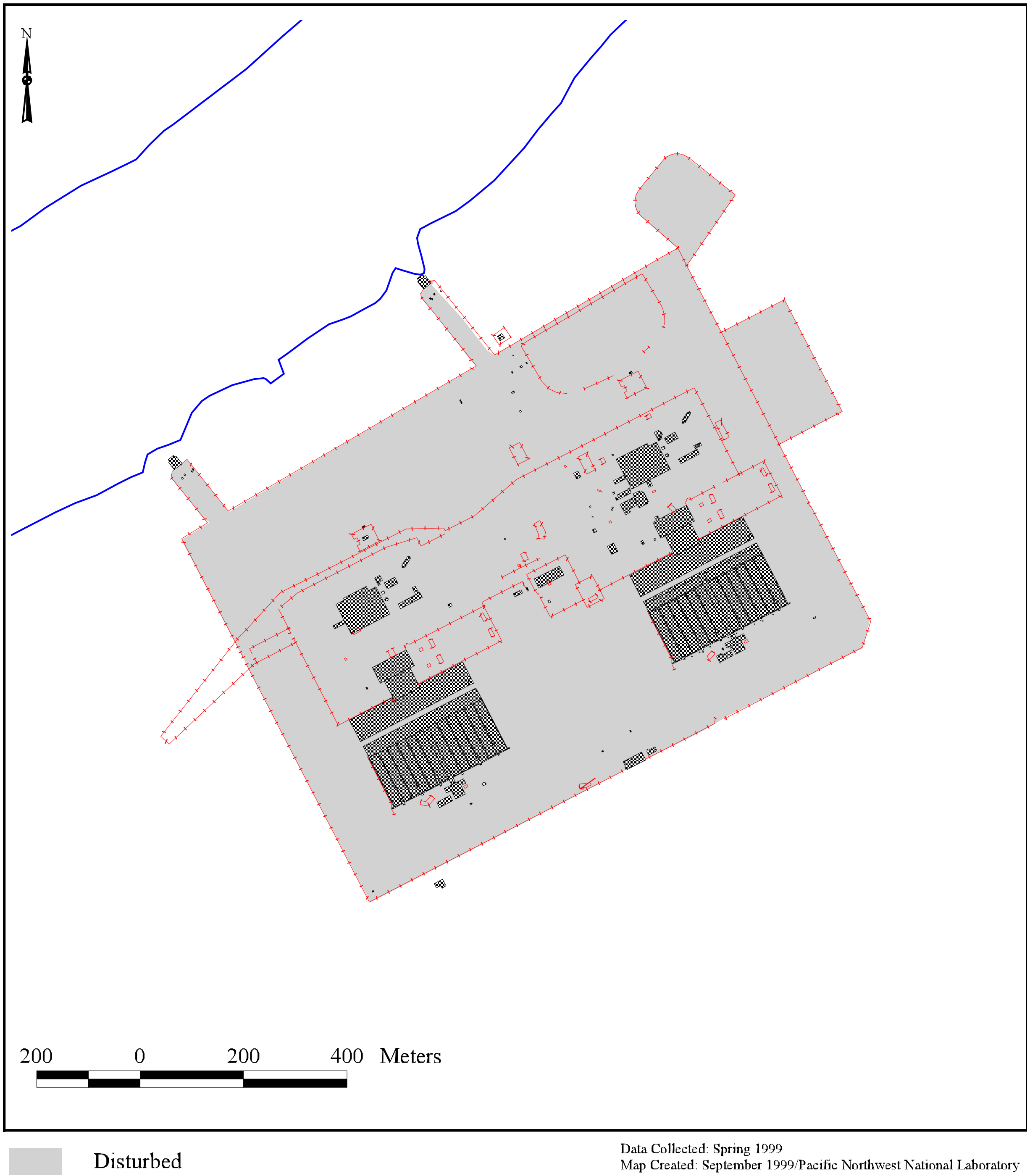


Figure D.7 100 K Area Land Cover Classes

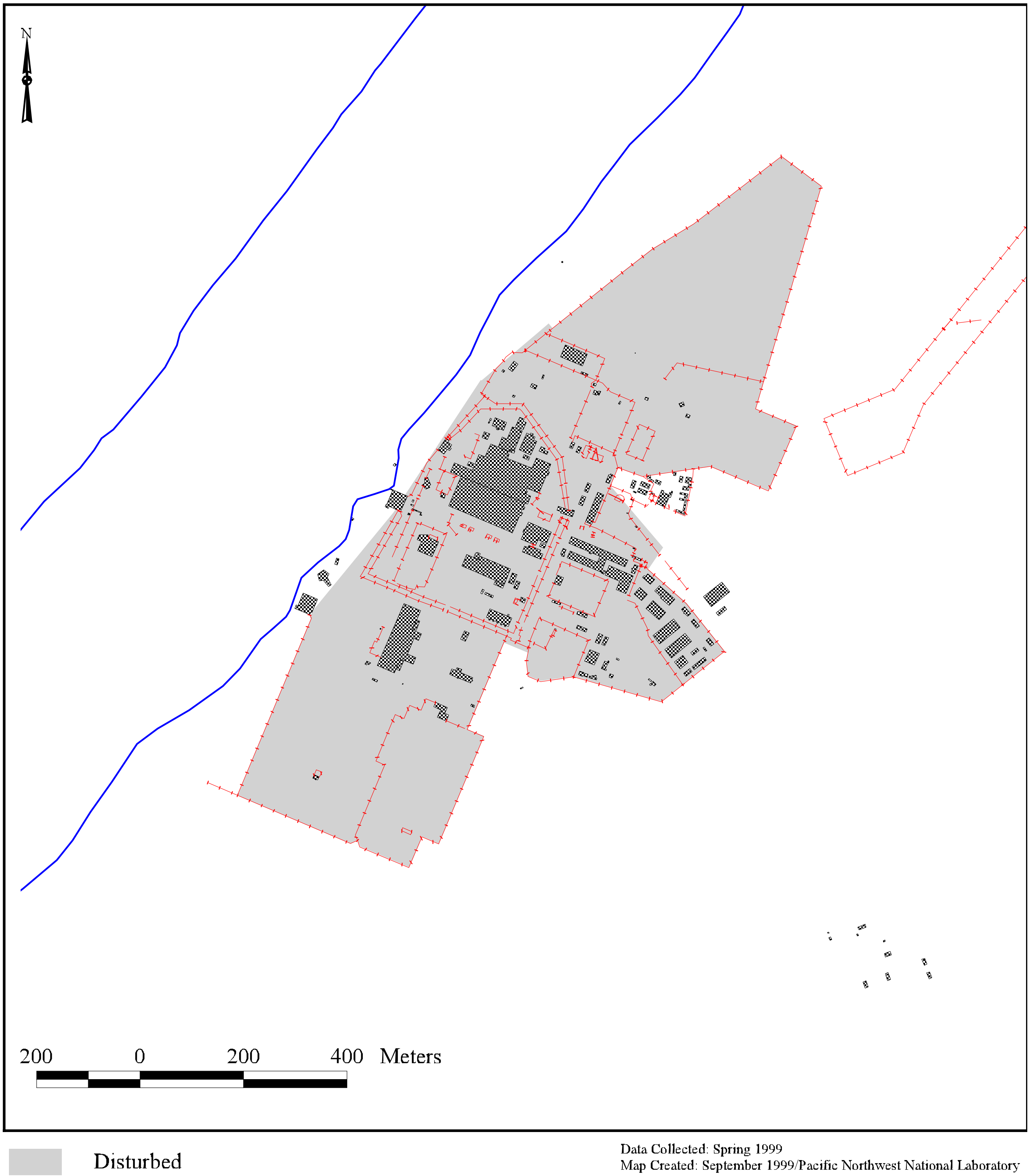


Figure D.8 100 N Area Land Cover Classes

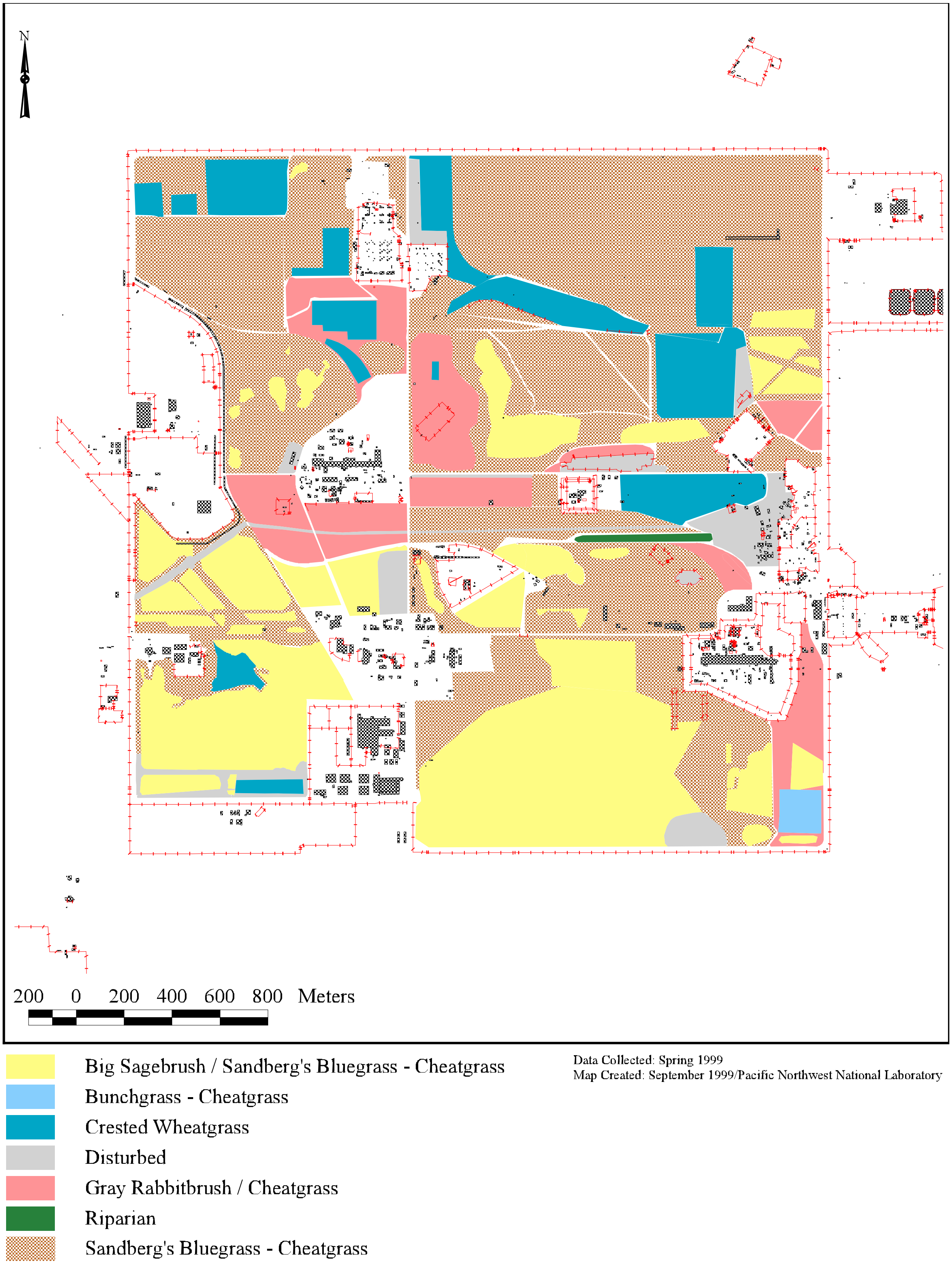


Figure D.9 200 E Area Land Cover Classes

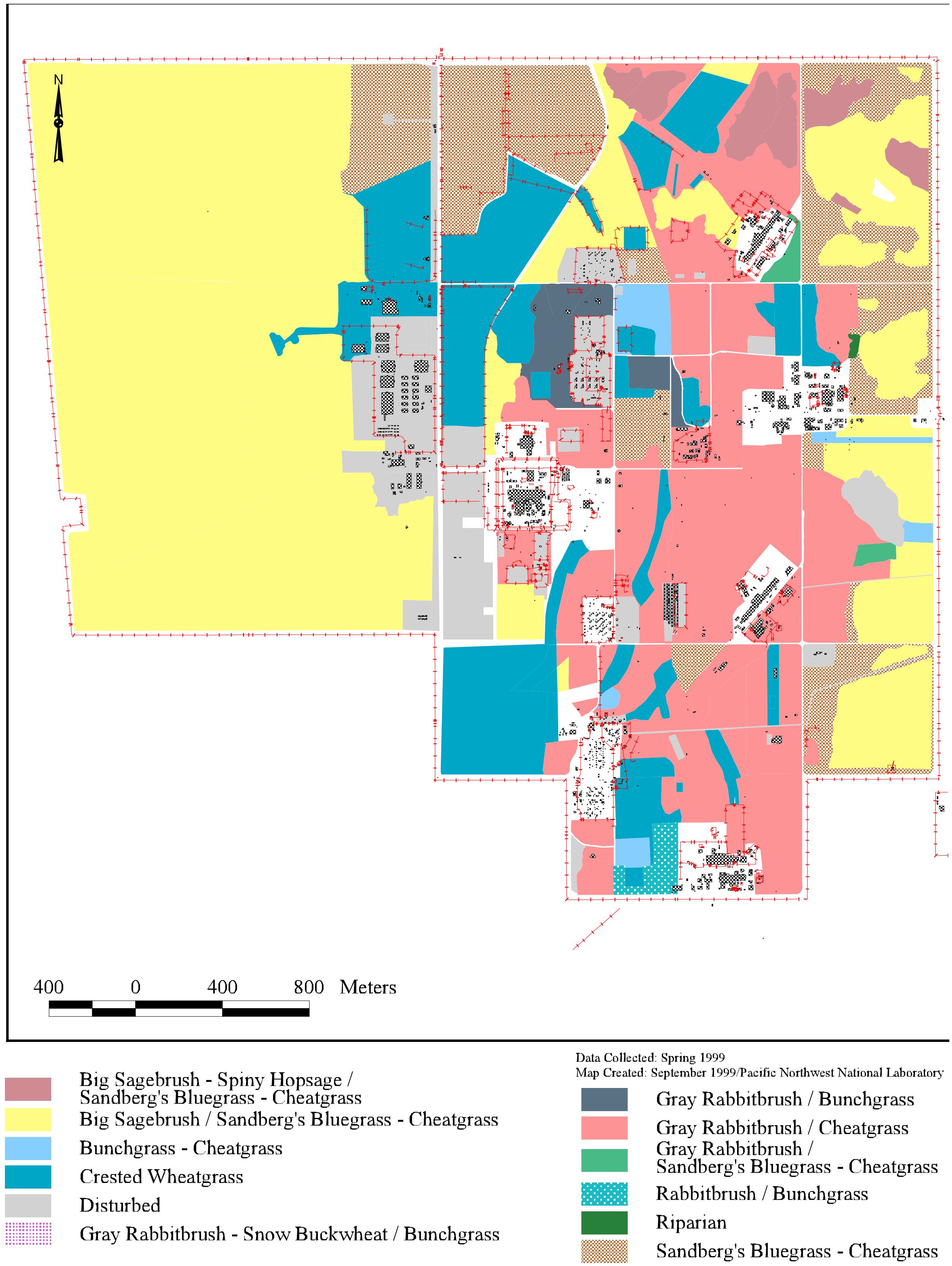


Figure D.10 200 W Area Land Cover Classes

Big Sagebrush / Sandberg's Bluegrass - Cheatgrass
Disturbed
Gray Rabbitbrush / Cheatgrass

Data Collected: Spring 1999
Map Created: September 1999/Pacific Northwest National Laboratory

Figure D.11 300 Area Land Cover Classes is not on single species but on habitats and plant communities as umbrella levels of ecological organization that contain species and ecosystem processes of concern. Such a change in focus is not at the expense of listed species; their management needs must still be met. Rather, the purpose of the shift is to head off future species listing by managing for the needs of a broader array of species and habitats now within a landscape perspective. This strategy is in line with an ecosystem management approach that recognizes that, although all levels of the biodiversity hierarchy have value, limited management resources must be focused on higher levels of the hierarchy.

Habitat is the combination of biotic and abiotic components that provides the ecological support system for plant and animal populations. Identification of habitats of concern on Hanford implies that areas designated as such have high fish or wildlife usage value or are important havens for populations of plant species of concern. This section discusses habitats of concern on Hanford and their relationship to WDFW priority habitats, habitat improvement areas, and specific sensitive resource areas, such as: wetlands, floodplains, rare habitats, and late-successional sagebrush-steppe habitat.

D.2.2.1 Habitats of Concern

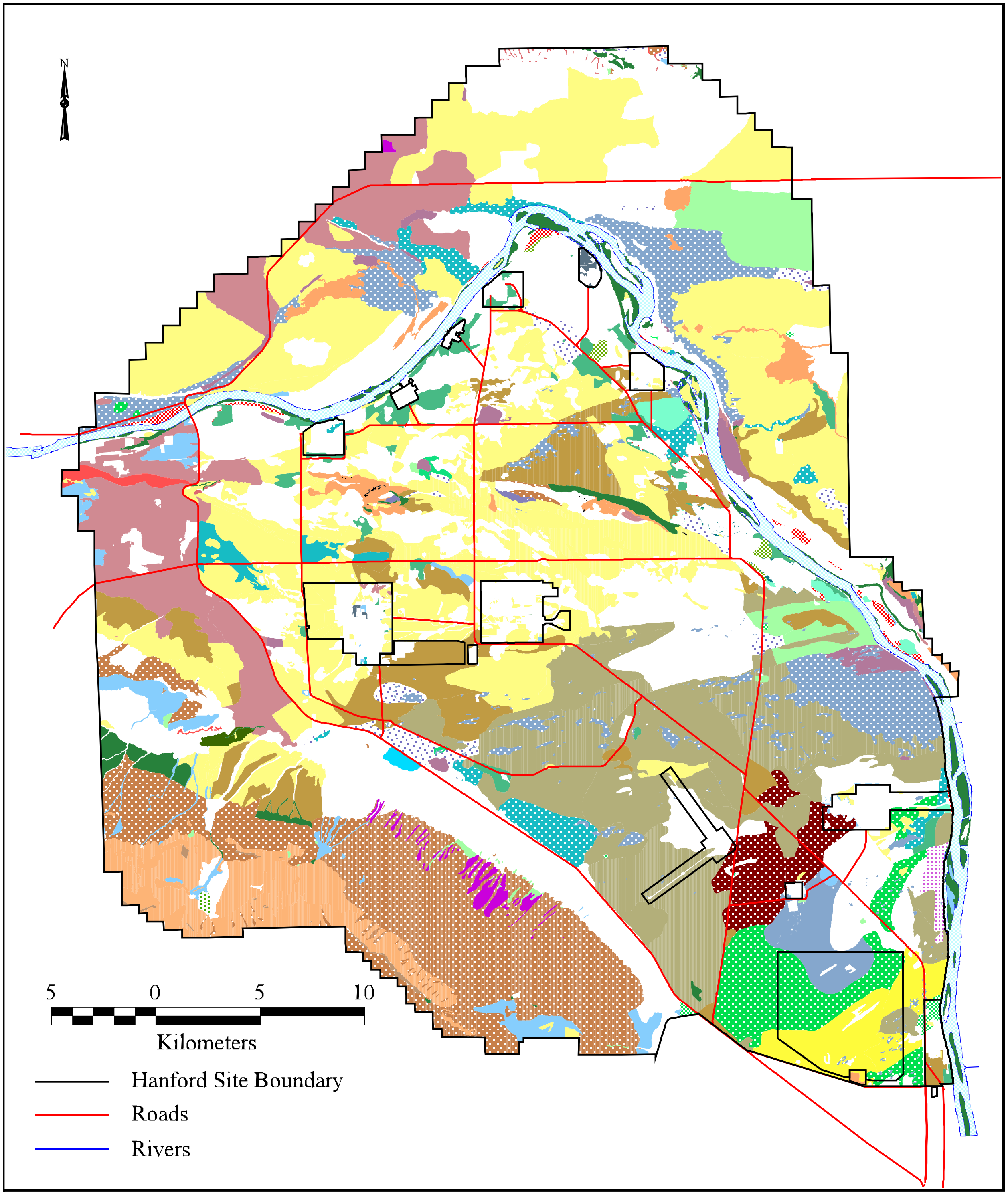
Figure D.12 depicts Hanford's habitats of concern. The map was derived from the Hanford Site land cover map (Figure D.1) by eliminating cover classes of low habitat value. Such classes reflect present human-induced disturbance (e.g., buildings) or the persistent effects of past human-induced disturbance (e.g., abandoned old fields, areas dominated by non-native grasses). Excluded cover classes included:

- rabbitbrush/cheatgrass
- Sandberg's bluegrass-cheatgrass
- planted non-native grass
- abandoned old fields
- buildings/parking lots/gravel pits/disturbed areas.

Individually, species of concern may use the excluded cover classes, and, thus, in accordance with the level of concern by which they are defined, they must still be addressed by appropriate management actions; however, the cover classes listed above in and of themselves are not considered crucial for individual species viability nor overall Hanford ecosystem integrity. (Depending on where they are located in the landscape, some occurrences of the excluded cover classes may still have importance as wildlife movement corridors or as locations within which habitat improvements can relieve the effects of fragmentation.) The remaining cover classes are considered important because they represent native habitat (albeit of variable quality) for species of concern Because maintaining the integrity of these habitats on Hanford will provide assurances that viable populations of associated species of concern will be maintained, the habitats of concern themselves will require status monitoring, impact assessment (and mitigation via avoidance and/or minimization), and, as appropriate, mitigation via rectification and/or compensation. For purposes of maintaining continuity with the land cover map (Figure D.1) and to enable monitoring of species diversity and wildlife usage within different plant community types, vegetation associations are retained as the principal means of identifying habitat.

The Ecosystem Monitoring Project and Hanford Biological Resources Laboratory both maintain databases that contain species of concern sighting information obtained from a number of sources for the Hanford Site (600 Area and the industrial areas, respectively). Data from the TNC surveys also are included. Sighting information documents the occurrence of particular species at Hanford and also provides some data on relative abundance and habitat association. Such information is useful in establishing which habitats are important to conserve.

Other than to infer something about habitat relationships, outside of the industrial areas most sighting data are not used directly in the BRMaP to identify specific resource areas of concern (bald eagles, ferruginous hawks, fall chinook salmon, and rare plant populations are conspicuous exceptions). There are three reasons for this. First, other than consideration of listed species and species associated with specific locations—e.g., rare plant population locations and salmon redds—the management approach taken here emphasizes habitat as an umbrella to protect a broad array of individual species. Second, incomplete sighting information can be misleading. For many species that occur at Hanford, complete distributional information is lacking. An absence of sighting data for a particular species in an area may reflect either inappropriate habitat or simply that the area was not surveyed.



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

Figure D.12 Habitats of Concern for the Hanford Site (Map)

Figure D.12 Habitats of Concern for the Hanford Site (Legend)

Third, species distributions across a landscape can be dynamic, especially for migratory species that do not return to the same locale each year to breed. Even annual plants may occur in different locations from year to year depending on seasonal weather patterns.

Because one implementation goal of BRMaP is a comprehensive monitoring (and inventory) strategy for Hanford's biological resources, future resource mapping may be able to make better use of sighting data. Because BRMaP emphasizes an ecosystem management approach, the emphasis is better placed on data that address the overall patterns of species diversity and not necessarily individual species.

D.2.2.2 Washington Department of Fish and Wildlife Priority Habitats

The WDFW has adopted the Hanford habitats of concern map (Figure D.12), minus the alkali saltgrass-cheatgrass cover class, as the basis for its priority habitat map for the Hanford Site.[3] The Habitat Program of WDFW publishes a priority habitats and species (PHS) list, which catalogs habitats and species considered to be priorities for conservation and management in the state of Washington (www.wa.gov/wdfw/hab/phspage.htm). According to WDFW, priority habitats (priority species are discussed in Section D.2.5.12) "are those habitat types or elements with unique or significant value to a diverse assemblage of species. Priority habitats may consist of a unique vegetation type or dominant plant species, a described successional stage, or a specific structural element." To be classified and mapped as a priority habitat, an area must contain one or more of the following attributes:

- comparatively high fish and wildlife density
- comparatively high fish and wildlife species diversity
- important fish and wildlife breeding habitat
- important fish and wildlife seasonal ranges
- important fish and wildlife movement corridors
- limited availability
- high vulnerability to habitat alteration
- unique or dependent species.

In the context of biological resource management amidst meeting growing human needs, WDFW uses the PHS program as a proactive measure to help mitigate human impacts on the state's fish and wildlife resources by identifying and preserving the best and most important habitats. The WDFW's adoption of the habitats of concern map (Figure D.12) as its priority habitat map for Hanford is further indication of the significant biological resources that Hanford contains.

Table D.1 indicates how the different cover classes that constitute the habitats of concern map (Figure D.12) correspond with WDFW's priority habitat elements (www.wa.gov/wdfw/hab/phspage.htm). In a number of instances, there is not a complete correspondence. For example, in the Hanford habitats of concern classification, basalt outcrops include talus plus four lithosol, shrub-steppe plant communities. Additionally, riparian and wetland habitat classifications are problematic. Riparian habitat is an area adjacent to aquatic systems with flowing water. In riparian systems, the biota and abiota of the terrestrial ecosystem are influenced by the juxtaposition of perennial or intermittent water. Simultaneously, the aquatic ecosystem (instream habitat) is influenced by the adjacent terrestrial vegetation. In WDFW's classification, the boundary between riparian habitat and instream habitat occurs at the ordinary high water mark; however, it is possible to have non-riverine wetland habitat (freshwater wetlands in the WDFW classification scheme) below the ordinary high water mark. For the land cover and habitats of concern maps (Figures D.1 and D.12), however, riparian habitat includes this wetland habitat [i.e., that area that contains hydrophytic vegetation but not including the zone of nonpersistent emergent vegetation (Cowardin et al. 1979)].

[3] Letter from T. A. Clausing, Regional Ecosystem Director, WDFW to J. E. Rasmussen, DOE-RL, Office of Site Services, dated March 4, 1996. The alkali saltgrass-cheatgrass community occurs in one locality on the North Slope. Because of its high stand quality and rarity, it qualifies as a Washington State Natural Heritage Program Element Occurrence (TNC 1995). This qualifies it as a Level IV resource and as such it is retained on the Hanford habitats of concern map.

Table D.1 Hanford Habitats of Concern Cover Classes and WDFW Priority Habitat Elements

WDFW Priority Habitat	Hanford Habitats of Concern
Cliffs	Cliffs (White Bluffs)
Riparian	Riparian
Shrub-steppe (small and large blocks)	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/Sandberg's bluegrass - cheatgrass Big sagebrush/bunchgrass Big sagebrush/bluebunch wheatgrass Big sagebrush/needle-and-thread grass Big sagebrush/sand dropseed Big sagebrush/Sandberg's bluegrass - cheatgrass Big sagebrush-spiny hopsage/bunchgrass 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 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 Rabbitbrush - snow buckwheat/bunchgrass Rabbitbrush/bunchgrass Rigid sagebrush/Sandberg's bluegrass Sand dropseed - Sandber'g bluegrass - cheatgrass Snow buckwheat - bitterbrush/bunchgrass Snow buckwheat/bunchgrass Spiny hopsage/Sandberg's bluegrass - cheatgrass Threetip sagebrush/bunchgrass Thymeleaf buckwheat/Sandberg's bluegrass Winterfat/bunchgrass Winterfat/cheatgrass
Talus	Talus
Freshwater wetlands and deepwater habitats	Non-riverine wetlands and associated deepwater habitats
Instream	Riverine wetlands and associated deepwater habitats
	Alkali saltgrass-cheatgrass

D.2.2.3 Sensitive Resource Areas: Wetlands

Sensitive resource areas are, in part, defined by DOE's NEPA Implementing Procedures and Guidelines (10 CFR 1021) (e.g., wetlands and floodplains) and in part by the rarity and fragility of specific resources typical of the Columbia Basin Ecoregion. These resource areas are not defined by the presence of one or a few species of concern; instead, they represent areas of high species richness or unique species assemblages.

Wetlands are areas that under normal circumstances have one or more of the following attributes (defined in Cowardin et al. 1979):

- at least periodically, the land supports predominantly hydrophytic vegetation

- the substrate is predominantly undrained hydric soil
- the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

In arriving at a determination of what wetlands constitute sensitive resources, federal regulations and guidelines make no distinction between human-made and natural wetlands (33 CFR 328.3); however, the formal jurisdictional delineation of wetlands exempts certain human-made waste treatment systems [(33 CFR 328.3(a)(7)]. Wetlands are often found in close association with deepwater habitats. Deepwater habitats are permanently flooded lands; they are defined separately because the term wetland has not been traditionally defined to include deep permanent water (Cowardin et al. 1979).

Although many areas on the Hanford Site can be considered wetlands, no formal delineation of wetlands on Hanford has been made. The system of jurisdictional delineation of wetlands is based on a 1987 U.S. Army Corps of Engineer's wetlands identification manual (ACOE 1987). Other wetland characterization schemes are also available that, even though they do not reflect a jurisdictional classification with respect to permitting requirements, provide a useful classification of different types of wetland habitat. Figures D.13 and D.14 identify wetlands and deepwater habitats of the Hanford Site based on National Wetlands Inventory (NWI) data that were obtained in digital format from the USFWS. Figure D.14 is a more detailed view of the northern portion of the Hanford Site that better illustrates the wetlands of the North Slope and portions of the Hanford Reach. The classification of the types of wetlands in the NWI data is based on Cowardin et al. (1979). For the areas depicted in Figures D.13 and D.14, the classification is based on aerial photographs (with most likely some ground truthing) that for different parts of the Hanford Site were taken in either June of 1976 or August of 1982.

The Cowardin et al. (1979) classification scheme is hierarchical and includes deepwater habitats as well as wetlands. Although the scheme encompasses five levels of classification plus modifying terms that can be applied at two of the levels, the data have been simplified in Figures D.13 and D.14 to reflect only three levels of classification without modifiers.

Table D.2 provides a breakdown of the classification scheme as used in Figures D.13 and D.14 with a brief definition/description for each of the relevant terms (see Cowardin et al. 1979 for more complete definitions and the complete classification scheme). Because Hanford has only freshwater habitats, Table D.2 does not address the effects of salinity on the classification scheme.

The advantage of the NWI wetland and deepwater habitat data versus the wetland cover classes of Figures D.1 and D.12 is that its classification scheme better reflects the ecological processes occurring and the potential floral/faunal associations present within each type of wetland or deepwater habitat. This is especially true at the class level of the classification scheme. Class-level descriptions define the habitat in terms of either the dominant life form of the vegetation (aquatic bed, scrub-shrub, emergent, and forested in Table D.2) or the physiography and composition of the substrate (unconsolidated bottom and unconsolidated shore in Table D.2) (Cowardin et al. 1979). Class designations are meant to apply to average conditions over a number of years. Because wetlands are dynamic, the correct classification of a wetland may require data to be collected over several years (Cowardin et al. 1979).

Although useful in indicating the breadth of wetland habitat present on the Hanford Site, there are some disadvantages associated with using the NWI data. First, the aerial photography data are 14 to 20 years old and represent only a snapshot in time of a dynamic system. Some areas that are depicted as wetlands in the central part of Hanford no longer exist. The accuracy of the data would be improved by ground-truthing current conditions. Second, the NWI data do not represent a jurisdictional delineation; although this is a disadvantage from a permitting perspective, it may not be too important a constraint [i.e., NWI data are recognized by DOE at 10 CFR 1022.11(c)(1) as a useful source of wetlands information]. Finally, some errors exist in the classification. The most glaring example is the classification of the entire Hanford Reach as a lake (lacustrine) (see below).

D.2.2.4 Sensitive Resource Areas: Floodplains

It is DOE's policy to (1) avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains, (2) avoid the support of floodplain development whenever there is a practicable alternative, and

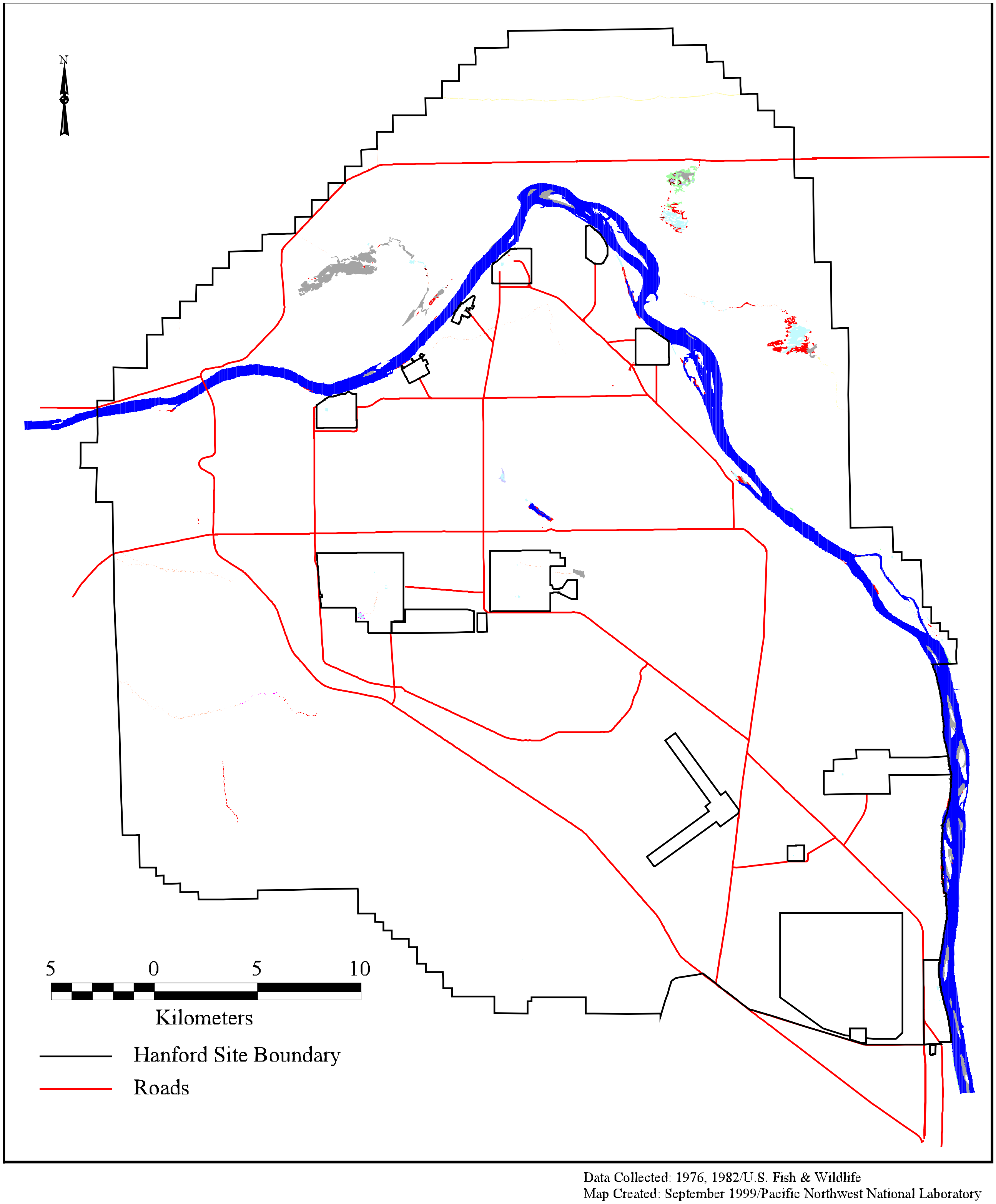


Figure D.13 Wetlands and Deepwater Habitats of the Hanford Site (Map)

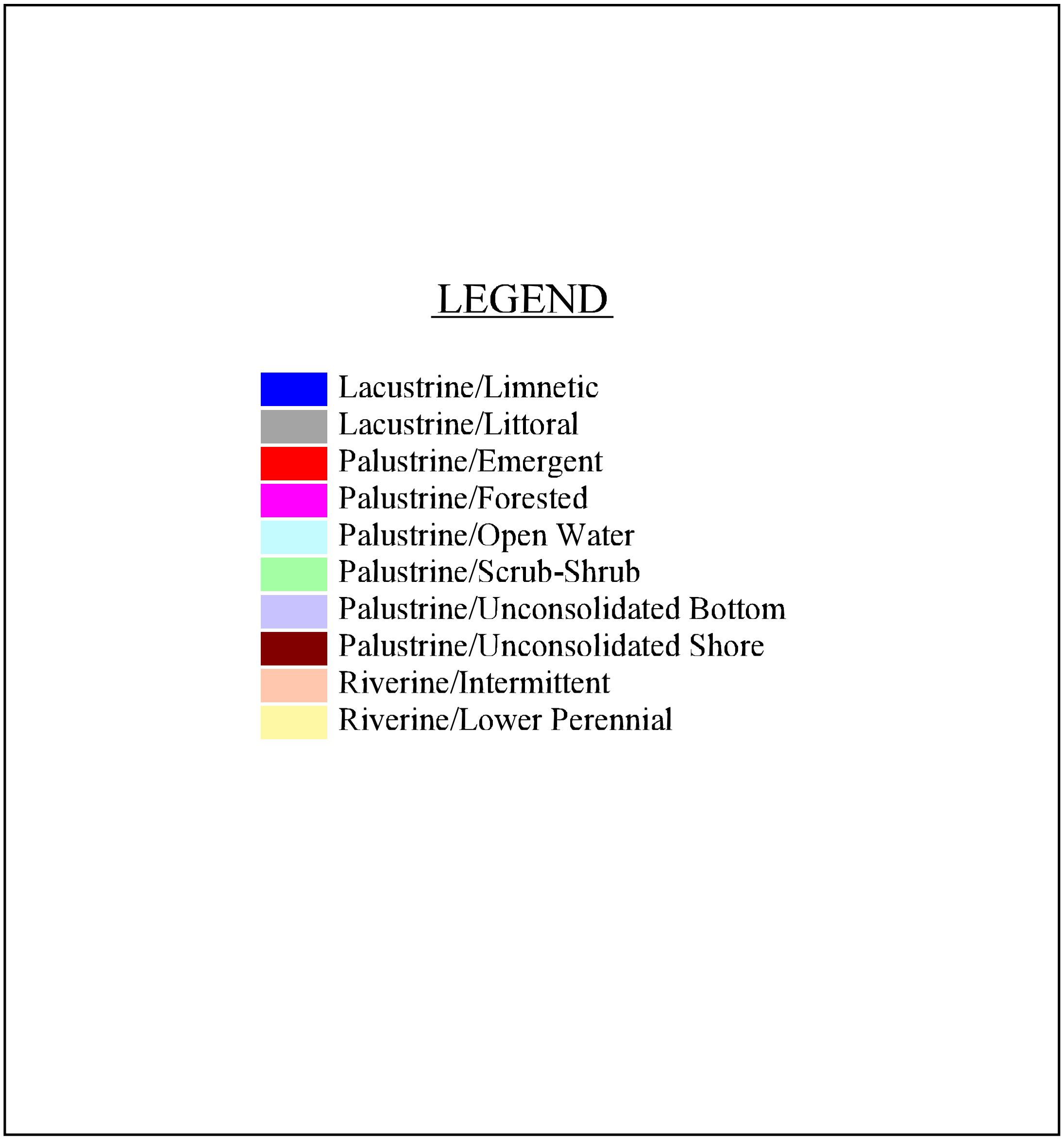


Figure D.13 Wetlands and Deepwater Habitats of the Hanford Site (Legend)

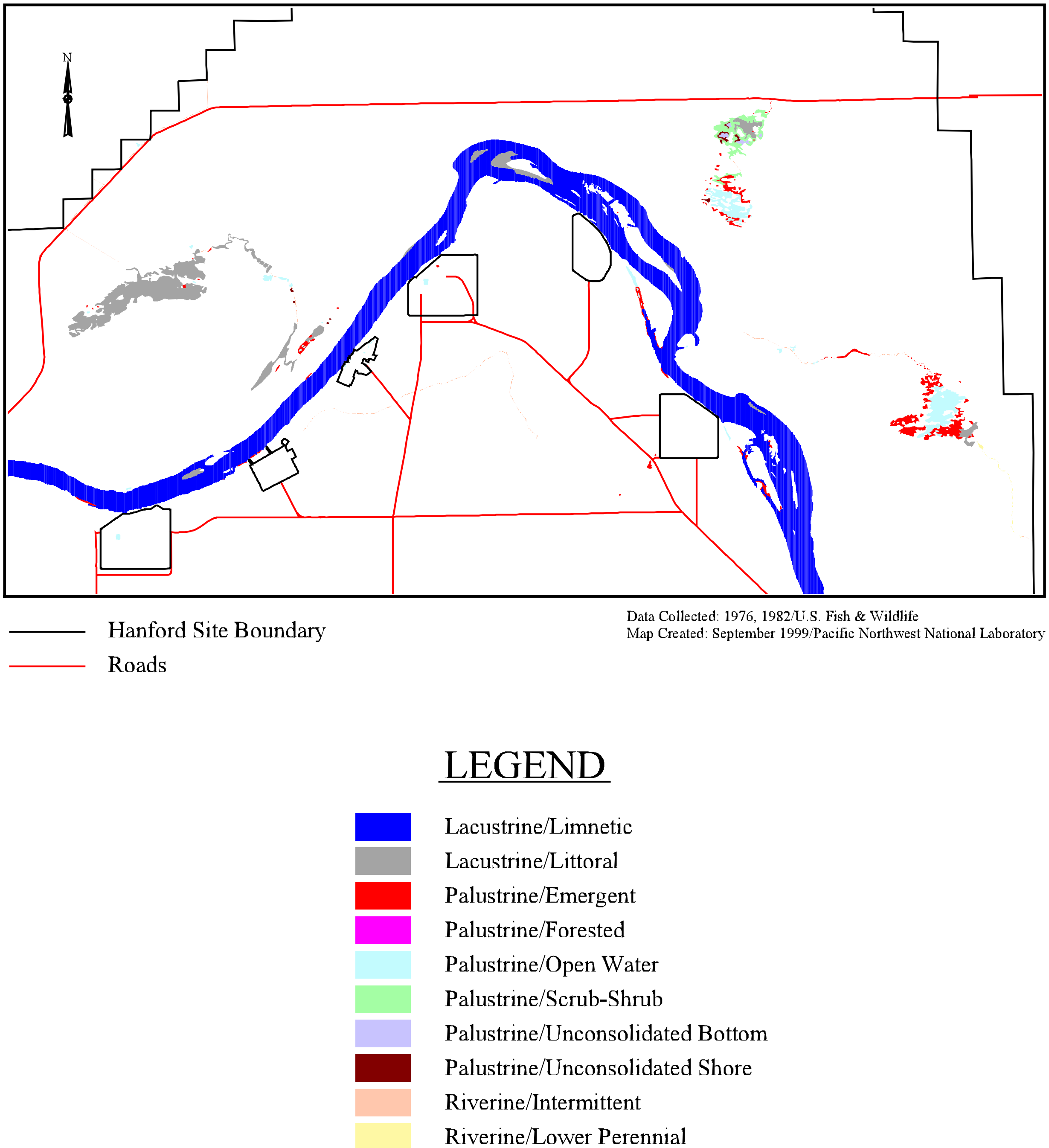


Figure D.14 Wetlands and Deepwater Habitats of the Hanford Site (Enlargement of the Northern Portion of the Site)

Table D.2 Description of the Classification Scheme Used in Figures D.13 and D.14

System	Subsystem	Class	Definition/Description
Riverine			All wetlands and deepwater habitats[(a)] contained within a channel except where the wetlands are dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens.
	Upper Perennial		Abiotic: gradient high and water velocity fast; some water flows throughout the year; oxygen concentrations normally near saturation; very little floodplain development; substrate rock, cobbles, or gravel with occasional patches of sand. Biotic: fauna characteristic of running water; few or no planktonic forms.
	Lower Perennial		Abiotic: gradient low and water velocity slow; some water flows throughout the year; oxygen deficits may sometimes occur; floodplain well developed; substrate mainly mud and sand. Biotic: fauna composed mostly of species that reach their maximum abundance in still water; true planktonic organisms are common.
	Intermittent		The channel contains flowing water for only part of the year; when nonflowing, the water may remain in isolated pools or surface water may be absent.
Lacustrine			All wetlands and deepwater habitats that: (1) are situated in a topographic depression or a dammed river channel; (2) lack trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) have a total area exceeding 8 ha (smaller areas are included if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 2 m at low water).
	Limnetic		All deepwater habitats within the lacustrine system
	Littoral		All wetland habitats in the lacustrine system from the shoreward boundary of the system to a depth of 2 m below low water or to the maximum extent of nonpersistent emergents, if these grow at depths greater than 2 m.
Palustrine			Abiotic (where vegetation is lacking): All wetlands with all of the following characteristics—(1) have an area less than 8 ha, (2) lack an active wave-formed or bedrock shoreline, and (3) have a water depth in the deepest part of the basin less than 2 m at low water. Biotic (where vegetation is present): All wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens
		Unconsolidated Bottom	Wetlands with at least 25% cover of particles smaller than stones and a vegetative cover less than 30%. This class is characterized by the lack of large stable surfaces for plant and animal attachment. Particle size of the substrate and water regime determine the types of plant and animal communities present.
		Unconsolidated Shore	Wetlands having: (1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock; (2) less than 30% areal cover of vegetation other than pioneering plants; and (3) water regimes that are intermediate between permanently exposed and permanently flooded. Associated landforms included in this class are beaches and bars.
		Aquatic Bed	Wetlands dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. The plants are either attached to the substrate or float freely in the water above the bottom or on the surface.
		Scrub-Shrub	Wetland areas dominated by woody vegetation less than 6 m tall. The species include true shrubs, young trees, and trees or shrubs that are stunted because of environmental conditions.
		Emergent	Wetland areas characterized by erect, rooted, usually perennial, herbaceous hydrophytes, excluding mosses and lichens. Vegetation is present for most of the growing season in most years. Persistent emergent wetlands are dominated by species that normally remain standing at least until the beginning of the next growing season.
		Forested	Wetland areas dominated by woody vegetation that is 6 m tall or taller.

(a) The boundary between wetland and deepwater habitat in the riverine and lacustrine systems lies at a depth of 2 m below low water; however, if emergents, shrubs, or trees grow beyond this depth at any time, their deepwater edge is the boundary. The palustrine system by definition does not include deepwater habitat (Cowardin et al. 1979).

(3) restore and preserve the natural and beneficial values served by floodplains (10 CFR 1022.3). Although the Hanford Reach is the last free-flowing U.S. stretch of the Columbia River upstream of Bonneville Dam, its flow regime is dam-regulated. Still, the periodic high river flows that can occur on the Hanford Reach, even under dam-regulated conditions, are important for maintaining natural processes within the Hanford Reach ecosystem. For example, the flushing of sloughs and scouring of shorelines removes fine sediments which could be important for the maintenance of native vegetation and other ecological conditions that native fish and wildlife depend on. The floodplain associated with such high river flows is thus of ecological significance.

Previous floodplain mapping for the Hanford Reach of the Columbia River has focused on accident-induced flooding (e.g., an upstream dam failure), historic floods previous to dam construction, and projected catrostrophic natural flooding (i.e., greater than 500-year periodicity) (Neitzel 1999); however, the appropriate floodplain of concern for protecting biological resource values is based on Executive Order 11988, "Floodplain Management." This Executive Order establishes the base or 100-year floodplain as that floodplain that should be considered for restoring and protecting the natural values of floodplains. The DOE implements Executive Order 11988 through 10 CFR 1022.

The relevance of the 100-year floodplain is somewhat arbitrary from a biological perspective. Consequently, the 100-year floodplain could be liberal or conservative in regard to protecting ecological processes that occur under high flow conditions on the Hanford Reach (e.g., flushing of sloughs). In the absence of specific information on the cause and effect relationship between river flow rates and ecological processes, the BRMaP relies on the regulatory floodplain of concern (i.e., that floodplain identified by Executive Order 11988) to protect biological resource values. Neitzel (1999) identifies the flow rate for the 100-year dam-regulated flood as 440,000 cubic feet per second (cfs) (12,460 m^3/s).[4]

To support the development of a floodplain map relevant to the protection of biological resources, water surface elevations at a number of different river flow rates, including 440,000 cfs, were computed using the PNL-CHARIMA river simulation model (Walters et al. 1994).[5] Figure D.15 shows the simulated water surface elevations that result for each of four flow rates. For reference, Priest Rapids Dam is at river mile 397 and the mouth of the Yakima River is at river mile 335. To determine the area that is flooded by a given flow rate, the simulated water surface elevations are compared to an elevation map. Additionally, to best illustrate changes in the extent of the floodplain under different flow regimes, comparisons that cover the extremes of expected flows are used. For the dam-regulated case, the water surface elevation curves in Figure D.15 that reflect the presence and effect of McNary Dam are the relevant curves.

The elevation map for the Hanford Site is typically based on the contour information contained on USGS topographic maps. Unfortunately, these maps are based on conditions when the Hanford Reach section of the Columbia River was at high flow. Thus, there is insufficient elevation information in USGS maps to model river flow conditions under the full range of flow conditions. To correct for this problem, additional elevation data were incorporated into the elevation base map. In October 1995, the U.S. Army Corps of Engineers recorded Hanford Reach channel elevation data (this included elevations below the water surface). These data were collected along irregularly spaced transects that were oriented approximately perpendicular to the river channel. An inverse distance weighting program was used to interpolate elevation values for locations between transects and between points on a transect within a 200 m (656 ft) area bounding the USGS river boundary on either side. This area included all transect points as well as areas, such as to the northeast of Savage Island, that were outside the transect data. After interpolation, the interpolated data were compared to the USGS elevations and a new elevation map was constructed with the interpolated points replacing the USGS elevations within the 200 m (656 ft) boundary whenever the interpolated elevations were less than the USGS elevations.

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4 The documented source of this flow rate as the 100-year flow rate is obscure; however, it was provided in a letter from D. Sweger, Department of the Army, Seattle District Corps of Engineers to R. A. Chitwood, Washington Public Power Supply System, dated May 30, 1980.

5 Model data provided by M. Richmond, Hydrologist, Pacific Northwest National Laboratory, Richland, Washington, 1995.

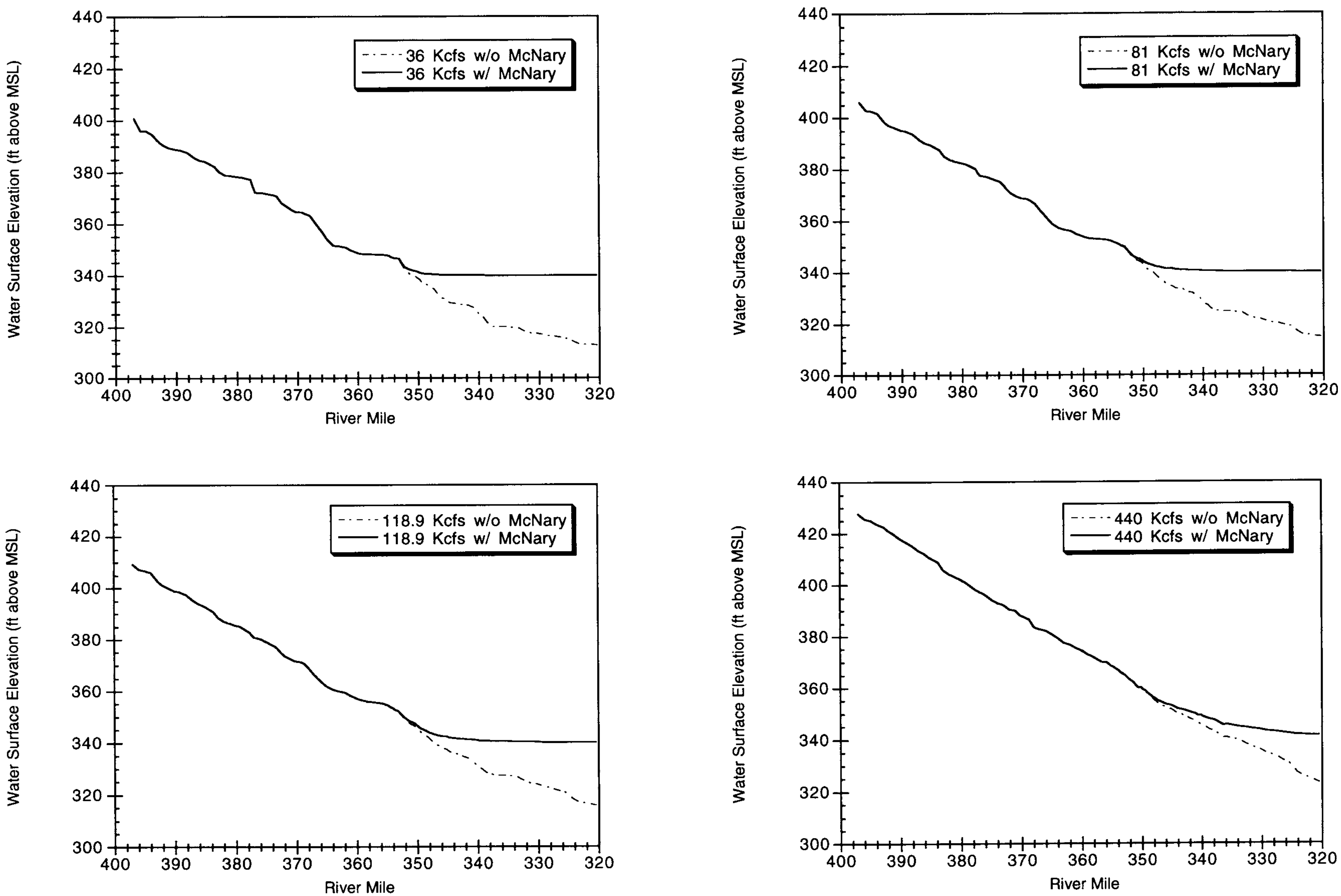

Figure D.15 Simulated Water Surface Elevations for the Columbia River Downstream from Priest Rapids Dam With and Without the Effect of McNary Dam

The new elevation base map was then compared to water surface elevation data from the PNNL-CHARIMA model for two flow rates, 440,000 cfs and 36,000 cfs (1020 m^3/s; the post Priest Rapids Dam, legally allowed low flow rate), to generate a floodplain map of the Hanford Reach portion of the Columbia River (Figure D.16). Because the river simulation model produces water surface elevation estimates at discrete distances along the river, the inverse distance weighting program was again used to interpolate elevations between modeled data points. Simulated water surface elevations greater than or equal to points on the elevation base map were considered under water. The base or 100-year dam-regulated floodplain is depicted in Figure D.16 as that area covered by water that is in addition to the amount of river channel present when flow rate is at the legal minimum.

The map represents one approximation of the dam-regulated floodplain; changes to the interpolation algorithm or increases in the available recorded elevation data points or simulated water surface elevation points could affect the depiction of the floodplain. The effects, however, are not expected to be major.

The curves in Figure D.15 also serve a second useful purpose. Within a dammed river channel, the terminal boundary of the lacustrine system formed behind a dam can best be defined by the extent of its reservoir. This is not a static condition, however, as the effect of a downstream dam's operating pool changes with upstream river flow rates.[6] The minimum flow rate of the upstream river in conjunction with the maximum operating level elevation of the downstream dam sets the maximum reservoir length. At higher river flow rates, the pool effect is lessened (i.e., the river functions as a free-flowing river farther downstream). Figure D.15 depicts water surface elevation curves, with and without the effect of the presence of McNary Dam, for two additional flow rates besides 36,000 cfs and 440,00 cfs: (1) the post Priest Rapids Dam mean flow during mid-November [i.e., peak period of fall chinook salmon spawning; 81,000 cfs (2290 m^3/s)] and (2) based on a 76-year record, the long-term mean flow rate [i.e., 118,900 cfs (3370 m^3/s)].

For each flow rate, the limits of the McNary Dam pool effect for the Hanford Reach can be determined by comparing the curves with and without McNary Dam. Based on model calibration accuracies, differences between the curves of less than a foot are not significant (M. Richmond 1995, pers. comm.). Thus, at minimum river flow (i.e., 36,000 cfs), the McNary reservoir (i.e., Lake Wallula) extends to about river mile 352; whereas, under mean flow conditions (i.e., 118,900 cfs), the reservoir terminates at about river mile 350.

Additionally, the change from a free-flowing to a more static flow condition is not immediate, as indicated by the shallow slope portions of the curves that precede the point at which the dam operating pool elevation is reached [i.e., 340 ft (103.6 m) above mean sea level (MSL)]. Thus, the free-flowing, riverine habitat of the Hanford Reach on average extends for about 75.6 km (about 47 mi) downstream from Priest Rapids Dam; however, below river mile 352, the transition point from river to lake is variable.

D.2.2.5 Rare Habitats

Rare habitats are defined here as those habitats important for plant, fish, and wildlife species that have low availability throughout the ecoregion, especially those in a protected status. The rare habitats at Hanford can be characterized on the basis of landform characteristics; however, a number of the habitats are associated with rare plant communities. Figure D.17 depicts the following kinds of rare habitat and their distribution on the Hanford Site and provides a basis for their protection:

- basalt outcrops: limited availability, associated rare plant communities, rare plants, easily disturbed, threatened by resource extraction
- cliffs (White Bluffs): limited availability, specialized wildlife usage, rare plants, threatened by groundwater seepage
- desert streams: limited availability, associated rare plant communities, high wildlife usage, unique species assemblages
- upland springs: limited availability, rare wildlife species, high wildlife usage

[6] Changes in operating pool elevation obviously also affect reservoir length. The normal pool elevation for McNary Dam is assumed to be no greater than 340 ft above mean sea level. With operating pool elevation held constant, changes in reservoir length are strictly dependent on upstream river flow rates.

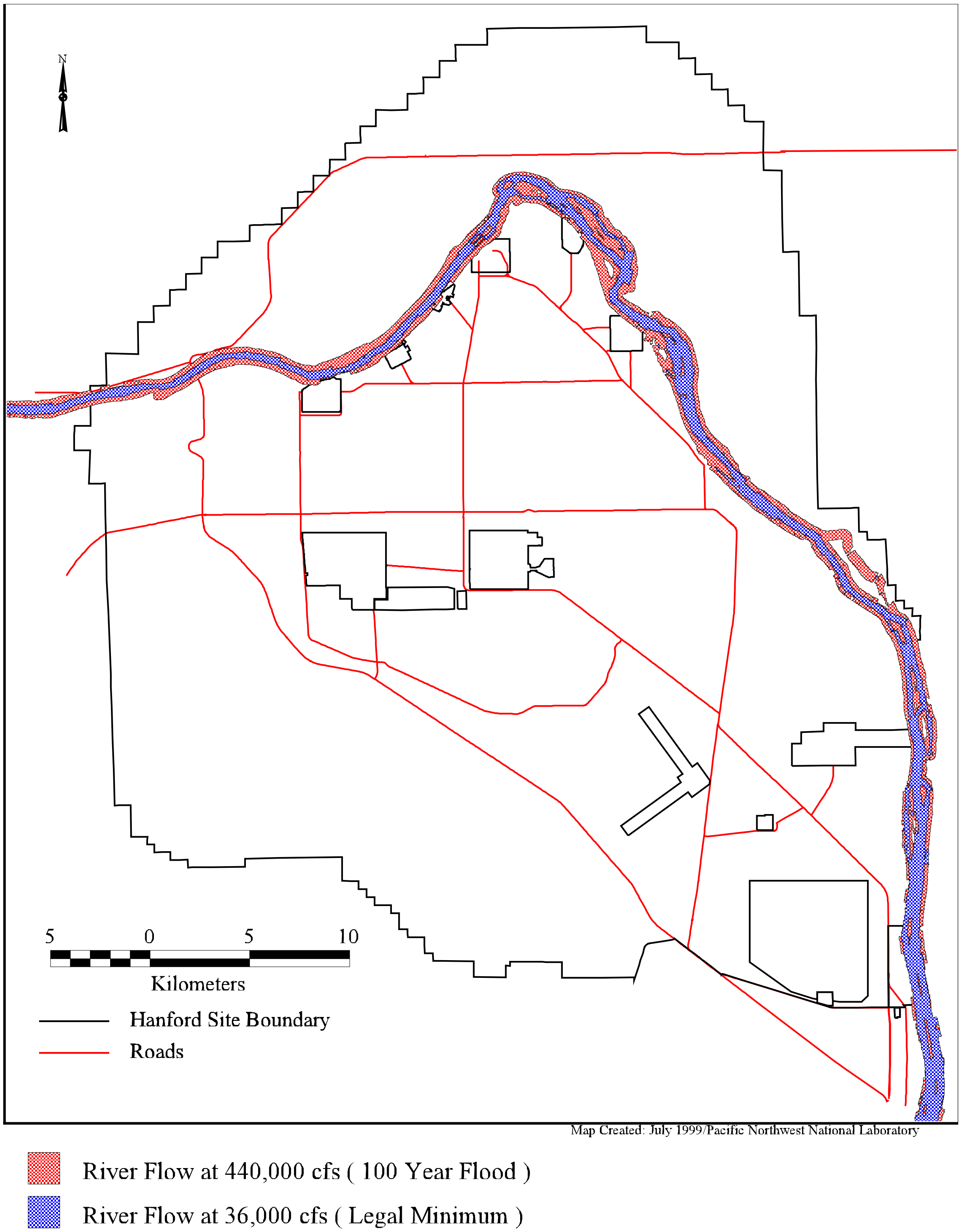

Figure D.16 Dam-Regulated 100-Year Floodplain of the Hanford Reach

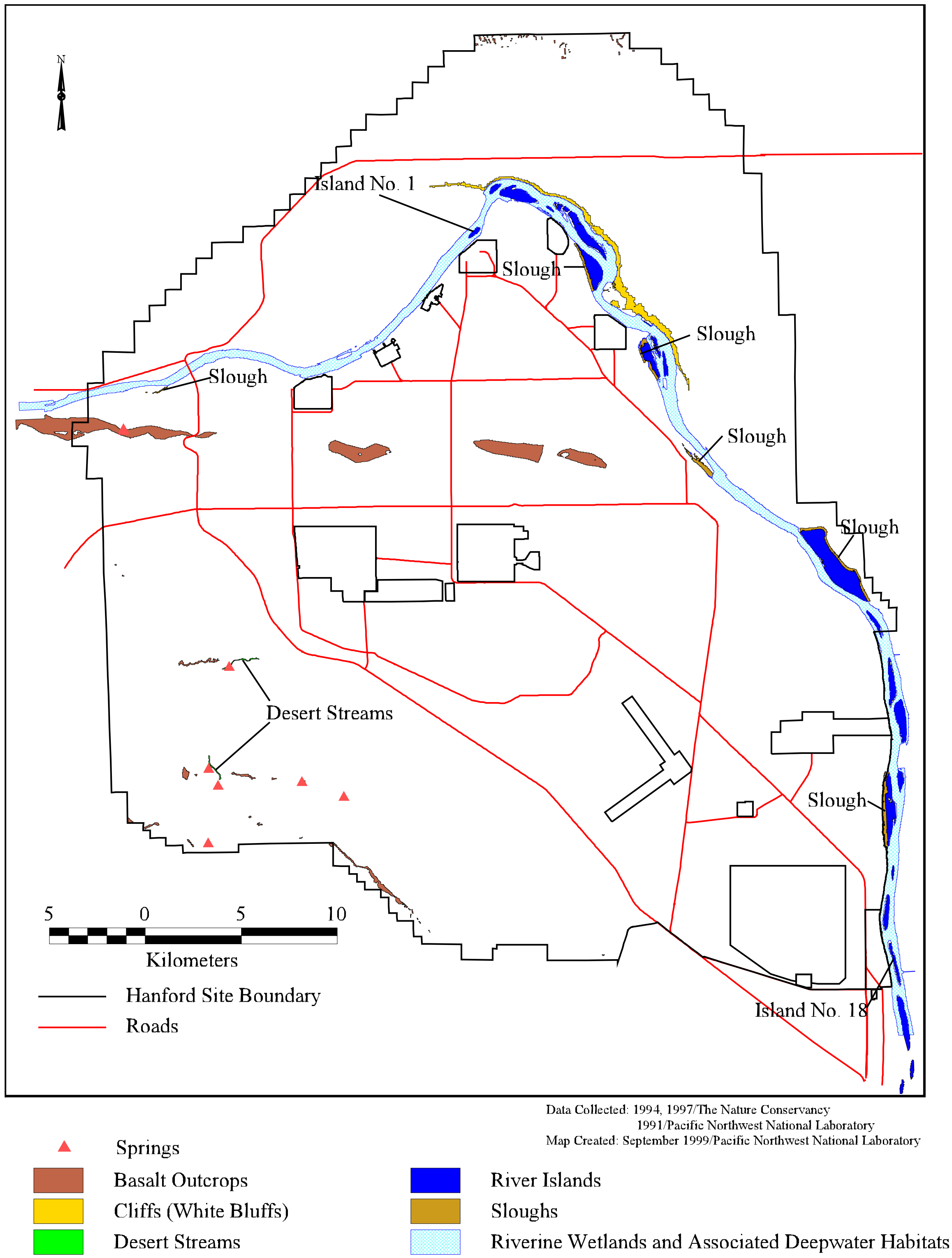

Figure D.17 Rare Habitats Present on the Hanford Site

- Columbia River sloughs: limited availability, high fish and wildlife usage (provide important habitat diversity within the Hanford Reach), associated rare plant communities, rare plants
- Columbia River islands: limited availability, high wildlife usage, rare plants.

More detailed information on each of these habitats and their associated fauna/flora can be found in Downs et al. (1993).

Basalt outcrops and cliffs (White Bluffs) are mapped the same as in Downs et al. (1993). As a generalized habitat class, however, basalt outcrops may consist of limited amounts of cliff (scarps) and talus (screes) habitat in addition to outcrop-associated, lithosol plant communities that have been identified by TNC and are included on the land cover map (Figure D.1). On Hanford, basalt outcrops are found along the crests and slopes of the Rattlesnake Hills, Yakima Ridge, Umtanum Ridge, Saddle Mountains, Gable Mountain, and Gable Butte. The White Bluffs occur along the eastern shore of the Hanford Reach.

The desert streams on the ALE Unit are identified on the Hanford land cover map (Figure D.1) as strips of riparian vegetation. There are two streams: Snively Creek, which extends as a permanent stream for about 2 km (1.25 mi) (Downs et al. 1993), and Dry Creek, which extends for about 2.5 km (1.55 mi) (Neitzel 1999). Most of the flow of Snively Creek is contributed by two springs: Snively Spring and Lower Snively Spring (Schwab et al. 1979). The permanent flow associated with Dry Creek is contributed by Rattlesnake Springs (Downs et al. 1993); however, depending on rainfall patterns, the flow and extent of Dry Creek can be quite variable.

Typically, both streams originate and terminate on the ALE Unit; however, under flood conditions, Dry Creek will cross State Highway 240. Snively Creek qualifies as a wetland and aquatic ecosystem element occurrence under the Natural Heritage Program (WDNR 1995).[7] Wetland and aquatic ecosystem elements are physical hydrologic systems and their component biota. Snively Creek is considered a representative of a low elevation stream and riparian system element. This element has a high priority for protection (WDNR 1995).

Other representatives of low-elevation stream and riparian system elements that qualify as element occurrences are present along the Hanford Reach of the Columbia River. A more complete description of element occurrences, their priority rankings, and their significance to biological resource management is provided in Section D.2.3.

Cold springs also are identified by the Natural Heritage Program as a wetland and aquatic ecosystem element (WDNR 1995). Two springs that occur on the ALE Unit—Snively Spring and Lower Snively Spring—are considered element occurrences by the Natural Heritage Program (C. Chappell, Plant Ecologist, WDNR, pers. comm., 1996). Not all potential spring areas are included in Figure D.17. The locations of the more prominent upland springs on the ALE Unit and Umtanum Ridge were digitized from USGS topographic maps for the Hanford Site. The spring locations digitized were:

- Lower Snively Spring
- Snively Spring
- Upper Snively Spring
- Rattlesnake Spring
- Benson Spring
- Doke Spring
- Juniper Springs (Lower)
- Juniper Springs (Upper).

Descriptions for each of these springs are provided in Frest and Johannes (1993) and/or Schwab et al. (1979). The first six springs listed are located on the ALE Unit and the last two are found on Umtanum Ridge. Frest and Johannes found that most springs had signs of human modifications such as diversion, addition of pipes, bulldozing, and excavation. They suggested that such modifications frequently negatively impacted the native land and freshwater mollusc fauna. During their surveys for molluscs they encountered one previously unknown land snail species on Umtanum Ridge (see Table D.6). Although the mollusc fauna may have been negatively impacted by mostly pre-Hanford activities, springs are still an important oasis for wildlife within the arid portions of the Hanford Site.

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7 The status of Snively Creek in regard to its qualification as an element occurrence is identified in a letter from M. Sheehan, Manager, Washington Natural Heritage Program, Washington Department of Natural Resources to L. Cadwell (PNNL), dated February 27, 1996.

Sloughs or backwater areas are waterbodies connected and adjacent to the main channel of the Hanford Reach. Sloughs are important breeding and foraging locations for a number of species. Although the advent of dams on the Columbia and Snake rivers has resulted in the loss of some backwater habitat and the gain of others, most of what has been gained is qualitatively different from the slough habitat on the Hanford Reach. On the Reach, the occasional high flows of the free-flowing river periodically connect the sloughs to the flow of the river. This periodic cycling of the nutrient conditions within the slough is typical of a natural river. The backwater areas of dammed stretches of the river do not experience this periodic flushing. The slough locations along the Hanford Reach were digitized from USGS topographic maps for the area. The USGS maps are based on conditions at one particular river flow rate; in actuality, total slough area will be different at different river flow rates.

River islands are a limited resource for those species that require isolation from ground predators to carry out portions of their life cycle. Colonial waterbirds and mule deer, for example, use the Columbia River islands for nesting and fawning, respectively. The rarity of islands and the relative importance of the islands that are present within the Hanford Reach can best be exemplified by the following: the ratio of island shoreline to river shoreline distance is 0.337 to 1 in the Hanford Reach as compared with 0.024 to 1 north of Priest Rapids Dam to the Canadian border (calculated from data from Table 1 in Payne et al. 1976). Figure D.17 shows the locations of the islands along the Hanford Reach from Island No. 1 near 100 D Area to Island No. 18 opposite the 300 Area (see Downs et al. 1993: Table 2.1, for information on ownership/administration of these islands). Islands 14 through 18 are included within the USFWS McNary National Wildlife Refuge, and three additional islands farther upstream are administered by the Bureau of Land Management as areas of critical environmental concern (NPS 1994).

Bathymetric profiles of the entire Hanford Reach do not exist, although some sounding data are available. There is a need to map the Hanford Reach so that critical habitat can be identified for aquatic species. For example, there may be a relationship between depth (or other hydraulic variables) and spawning sites for fall chinook salmon. Additionally, white sturgeon are known to overwinter in deep holes prior to migration to spawning and feeding areas in the spring (Haynes et al. 1978). Finally, some mollusc species may exist in deep water habitat, though no surveys have been made. Designation of deepwater habitats greater than 10 m would be useful in limiting potential impacts to species that require these areas during some portion of their life cycle.

Finally, various kinds of wetland habitat, either associated with the Hanford Reach or the North Slope, also may be worthy of protection as rare habitat. Such delineation, however, awaits a more refined mapping of wetland habitat on the Hanford Site (Section D.2.3.3 describes those wetland areas that have been mapped and that qualify as element occurrences).

D.2.2.6 Late-Successional Sagebrush-Steppe Habitat

The steppe[8] and shrub-steppe communities of the Columbia Basin Ecoregion have undergone substantial loss or degradation in the post-European era that can be attributed primarily to human-induced change (Dobler 1992; Noss et al. 1995; see further discussion in Appendix C). Although prior to federal acquisition the Hanford Site experienced a moderate level of agricultural development and livestock grazing, the subsequent use of Hanford for the production of defense nuclear materials and later as a center of environmental restoration ironically has protected much of the Site from industrial development and continued encroachment by agricultural and grazing practices (Gray and Becker 1993; Gray and Rickard 1989). Because of this, the Hanford Site retains the largest remnants of native shrub-steppe in the Columbia Basin Ecoregion (Smith 1994).

Prior to the introduction to the shrub-steppe of non-native annual plants, fire maintained the shrub-steppe in a mosaic of different successional stages (see Knick and Rotenberry 1995, for a similar

[8] Also referred to as steppe without big sagebrush (Franklin and Dyrness 1973) or grassland-steppe (Noss et al. 1995), though in actuality steppe also can contain shrubs including big sagebrush (Daubenmire 1970). Shrub-steppe is a physiognomic subdivision of steppe. Hanford is within the shrub-steppe vegetation zones (Daubenmire 1970; see Appendix C for additional details).

overview of this topic as it applies to Great Basin shrub-steppe). With the presence of non-natives across the landscape, fire frequencies have increased, and the role of fire has changed to one that creates increased opportunities for colonization by aggressive, non-native annual species. The consequences of this new fire pattern and other human impacts to the shrub-steppe have been twofold: (1) within the existing shrub-steppe, the proportion that is late-successional[9] is less than during pre-European times, and (2) once disturbed, the recovery of early successional stages of shrub-steppe to a late-successional stage is less likely. Thus, late-successional shrub-steppe communities, especially those on deep soils and those that have been left relatively undisturbed, are at a premium within the Columbia Basin Ecoregion.

The DOE-RL recognizes both the importance of late-successional shrub-steppe habitat to the Columbia Basin Ecoregion and the role Hanford plays as a refugium for this habitat.[10] Moreover, the Hanford habitats of concern map (Figure D.12) indicates that all shrub-steppe community types and successional stages of reasonable quality are considered important from the standpoint of impact mitigation.

Although preservation of a mosaic of different successional stages of shrub-steppe on Hanford is vital for maintaining the full diversity of shrub-steppe dependent species, the late-successional stages are most important because recent wildfires have removed much of this habitat. The remainder is at risk from potential land conversion due to waste management and CERCLA cleanup activities on the central plateau of Hanford (an area that contains extensive blocks of late-successional shrub-steppe, principally sagebrush-steppe).

Within the area on Hanford that is covered by late-successional plant communities, there is a mix of shrub and understory conditions (e.g., native perennial bunchgrasses versus non-native annual grasses). To better assess the quality (condition) of the late-successional communities, and by so doing identify those areas for which adverse impacts should be mitigated, a habitat association model is presented below that relates the condition of the habitat to its suitability for use by a shrub-steppe obligate species: the sage sparrow. This species is known to be strongly associated with native shrub-steppe communities containing mature shrubs, especially sagebrush (Braun et al. 1976; Dobler 1992; Rotenberry and Wiens 1978; Schuler et al. 1993).

Typical habitat association models, such as Habitat Suitability Index Models developed by the USFWS, attempt to derive a linear or other relationship between continuous measures of habitat quality and use (e.g., some measure of success in reproduction within the habitat) by an evaluation species. Conversely, the sage sparrow habitat association model presented here is a threshold model, in that the model output indicates a particular locale is suitable for sage sparrows or it is not. The model is applied conservatively. The decision rule associated with application of the model minimizes the error of identifying an area as unsuitable for sage sparrows when in actuality it was.[11] To improve its accuracy, the model should be evaluated in the field in the future.

Model variables for characterizing suitable sage sparrow habitat were based on the literature for sagebrush-dominated plant communities. Sage sparrow probability of occupancy and densities within sagebrush-steppe habitats show a positive relationship with increasing sagebrush coverage (Knick and Rotenberry 1995; Rotenberry and Wiens 1978). At least for density, there seems to be a threshold (about 10% coverage or so) above which the habitat is saturated; that is, sage sparrow density does not increase further (Rotenberry and Wiens 1978). Other studies have assessed differences in sagebrush coverage at sites at which sage sparrows occurred versus sites at which they did not. Although the different results may reflect other site-specific habitat variables or landscape effects not taken into account, sage sparrows seemed to use sites with higher than average sagebrush coverage when the average coverage was low (i.e., less

9 As defined for the purposes of this section, late-successional shrub-steppe is characterized by a relatively constant plant species composition and by large shrubs (usually big sagebrush) whose canopy cover is relatively stable in the absence of a disturbance.

10 Letter from J. E. Rasmussen to The Hanford Natural Resource Trustees, dated May 22, 1995. Cumulative Impacts on the Mature Shrub-Steppe Habitat of the Central Plateau (200 Area and Vicinity) of the Hanford Site.

11 In applied science, such as when determining biological resource preservation needs, it is important to avoid errors of commission. This is because errors of this type can have irreversibly adverse impacts to biological resources. See Noss (1994) and Shrader-Frechette and McCoy (1993) for an analogous discussion.

than about 10%) (Dobler 1994; Larson and Bock 1986; Wiens 1985). At coverages above about 20%, sage sparrows may select for areas that match the average coverage or are slightly less than average (Larson and Bock 1986; Petersen and Best 1985; Wiens 1985). Based on the preceding data, sagebrush coverage of 10% or more was chosen as a model threshold variable.

Nest-site selection by sage sparrows may be affected by the size distribution of available shrubs and may even include selecting sites on the ground (Winter and Best 1985). Nest-site selection may depend on both maintaining adequate vegetation above the nest for cover and avoiding the high temperatures present at ground level (Winter and Best 1985). Also, selection of the nest shrub may depend on the overall vertical profile of the surrounding vegetation, as well as on the height of the nest shrub itself. The sage sparrow generally selects areas and nest shrubs of above average shrub height (Larson and Bock 1986; Petersen and Best 1985). Finally, sage sparrows generally select sagebrush as nest shrubs that are at least 50 cm (20 in.) in height (Petersen and Best 1985; Reynolds 1981, Rich 1980a). The second model threshold variable was set as: average sagebrush height of at least 50 cm.

Together, the thresholds for the first two variables establish criteria that focus management attention on late-successional sagebrush-steppe habitat. The third model variable addresses the condition of that habitat in regard to the amount of non-native annual grasses that it contains. Most studies that have addressed aspects of sage sparrow habitat association have not dealt directly with the effect of non-native annual grasses, generally cheatgrass, on that association. Indirectly, however, a number of studies have indicated that sage sparrows select areas for nesting that have a greater amount of bare ground than unoccupied areas (Larson and Bock 1986; Rotenberry and Wiens 1980; Wiens 1985).

Sage sparrows spend a significant amount of time on the ground foraging; thus, sufficient amounts of bare ground in the habitat may be necessary to provide favorable foraging locations (Petersen and Best 1985; Wiens 1985). On Hanford, areas in which cheatgrass dominates tend to have less bare ground as compared with areas in which native perennial bunchgrasses are the major understory component. A few studies compared annual grass coverage (essentially cheatgrass) in occupied versus unoccupied sites (Dobler 1994; M. Vander Haegen, Senior Research Biologist, WDFW, letter report to J. Hall, dated August 2, 1995). Although the data suggest that sage sparrows, on average, use sites with less cheatgrass coverage (mean values of less than 20%) than what is found in unoccupied sites, the relationship between cheatgrass coverage and usage by sage sparrows seems to be more complex (Vander Haegen, Ibid., 1995).

Two considerations govern the selection of an appropriate threshold value for cheatgrass coverage within the habitat association model. First, the information above indicates there is uncertainty relative to the effect of the presence of cheatgrass on habitat usage by sage sparrows. Second, when conducting annual baseline surveys, Hanford Biological Resources Laboratory field crew members qualitatively evaluate ground coverage for each plant species by use of coverage scales that include a range of values (e.g., 5–10%, 10–25%, 25–50%, etc.). Based on these considerations, a threshold value of no greater than 25% ground cover of cheatgrass was used in the model. This value accounts for both the uncertainty of cheatgrass's role in habitat selection by sage sparrows and the manner of vegetation sampling used during baseline surveys of Hanford's industrial areas.

Measured values for the above variables were used to construct a map of suitable sage sparrow habitat via a multi-step process. The first step consisted of determining the modeling region (i.e., that area of the Hanford Site for which the model would apply). Because the model is for late-successional sagebrush-steppe, the modeling region did not include the post-fire land cover class, nor any of the other cover classes in which big sagebrush was not the dominant contributor to cover. The cover classes that were included in the modeling region were (1) big sagebrush/bunchgrasses-cheatgrass, and (2) big sagebrush-spiny hopsage/bunchgrasses-cheatgrass (Figure D.18).

Step two consisted of assembling vegetation transect data. Within the areal extent of the two cover classes identified above, data were available for the three habitat variables at 96 different locations (Figure D.18). These data were assembled from a number of different projects that collected vegetation characterization data using a consistent sampling protocol. Data sources the Ecosystem Monitoring Project (data from spring/summer of 1993 collected in the 600 Area), from Westinghouse Hanford (data from the summer of 1993 collected within

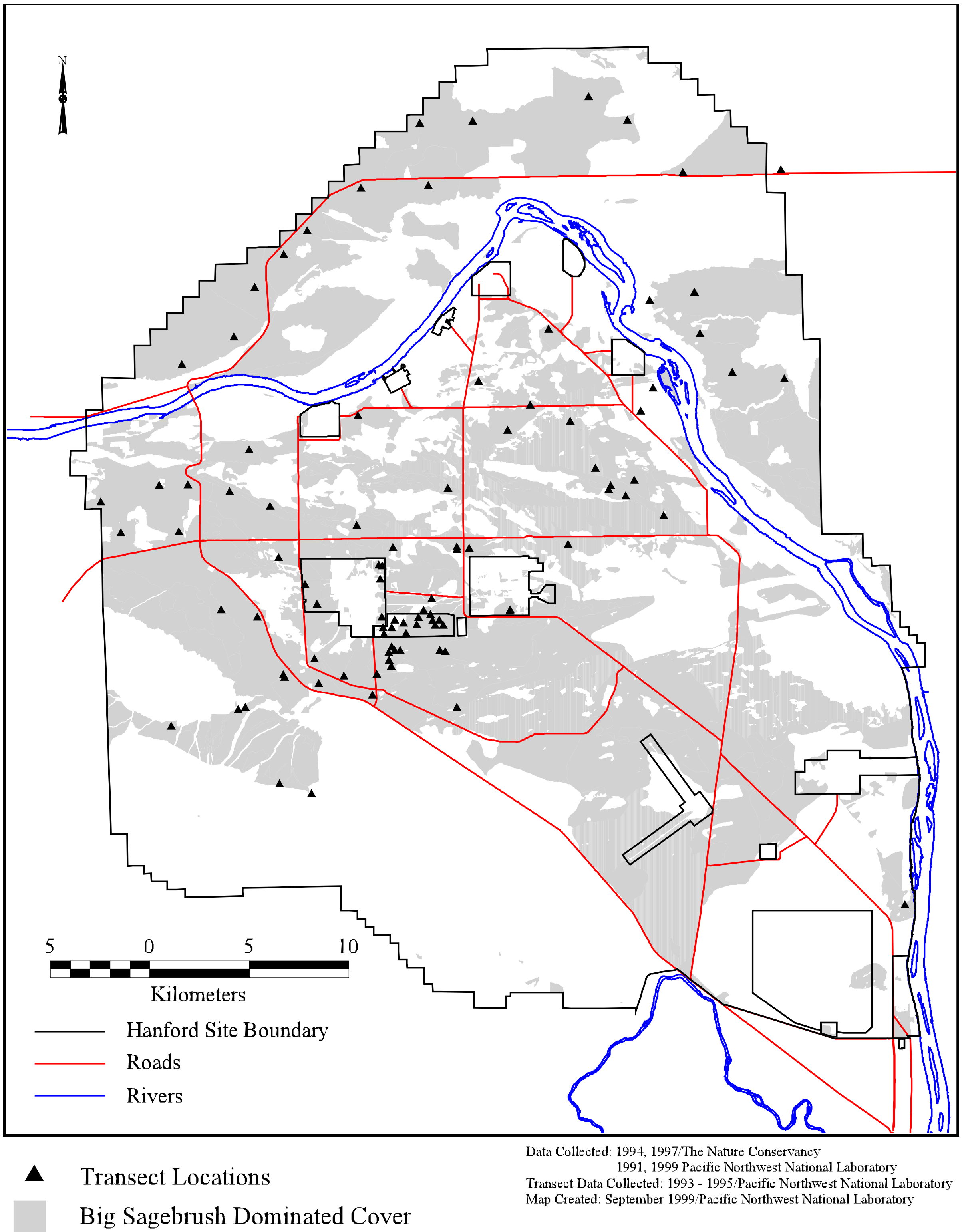

Figure D.18 Areal Extent of Late-Successional, Big Sagebrush-Dominated Cover Classes and Vegetation Transect Sampling Locations the 200 Areas), characterization data for the Environmental Restoration Disposal Facility (ERDF) from the Hanford Biological Resources Laboratory (data from the summer of 1994 within and in proximity to the ERDF site), and data from additional sampling conducted by the laboratory within the 200 Areas (summer of 1995). A total of 69 locations were sampled in 1993, 22 in 1994, and 5 in 1995.

The habitat variable data were collected along 100-m- (330-ft) long transects that extended in a randomly oriented direction. The location of each transect was recorded using topographic maps in 1993 and a GPS in 1994 and 1995. Three replicates of sagebrush cover and mean height were measured along each transect within 10 x 10 m (3.3 x 3.3 ft) plots (spaced at 25–35 m, 50–60 m, and 75–85 m along the transect). Twenty replicates of herbaceous canopy cover were visually estimated using modified Daubenmire plot frames [0.1 m^2 (1.1 ft^2); Daubenmire 1959] spaced 5 m (16 ft) apart. The Daubenmire procedure was modified by placing a 10-cm x 10-cm (4 x 4 in.) grid within the plot frame to aid in estimating percent cover. Cheatgrass cover was recorded as a percentage of ground cover.

For many of the sampling locations, big sagebrush was not the only shrub present. When big sagebrush accounted for roughly 80% or more of the shrub cover recorded along a transect, total shrub cover was used as the value for sagebrush cover, and the height of all shrubs was used to calculate mean shrub height. In these cases, the secondarily dominant shrub was either spiny hopsage or bitterbrush. Both of these shrubs are tall shrubs as is big sagebrush. In other cases, when big sagebrush was not the dominant shrub along the transect, the dominant shrub was rabbitbrush. Rabbitbrush are medium stature shrubs and are generally indicative of a seral stage. For these sampling locations, zero values were assigned for sagebrush cover and height.

Step three consisted of conducting a geostatistical analysis of the habitat data. Geostatistics is a specialized form of statistics that focuses on the spatial continuity (or spatial autocorrelation) of data distributed in space (Isaaks and Srivastava 1989). Most classical statistical analysis techniques assume that data are completely independent of one another. This assumption is incorrect for the majority of environmental data (e.g., geological, soils, or botanical data), because the data normally result from the action of physical and chemical processes that operate continuously over distinct regions of the earth. This results in a strong correlation between data from nearby locations (i.e., a spatial autocorrelation). Geostatistics attempts to quantitatively model this spatial autocorrelation and use the models to improve the accuracy of maps.

The majority of the geostatistical analysis was performed using the averages of the replicate measurements for each variable. The average cover and height of sagebrush at the 96 sample locations were symmetrically distributed around means of 16% and 83 cm (33 in.), respectively. The average cheatgrass cover had a distribution with a slight positive skew with mean and median cover of 20% and 18%, respectively. Examination of the bivariate relationships between the three variables did not reveal any correlation between them (i.e., the highest Spearman rank correlation coefficient was 0.28 between average shrub cover and shrub height).

Variogram analysis and modeling (Isaaks and Srivastava 1989) was performed to determine quantitative models of the spatial continuity of each of the three variables. The variogram plots the average squared difference between pairs of data values separated by a given distance as a function of that distance (Figure D.19). Environmental data normally have lower variogram values for pairs of nearby data points and higher values for pairs of points separated by greater distances. Mathematical functions (e.g., exponential or spherical functions, Isaaks and Srivastava 1989) can then be fit to the experimental variogram to quantitatively describe the spatial continuity of the data set.

Because the geostatistical mapping technique employed in the study was sequential Gaussian simulation (see description below), a normal score transform (Deutsch and Journel 1992) was first applied to the data to transform it to a Gaussian (i.e., normal) distribution. Omnidirectional variogram models were used because no preferential direction of spatial continuity could be detected in the data and there was no prior ecological reason to postulate that any of the three variables would be more continuous in one direction than another. Spherical variogram models (Isaaks and Srivastava 1989) were fit to the normal score transforms of the three variables:

- cheatgrass cover: $((h) = 0.30 + 0.70\ Sph_{4240}(h)$
- sagebrush cover: $((h) = 0.34 + 0.66\ Sph_{3840}(h)$
- sagebrush mean height: $((h) = 0.28 + 0.72\ Sph_{2720}(h)$

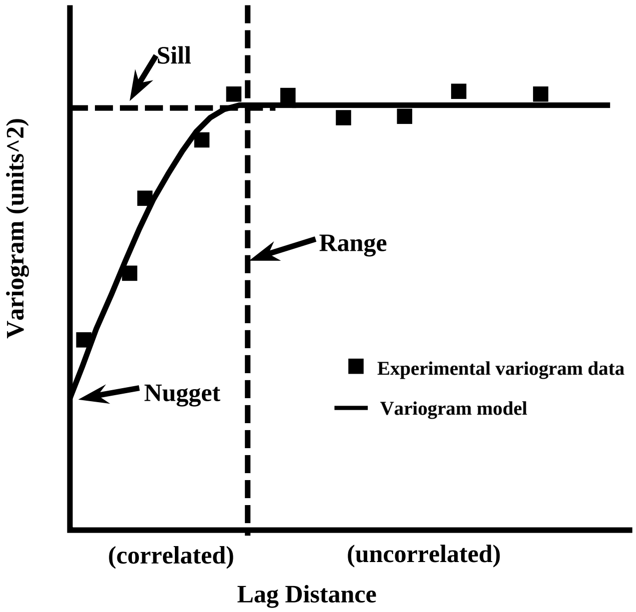

Figure D.19 Sample Variogram Model. The variogram is a geostatistical tool that measures the average squared difference between pairs of data values separated by a given lag distance. At distances less than the range, the variogram is a function of distance related to the degree of spatial correlation. Points separated by distances greater than the range are uncorrelated. The variogram is constant beyond the range, at a value termed the sill, which is usually equal to the total variance. The value of the variogram is defined as zero for a distance of zero, but the nugget can be used to model short-range variability that exists at distances smaller than the sampling interval.

The equations indicate that, for example, the range of spatial continuity of cheatgrass cover was 4240 m (13,910 ft), and that 70% of the total variability in the data can be explained by spatial dependence. The remaining 30% is due to measurement error and small-scale spatial variability that occurs at distances less than the shortest interval between sample pairs [see Isaaks and Srivastava (1989) for a more complete discussion of variogram modeling for the quantification of spatial continuity].

The geostatistical technique used to map the habitat variables was conditional simulation. Conditional simulation is a Monte Carlo technique that can be used to generate large numbers of equally probable maps of a variable. Each of the equally probable maps honors the conditioning sample data and the variogram model of spatial continuity. The simulations are generated at a regular series of locations (grid nodes) laid across the area. The grid spacing for the simulations of shrub height, shrub cover, and cheatgrass cover produced for this study was 100 m (330 ft). At each grid node, the surrounding data and the variogram model are used to estimate the conditional distribution of the variable at that node. A uniform random number between 0 and 1 is then used to draw a value from the conditional distribution. For this study, 100 conditional simulations of each variable were then generated using the sequential Gaussian simulation program SGSIM (Deutsch and Journel 1992). Conditional simulations honor the available data, the frequency distribution (histogram) of the data, and the spatial continuity model (variogram model) fit to the data. The simulations were generated independently because no correlation was detected between the three variables.

For step four, the output of the geostatistical analysis was used to determine the suitability of each location on the 100-m grid as sage sparrow habitat. A program was written to read in the three simulated values at each grid node within a geographic area (the simulation space) that includes the modeling region. (At the end of the process, the output values of the simulation outside of the modeling region were masked out.) To determine if the grid node would be mapped as sage sparrow habitat, the following test was applied for each simulation:

- suitable habitat = cheatgrass ground cover ≤25% AND sagebrush cover ≥10% AND sagebrush mean height ≥50 cm (20 in.).

If the grid node tested positive for sage sparrow habitat for that simulation, then a counter was incremented. The output of the program was an array that contained the counts of the number of simulations for which sage sparrow habitat tested positive at each grid node. This Monte Carlo approach was used to estimate the probability that the area represented by a given grid node contains sage sparrow habitat by using the proportion of simulations for which the test was positive. For example, if 45 simulations out of 100 at a grid node tested positive for sage sparrow habitat, then the estimated probability of suitability for that area would be 45%.

Because the impact to suitable habitat may be irreversible, the model was applied conservatively (see earlier discussion above). Therefore, for the map of suitable habitat, only five simulations had to be positive for a given grid node to be considered suitable sage sparrow habitat. For the final step, the cover map (Figure D.18) was then applied as a mask to the results of the probability map to blank all areas outside of the modeling region (i.e., areas that did not contain late-successional sagebrush-steppe habitat). The final result of habitat association modeling for the sage sparrow is presented in Figure D.20. In addition to removing certain areas from consideration as potential sage sparrow habitat based on the model output, the final map also includes the effect of constructing the ERDF.

Actual occupancy by sage sparrows of areas depicted in Figure D.20 also may depend on landscape effects (Knick and Rotenberry 1995) not examined by the geostatistical model. Knick and Rotenberry found that habitat usage by sage sparrows depended on the patch size of shrub-steppe habitats and the spatial similarity of the habitat within the patch (i.e., how homogeneous the patch is). Their results suggest that fragmentation of the shrub-steppe adversely affects the presence of sage sparrows (as well as other shrub-obligate species). The application of Figure D.20 at the landscape level is to recognize the detrimental effects of fragmentation and to manage the remaining late-successional communities in a manner that minimizes additional fragmentation or even reverses it. Moreover, if further impacts to the shrub-steppe are unavoidable, their spatial occurrence should be directed away from the largest patches of remaining late-successional shrub-steppe.

Although Figure D.20 is intended to help steer site-wide development plans away from late-successional sagebrush-steppe, and by doing so reduce both impacts to biological resources and compensatory mitigation costs, habitat quality models also may be necessary to apply at a smaller scale such as in determining both appropriate site selection for individual projects and any mitigation costs. For individual projects, it may be appropriate to consider a threshold value for the amount of habitat loss that is allowed before it is necessary to consider compensatory mitigation. A possible approach is to base such a threshold value on the breeding territory size of a sage sparrow pair.

For sage sparrows, territory size is positively related to reproductive success (Petersen and Best 1987). Males occupy non-overlapping singing territories; however, foraging areas may overlap (Wiens et al. 1985; see also Petersen and Best 1987). Rich (1980b) reported that territory size changed in size and shape both daily and seasonally as breeding progressed; however, once established, Petersen and Best (1987) reported that territories remained fixed throughout the breeding season. The size of the territory may depend on habitat features; thus, sage sparrow territories tend to be larger in habitats that include spinescent shrubs (i.e., spiny hopsage) compared with pure sagebrush habitats (Wiens et al. 1985).

The ability to detect the effects of habitat differences on territory size are complicated, however, by the effects of differences in population density. Although at low population densities sage sparrows may select for optimal habitat conditions, at high densities (when a minimal acceptable territory size may be reached) individuals may be forced to occupy habitats with suboptimal conditions (Wiens et al. 1985). Finally, sage sparrows seem to possess an adaptive behavior that expresses itself as a shift in the location of the territory with each breeding season. The behavior seems to be directed at achieving an increase in territory size (Petersen and Best 1987).

Documented sage sparrow territory sizes range from around 0.4 ha (1 acre) (Petersen and Best 1987) to about 7.1 ha (17.5 acres) (Rich 1980b). Data collected specifically at Hanford on the ALE Unit depict plot means that range from 0.65 ha (1.6 acres) (mean of nine territories) to 1.57 ha (3.9 acres) (mean of 6 territories) (Wiens et al. 1985). Relative to data from other geographic locations, the ALE Unit data correspond to territory sizes that occur under high population densities (Wiens et al. 1985, their Figure 3). Based on the preceding discussion, 0.5 ha (1.2 acres) seems to be a reasonable, conservative estimate of the minimum territory size that may be expected to occur for a sage sparrow at Hanford.

D.2.3 Plant Communities

D.2.3.1 Protection of Washington's Natural Heritage: The Natural Heritage Program

Unaltered ecosystems are highly evolved, interactive associations of abiotic and biotic components. These associations cannot be duplicated artificially. Moreover, they represent storehouses of natural diversity. Examples of these complex ecological systems may be invaluable to future generations in

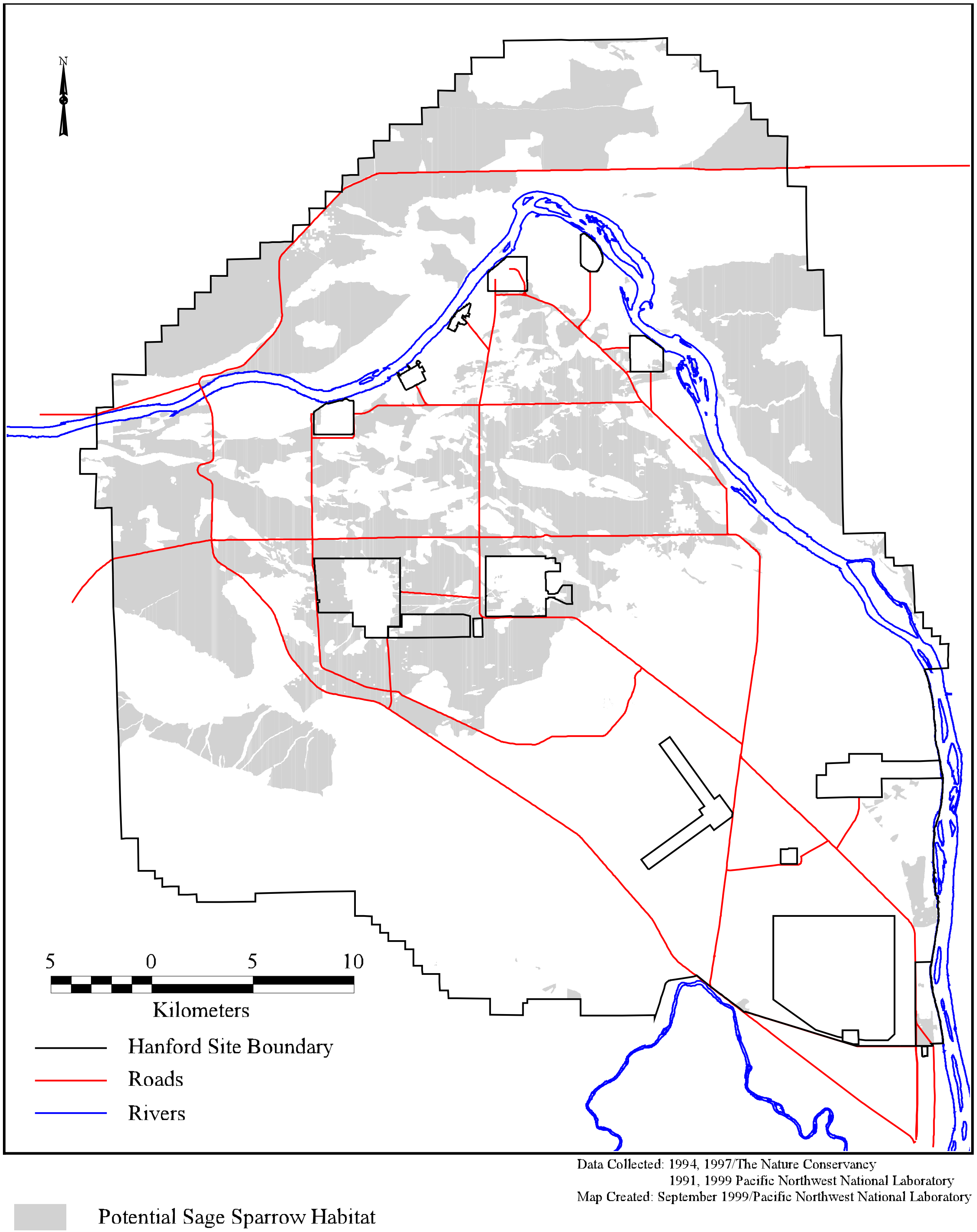

Figure D.20 Areas of Potential Usage by Sage Sparrows Based on a Modeling of Habitat Association ways that presently cannot be foreseen (WDNR 1995). In 1972, the Washington State Legislature recognized the need to preserve such areas and passed the Natural Area Preserves Act [Chap ter 79.70 Revised Code of Washington (RCW)]. The legislature declared: "It is, therefore, the public policy of the State of Washington to secure for the people of present and future generations the benefit of an enduring resource of natural areas" (RCW 79.70.010). The act authorized the WDNR to cooperate with federal and other governmental agencies to establish and manage natural areas. Federal counterparts to the state system of managed natural areas include Research Natural Areas (such as the ALE Unit) and Areas of Critical Environmental Concern (managed by the Bureau of Land Management). Washington State law (i.e., RCW 79.70) and regulations (Washington Administrative Code 332–60) enable registration of federal natural areas as components of the statewide Natural Area System (WDNR 1995).

A 1981 amendment to the Natural Area Preserves Act established the Natural Heritage Program within WDNR. Part of this program's mandate was to establish a classification scheme for the state's natural heritage resources (i.e., the state's natural diversity) and to provide assistance in the selection and nomination of areas for the protection of their qualifying resources (WDNR 1995).

D.2.3.2 Ecological Significance of Element Occurrences

Washington's natural diversity consists of thousands of plant and animal species that interact with each other and their physical environment. Faced with such numbers, a systematic approach is needed to inventory and protect the state's natural diversity. The technique used by WDNR's Natural Heritage Program is to classify Washington's natural diversity into elements. As defined in the Natural Heritage Plan, an element is a basic unit of Washington's biologic and geologic environment identified as a needed component of a system of natural areas. An element is an entire ecological system, such as a plant community or a wetland ecosystem, that includes the common plants and animals of that system (WDNR 1995).

Elements are evaluated for their present condition and ability to persist over time. Additionally, their ecological quality, diversity, and viability are compared with other occurrences of the element to determine which occurrence(s) provides the best representation of the element. There also is a site analysis that considers the ability of the location containing the element to both provide protection against human-induced disturbances and to enable management, either actively or passively, that maintains the element (or natural processes) through time. By tracking the location and quality of the various occurrences of a particular element, the Natural Heritage Program can assess the significance of a given occurrence relative to other occurrences in the state or region.

Because it is a more efficient use of public and private lands and funds to select sites with multiple elements, selection of a natural area favors those sites containing multiple elements. Many federal agencies use WDNR's approach for selecting natural areas (WDNR 1995).

Elements also are ranked in regard to their priority for receiving protection based on the element's rarity (regionally as well as state), the degree of threat to which the element is exposed to within Washington, and the adequacy of protection for the element by existing land management (WDNR 1995). The evaluation of protection adequacy also considers whether currently protected element occurrences are adequate representatives of an element. Based on these guidelines WDNR assigns one of three priority rankings to each terrestrial, wetland, or aquatic ecosystem element. Priority designations are as follows:

- Priority 1: elements in the greatest jeopardy of being destroyed or degraded, with few occurrences in natural condition and little or no protection in existing natural areas
- Priority 2: elements in an intermediate level of jeopardy, with few occurrences in natural condition, and little or no protection in existing natural areas
- Priority 3: elements not in immediate jeopardy, with varying numbers of occurrences in natural condition, and some protection in existing natural area.

D.2.3.3 Element Occurrences on the Hanford Site

In 1994, TNC evaluated for the ALE Unit and North Slope each occurrence of a plant community type considered by the Natural Heritage Program to be an element (TNC 1995). Each element was evaluated as to its condition, size, and proximity to disturbance vectors such as roads, power lines, off-road vehicle trails, or livestock grazing. Three factors formed the basis for the condition evaluation: (1) the degree of invasion by non-native plant species; (2) the composition of the community as compared with descriptions by Daubenmire (1970), the Natural Heritage Program, or other occurrences of the same element; and (3) the degree of soil disturbance and amount of microbiotic crust cover. The Nature Conservancy identified as potential element occurrences (i.e., a high-quality representative of a native plant community type) only those occurrences that met high-quality standards associated with the evaluation factors described above. The Natural Heritage Program subsequently reviewed the TNC evaluation results and made the final determination as to which occurrences qualified as element occurrences.[12]

The Nature Conservancy conducted additional field work along the south shore of the Hanford Reach during 1995. They identified six potential element occurrences of low elevation riparian wetlands (Salstrom and Easterly 1995). The Natural Heritage Program subsequently determined that all six qualified as element occurrences.[13] Based on field work conducted in 1996, Natural Heritage Program staff added an additional six element occurrences of the big sagebrush/Sandberg's bluegrass plant community type. This community type is not yet identified in the Natural Heritage Plan (WDNR 1995), but it is intended to be added to the next addition of the plan.[14]

The results of the 1994, 1995, and 1997 TNC evaluations and Natural Heritage Program reviews and 1996 field work are summarized pictorally in Figure D.21. The map is a reclassification of the appropriate portions of the Figure D.1 land cover classes. Because identification of an element is based on the potential plant community type (i.e., the plant composition that represents a last stage of succession), some of the qualifying seral communities identified in Figure D.1 are reclassified in Figure D.21 on this basis. Data on Natural Heritage Program priority ranking, number of occurrences, and area totals for each plant community type are summarized in Table D.3. The six low-elevation riparian wetland element occurrences, which occurred along the south shore of the Hanford Reach, are not included in Table D.3. Currently, only approximate locational information (shown in Figure D.21) is available for these element occurrences. Area information will be added at a later date.

A total of 38 separate terrestrial plant communities, representing 17 elements recognized by the Natural Heritage Program qualified as element occurrences. The 17 elements constitute about 40% of all the terrestrial elements found in the Columbia Basin Province of Washington (WDNR 1995).[15] Only three elements are common to both the ALE Unit and North Slope. This indicates that, to protect the full range of element diversity, both the ALE Unit and the North Slope must be considered. The element occurrences occupy about 18,280 ha (45,170 acres) of the ALE Unit and about 6,290 ha (15,540 acres) of the North Slope. The large sizes and excellent conditions of the big sagebrush/bluebunch wheatgrass community (ALE Unit) and the bitterbrush/Indian ricegrass sand dune complex (North Slope) are especially noteworthy (TNC 1995).

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12 TNC (1995) identified 38 potential element occurrences; however, the Natural Heritage Program determined that six of these did not qualify as element occurrences because of inadequate ecological condition and/or size [Letter from M. Sheehan, Washington Natural Heritage Program, Washington Department of Natural Resources to L. Cadwell (PNNL), dated February 27, 1996.]

13 Although the Natural Heritage Program recognized all six occurrences, the areal extent accepted was smaller than that indicated in Salstrom and Easterly (1995) [Letter from C. Chappell, Washington Natural Heritage Program, Washington Department of Natural Resources to L. Cadwell (PNNL), dated May 31, 1996]. Because the element occurrences are connected to nearby cover types through hydrology and fluvial processes, the Natural Heritage Program recommended, however, the protection of the entire original areas mapped as element occurrences by Salstrom and Easterly (1995) to protect the integrity of the element occurrences.

14 Letter from C. Chappell, Washington Natural Heritage Program, Washington Department of Natural Resources to L. Cadwell (PNNL), dated August 6, 1996. Letter from M. Sheehan, Washington Natural Heritage Program, Washington Department of Natural Resources to L. Cadwell (PNNL), dated February 27, 1996.

15 The boundaries of the Columbia Basin Province as described in WDNR (1995) mostly encompasses the Washington portion of the Columbia Basin Ecoregion.

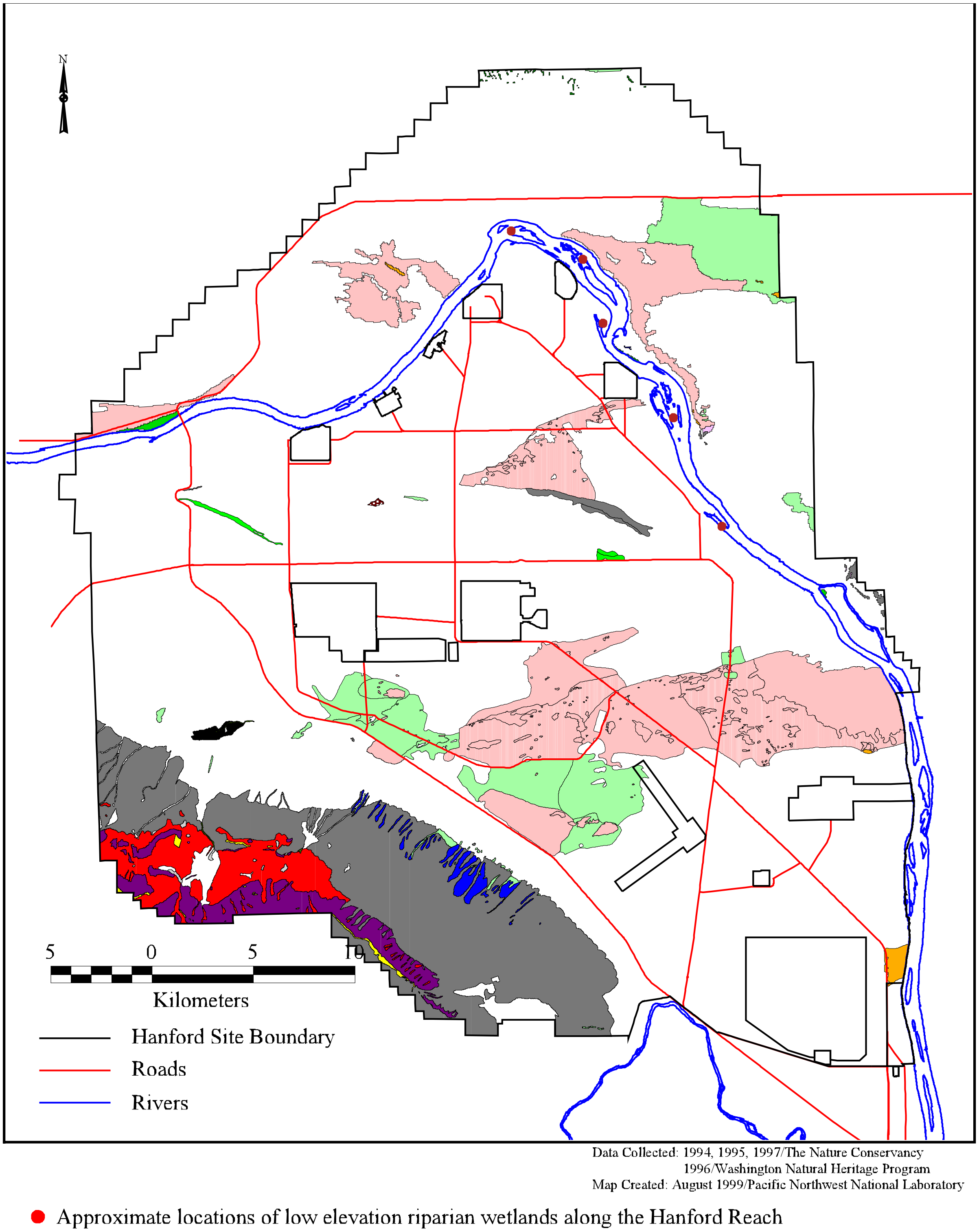


Figure D.21 Washington State Natural Heritage Program Element Occurrences on the Hanford Site Exclusive of the Upland Portions of the Central Core (Map)

LEGEND

- Alkali Saltgrass
- Big Sagebrush / Bluebunch Wheatgrass
- Big Sagebrush / Needle-and-Thread
- Bitterbrush / Indian Ricegrass Sand Dune Complex
- Bitterbrush / Needle-and-Thread
- Black Greasewood / Alkali Saltgrass
- Rock Buckwheat / Sandberg's Bluegrass
- Sand Dropseed - Sandberg's Bluegrass
- Spiny Hopsage / Sandberg's Bludgrass
- Stiff Sagebrush / Sandberg's Bluegrass
- Threetip Sagebrush / Bluebunch Wheatgrass
- Threetip Sagebrush / Idaho Fescue
- Threetip Sagebrush / Needle-and-Thread
- Thyme Buckwheat - Rock Buckwheat / Sandbergs Bluegrass
- Willow Riparian Complex
- Winterfat / Sandberg's Bluegrass
- Big Sagebrush / Sandberg's Bluegrass
- Special Mosaic Type
  Big Sagebrush / Bluebunch Wheatgrass
  Big Sagebrush / Needle-and-Thread
  Stiff Sagebrush / Sandberg's Bluegrass

Figure D.21 Washington State Natural Heritage Program Element Occurrences on the Hanford Site Exclusive of the Upland Portions of the Central Core (Legend)

Table D.3 Potential Plant Community Types of the Hanford Site that had at Least One Qualifying Element Occurrence (EO)

Potential Plant Community Type	**Total Acreage on the Hanford Site (acres/ha)**	**WNHP Protection Priority Status***	**Number of EOs on the ALE Reserve**	**Total Acreage Qualifying as EOs on the ALE Reserve (acres/ha)**	**Number of EOs on the North Slope**	**Total Acreage Qualifying as EOs on the North Slope (acres/ha)**	**Number of EOs on Central Hanford[a]**	**Total Acreage Qualifying as EOs on Central Hanford (acres/ha)[a]**
Alkali saltgrass	6/3	1	0	0	1	6/3	0	0
Big sagebrush/bluebunch wheatgrass	37,384/15,129	2	1	28,714/11,622	2	163/66	1	665/269
Big sagebrush/needle-and-thread	84,701/34,278	1	1	245/99	3	5330/2156	2	8133/3291
Big sagebrush/Sandberg's bluegrass	43,060/17,426	3	5	3669/1485	1	1223/495	2	322/130
Bitterbrush/Indian ricegrass dune complex	34,379/13,913	1	0	0	3	8433/3413	3	20,993/8496
Bitterbrush/needle-and-thread	1384/560	1	0	0	3	63/25	1	349/141
Black greasewood/alkali saltgrass	299/122	1	1	299/122	0	0	0	0
Rock buckwheat/ Sandberg's bluegrass[b]	126/51	ap	2	126/51	0	0	0	0
Sand dropseed/ Sandberg's bluegrass	4332/1753	2	0	0	3	225/90	0	0
Spiny hopsage/ Sandberg's bluegrass	2713/1098	3	0	0	2	37/15	0	0
Stiff sagebrush/ Sandberg's bluegrass	144/58	3	0	0	1	74/30	0	10/4
Threetip sagebrush/ bluebunch wheatgrass	6227/2520	2	2	6059/2451	0	0	0	0
Threetip sagebrush/Idaho fescue	4703/1903	2	1	4703/1903	0	0	0	0
Threetip sagebrush/ needle-and-thread	116/45	1	1	116/45	0	0	0	0
Thyme buckwheat/ Sandberg's bluegrass[b]	124/50	2	2	124/50	0	0	0	0
Willow riparian complex	61/25	1	2	24/10	0	0	0	0
Winterfat/Sandberg's bluegrass	1164/471	3	1	1092/443	0	0	0	0
Total	220,923/89,405	—	19	45,171/18,281	19	15,554/6293	10	30,472/12,331

*Washington Natural Heritage Program (WNHP) Protection Priority Status (WDNR 1995): **ap**—adequately protected.
Priority 1—Elements in the greatest jeopardy of being destroyed or degraded, limited distribution in Washington and few occurrences in natural condition, and little or no representation in existing natural areas or other protected areas.
Priority 2—Elements at an intermediate level of jeopardy, regional distribution in Washington and few occurrences in natural condition, and little or no representation in existing natural areas or protected areas (may receive some *de facto* protection in other managed areas).
Priority 3—Elements not in immediate jeopardy but are still significant components of the state's natural heritage, regional distribution in Washington, and varying numbers of occurrences in natural condition, and may be partially represented in existing natural areas (or, if not in natural areas, are in areas that provide *de facto* protection).
(a) The tally for the number of element occurrences per potential plant community type includes instances when a type contributed solely to an element occurrence plus when it was the largest type (by acreage) within a mosaic of multiple potential plant community types, each of which qualified as an element occurrence. Total acreage per potential plant community type also includes the percentage amount contributed by a type when it qualified as an element occurrence as part of a mosaic. See text for additional details.
(b) Rock and thyme buckwheat mostly occurred together. Where they occurred together, the total area occupied was split equally between the two shrub community types.

D.2.3.4 Use of Designated Natural Areas to Manage Hanford's Element Occurrences

In 1971, the ALE Unit was designated the Rattlesnake Hills Research Natural Area as a result of an interagency federal cooperative agreement (PNL 1993). It constitutes the single largest tract in the federal RNA system for Oregon and Washington (Franklin et al. 1972; Rickard 1972). Research Natural Areas preserve plant communities and other natural features primarily for scientific and educational purposes. In short, RNAs provide: (1) baseline areas against which to compare the effects of human activities in similar environments, (2) sites for study of natural processes in undisturbed ecosystems, and (3) gene pool preserves for plant and animal species, especially species of concern (Franklin et al. 1972). Because of their purpose and protection status, federal RNAs can be important components of Washington State's Natural Area System (WDNR 1995).

Prior to the 1994 TNC surveys, Washington's Natural Heritage Plan (WDNR 1995) had identified the presence of six types of terrestrial (i.e., plant community) element occurrences and two types of wetland and aquatic ecosystem element occurrences (see section on rare habitats in D.3.2) on the ALE Unit. The TNC study identified the presence of five new types of terrestrial element occurrences on the ALE Unit (TNC 1995).[16] Natural Heritage Program surveys during 1996 added one more. Moreover, the number and extent of the ALE Unit element occurrences are now mapped (Figures D.17 and D.21) and their condition documented.

Because the ALE Unit already is administered as a RNA, the element occurrences, new and old, are considered to exist under a high degree of protection (WDNR 1995). Such protection is not necessarily the case for the newly identified element occurrences on the North Slope. Current management practices and administrative designations on the North Slope may require revision in order to appropriately protect the 19 occurrences of nine elements on the North Slope as natural areas. Appropriate management strategies are discussed in Sections 7.3 and 7.4.

D.2.4 Administrative Areas

Some areas of the Hanford Site have administrative designations that establish the perpetuation of biological resources values, among other values, as at least one of their top priorities (Figure D.22). These are no impact zones or at least areas within which adverse impacts to biological resources of concern (i.e., levels III and IV) should be fully mitigated.

As an RNA, the ALE Unit is managed primarily for its scientific and educational values insofar as these values relate to the ALE Unit's role as perhaps the best remnant of the shrub-steppe ecosystem in the Columbia Basin Ecoregion. Access to the ALE Unit is restricted if the purposes are not compatible with the primary management goals. As a natural area, management emphasis for the ALE Unit must be on maintaining (or enabling to change naturally) the native biotic composition and natural ecological processes that presently exist. To accomplish this, even mitigation (or buffering) of human-induced changes adjacent to the ALE Unit may need to be considered.

The Saddle Mountain Unit and the Wahluke Unit are managed primarily for their wildlife and habitat values. Access to the national refuge is restricted; whereas, regulated public access is allowed on the Wahluke Unit. The documented presence of numerous plant community element occurrences and rare plant populations (TNC 1995) may necessitate some changes in management approach for these areas.

D.2.5 Species of Concern

In this section, detailed biological and regulatory information is provided at the level of the individual species. The information provided includes: (1) federal and state listing status, (2) WDNR Natural Heritage Program or WDFW Priority Species status, (3) state and global rarity data, (4) whether the species is endemic to the ecoregion, (5) distribution within the ecoregion, (6) habitat association, (7) Hanford relative abundance, (8) and the resource level of concern to which the species is assigned to at Hanford.

16 One plant community type previously identified in the Heritage Plan, spiny hopsage/Sandberg's bluegrass, was not identified on the ALE Unit by TNC but is present on the North Slope and more than likely within the central core. See text for additional discussion.

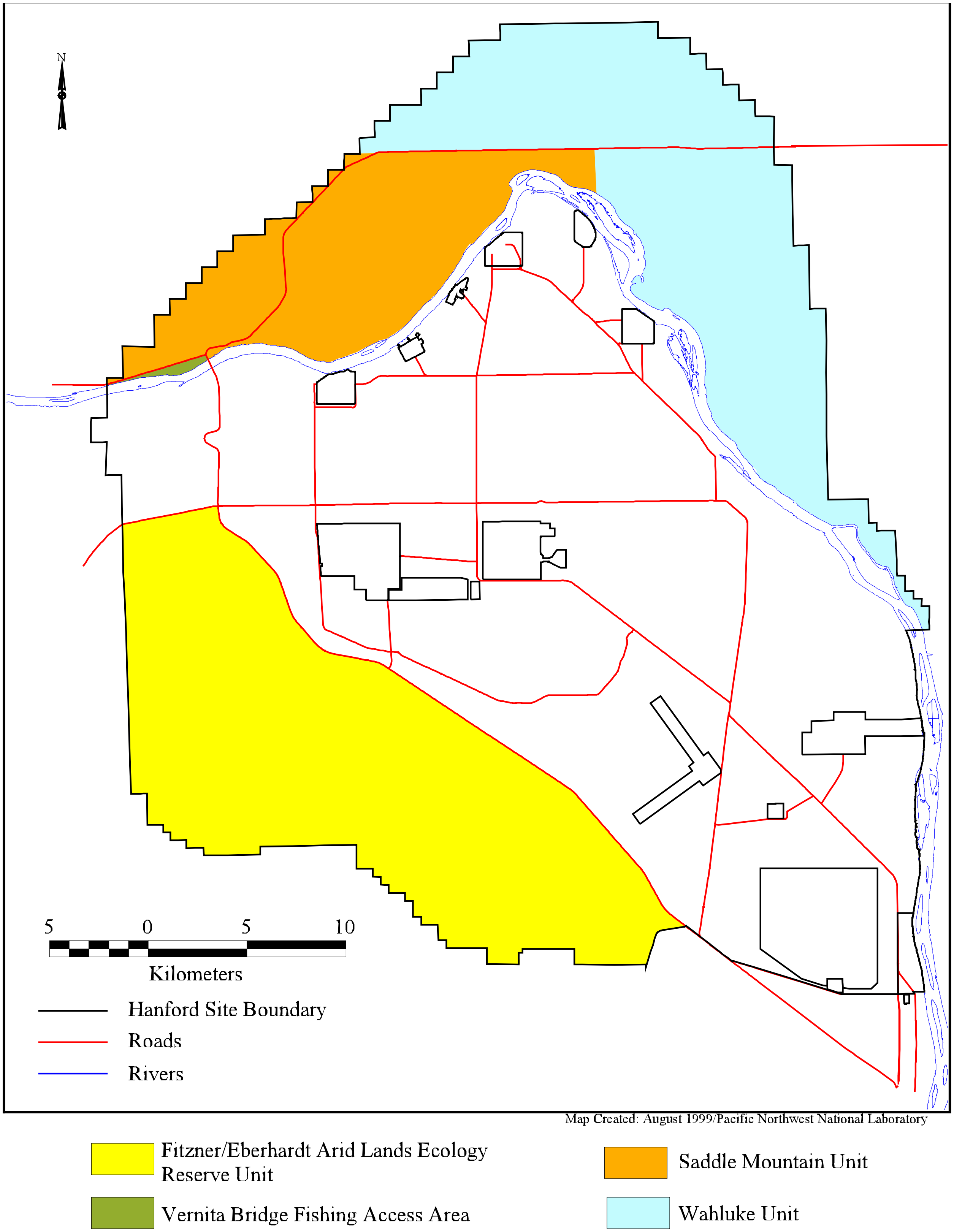


Figure D.22 Administratively Designated Areas of Hanford Within Which Protection of Biological Resource Values is a Priority Consideration

Because the Columbia Basin Ecoregion constitutes the relevant ecological boundary for assessing the significance of and impacts to species of concern, information relative to each species for Oregon is provided when available to supplement the Washington data. For some taxa or specific species, the information is not as complete. In general, however, the tabular information that follows represents the best information available.

Species data are provided first by taxa. Additional tabular information includes culturally and ecologically important species not otherwise identified as species of concern. Finally, information is provided on species recently discovered at Hanford that are either new to science, new to Washington, or new to Hanford. For the first two new species categories, federal and/or state listing statuses still need to be determined. To facilitate review of the tabular information, this section begins by providing definitions of federal and state listing and priority species categories, protection priorities, and rarity statuses. This information is common to many of the tables. By providing it in one place, the need to repeat the information for each table is avoided.

D.2.5.1 Common Reference Information for Species of Concern Data Tables

Federally Listed and Federal Candidate Species: References

U.S. Fish and Wildlife Service. August 20, 1994. Endangered and Threatened Wildlife and Plants. 50 CFR 17.11 and 17.12.

U.S. Fish and Wildlife Service. February 28, 1996. Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that are Candidates for Listing as Endangered or Threatened Species. 61 FR 7595–7613.

www.fws.gov/r9endspp/endspp.html

Federally Listed and Federal Candidate Species: Category Definitions

Endangered - a species which is likely to become extinct throughout all or a significant portion of its range.

Threatened - a species which is likely to become endangered in the foreseeable future.

Proposed - a species for which a proposed rule to list as endangered or threatened has been published in the Federal Register.

Candidate (previously defined as candidate category 1) **-** a species for which there is sufficient information on biological vulnerability and threat(s) to support issuance of a proposed rule to list it as endangered or threatened but issuance of the proposed rule is precluded (i.e., by other listing activity or lack of funding).

Added definition for the purposes of BRMaP:

Former Candidate - a species previously proposed for listing (whether or not a proposed rule was ever published in the Federal Register) or a species for which information at one time indicated that proposing to list it as endangered or threatened was possibly appropriate, but for which sufficient information on biological vulnerability and threat(s) were not available to support a proposed rule to list.

Washington State Listed, Candidate, and Monitor Species: References

Plants

Washington Department of Natural Resources. 1994. Endangered, Threatened & Sensitive Vascular Plants of Washington. Washington Department of Natural Resources, Washington Natural Heritage Program, Olympia, Washington.

www.wa.gov/dnr/
www.wa.gov/wdfw/hab/phspage.htm

Animals

Washington Department of Wildlife. 1994. Species of Special Concern in Washington. Washington Department of Wildlife, Olympia, Washington, as amended by a listing and candidate notice update by the now Washington Department of Fish and Wildlife, dated April 2, 1996.

www.wa.gov/wdfw

Washington State Listed, Candidate, and Monitor Species: Category Definitions

Plants

Endangered - a species which is likely to become extinct throughout all or a significant portion of its range within the state.

Threatened - a species which is likely to become endangered in the foreseeable future.

Sensitive - a species which is likely to become endangered or threatened in a significant portion of its range within the state.

Review 1 - a species in need of additional field work before a status can be assigned.

Review 2 - a species with unresolved taxonomic questions.

Watch List Species - a species more abundant and/or less threatened in Washington than previously assumed.

Animals

Endangered - wildlife species native to the state of Washington that are seriously threatened with extinction throughout all or a significant portion of its range within the state.

Threatened - wildlife species native to the state of Washington that are likely to become endangered in the foreseeable future throughout significant portions of their ranges within the state without cooperative management or the removal of threats.

Sensitive - wildlife species native to the state of Washington that are vulnerable or declining and are likely to become endangered or threatened throughout significant portions of their ranges within the state without cooperative management or the removal of threats.

Candidate - wildlife species that are under review by the Washington Department of Wildlife for possible listing as endangered, threatened, or sensitive.

Monitor - Wildlife species native to the state of Washington that:

1 - were at one time classified as endangered, threatened, or sensitive

2 - require habitat that has limited availability during some portion of its life cycle

3 - are indicators of environmental quality

4 - require further field investigations to determine population status

5 - have unresolved taxonomy which may bear upon their status classification

6 - may be competing with and impacting other species of concern

7 - have significant popular appeal.

Washington State Species Protection Priorities: References

Plants

Washington Department of Natural Resources. 1995. State of Washington Natural Heritage Plan: 1993/1995 Update. Washington Department of Natural Resources, Washington Natural Heritage Program, Olympia, Washington.

Animals

Washington Department of Fish and Wildlife. 1996. Priority Habitats and Species List. Washington Department of Fish and Wildlife, Habitat Program, Olympia, Washington.

Washington State Species Protection Priorities: Category Definitions

Plants

Priority 1 - These taxa are in danger of becoming extinct throughout their ranges. These taxa's populations are at critically low levels or their habitats are degraded or depleted to a significant degree. These taxa are the highest priorities for preservation.

Priority 2 - These taxa will become endangered in Washington if factors contributing to their population decline or habitat degradation or loss continue. These taxa area high priorities for preservation efforts.

Priority 3 - These taxa are vulnerable or declining and could become endangered or threatened in the state without active management or removal of threats. These taxa should be important in the analysis of potential preserve sites.

Animals

Criterion 1 (State Listed and Candidate Species) - State listed species are those native fish and wildlife species legally designated as Endangered (WAC 232-12-014), Threatened (WAC 32-12-011), or Sensitive (WAC 232-12-011). State Candidate species are those fish and wildlife species that will be reviewed by the department (POL-M-6001) for possible listing as Endangered, Threatened, or Sensitive according to the process and criteria defined in

WAC 232-12-297. Federal Candidate species are evaluated individually to determine their status in Washington and whether inclusion as a priority species is justified.

Criterion 2 (Vulnerable Aggregations) - Vulnerable aggregations include those species or groups of animals susceptible to significant population declines, within a specific area or statewide, by virtue of their inclination to aggregate. Examples include heron rookeries, seabird concentrations, marine mammal haulouts, shellfish beds, and fish spawning and rearing areas.

Criterion 3 (Species of Recreational, Commercial, and/or Tribal Importance) - Native and non-native fish and wildlife species of recreational or commercial importance and recognized species used for tribal ceremonial and subsistence purposes that are vulnerable to habitat loss or degradation.

Oregon State Listed, Sensitive, and Candidate Species: References

Plants

Oregon Department of Agriculture. 1995. Oregon Administrative Rules 603, Division 73. Plants: Endangered, Threatened, and Candidate Species. Oregon Department of Agriculture, Salem, Oregon.

Animals

Oregon Department of Fish and Wildlife. 1993. State List of Sensitive Species. Oregon Department of Fish and Wildlife, Portland, Oregon.

Oregon Department of Fish and Wildlife. 1994. Oregon Administrative Rules (635–100–125): State List of Threatened and Endangered Species. Oregon Department of Fish and Wildlife, Portland, Oregon.

Oregon Department of Fish and Wildlife. 1994. Oregon Administrative Rules (635–100–100): Definition of Terms. Oregon Department of Fish and Wildlife Portland, Oregon.

Oregon State Listed, Sensitive, and Candidate Species: Category Definitions

Plants

Endangered - a species which is likely to become extinct throughout all or a significant portion of its range within the state.

Threatened - a species which is likely to become endangered in the foreseeable future.

Candidate - a species under review for listing as endangered or threatened.

Animals

Endangered - a species which is likely to become extinct throughout all or a significant portion of its range within the state.

Threatened - a species which is likely to become endangered in the foreseeable future.

Sensitive species are divided into the following categories:

Sensitive/critical - a species for which listing as threatened or endangered is pending or one for which listing as threatened or endangered may be appropriate if conservation actions are not taken.

Sensitive/vulnerable - a species for which listing as threatened or endangered is not believed to be imminent and can be avoided through continued or expanded use of adequate protective measures and monitoring.

Sensitive/peripheral and sensitive/naturally rare (considered one category) - a species whose Oregon populations are on the edge of their range and which had low population numbers historically in Oregon because of naturally limiting factors, respectively.

Sensitive/undetermined status - a species whose status is unclear and for which scientific study is required before its status can be determined.

Global and State Rarity Status: References

Plants

Washington Department of Natural Resources. 1994. Endangered, Threatened & Sensitive Vascular Plants of Washington. Washington Department of Natural Resources, Washington Natural Heritage Program, Olympia, Washington.

The Nature Conservancy of Oregon. 1995. Oregon Natural Heritage Program, Rare Plant and Animal Data Base. The Nature Conservancy, Portland, Oregon.

Animals

Washington Department of Natural Resources. 1995. Washington National Heritage Information System. Washington Department of Natural Resources, Washington Natural Heritage Program, Olympia, Washington.

The Nature Conservancy of Oregon. 1995. Oregon Natural Heritage Program, Rare Plant and Animal Data Base. The Nature Conservancy, Portland, Oregon.

Global and State Rarity Status: Category Definitions

Plants

G - indicator of global, i.e., rangewide, status.

T - indicator of status of infraspecific taxa, always used in conjunction with a global rank.

S - indicator of state status (for both Washington and Oregon):

1 - critically imperiled because of extreme rarity or because it is particularly vulnerable to extinction or extirpation, typically 5 or fewer occurrences

2 - imperiled because of rarity or because it is vulnerable to extinction or extirpation, typically 6 to 20 occurrences

3 - either very rare and local throughout its range or found locally (even abundantly) in a restricted range, typically 21 to 100 occurrences

4 - apparently secure, typically more than 100 occurrences

5 - demonstrably widespread, abundant and secure.

X - presumed extinct or extirpated.

H - historically known with the expectation that it may be rediscovered.

U - status uncertain, additional information is needed.

SR - reported from the state but without persuasive documentation.

SRF - reported falsely (in error) from the state, but the error persists in the literature.

? - indicates uncertainty about the assigned rank.

Q - indicates uncertainty about the taxonomic status.

Note: Washington State references were used to assign global rarity status in each of the species of concern data tables.

Animals

G - indicator of global, i.e., rangewide, status, always followed by another character.

T - a global rank for subspecific taxa.

S - indicator of state status:

1 - extremely rare, typically 5 or fewer estimated occurrences in the state, or only a few remaining individuals, may be especially vulnerable to extirpation

2 - very rare, typically between 5 and 20 estimated occurrences, or with many individuals in fewer occurrences, often susceptible to becoming extirpated

3 - rare to uncommon, typically 20 to 100 estimated occurrences, may have fewer occurrences but with a large number of individuals in some populations, may be susceptible to large-scale disturbances

4 - common, apparently secure under present conditions, typically 100 or more estimated occurrences, but may be fewer with many large populations, may be restricted to only a portion of the state, usually not susceptible to immediate threats

5 - very common, demonstrably secure under present conditions.

X - apparently extinct or extirpated.

H - historically known from the state, but not verified for an extended period, usually 15 years.

U - status uncertain, often because of low search effort or cryptic nature of the element, uncertainty spans a range of 4 to 5 ranks as defined above.

R - reported from the state, but without persuasive documentation that would provide a basis for either accepting or rejecting (e.g., misidentified specimen) the report.

SRF - reported falsely (in error) from the state, but the error persists in the literature.

A - accidental (occurring only once or a few times) or casual (occurring more regularly although not every year) in state; a few of these species (typically long-distance migrants such as some birds, butterflies, and cetaceans) may have even bred on one or more of the occasions when they were recorded.

E - exotic (introduced through human actions) in the state.

P - likely to occur or to have occurred (but having not been previously documented) in the state.

Z - not of significant conservation concern in the state, although the taxon is native and appears regularly in the state for a reason other than being exotic (E) or accidental/casual (A) or absent.

Q - a qualifying "Q" with a global rank indicates that a taxonomic question concerning the taxon exists.

C - a qualifying "C" with a GH or GX rank indicates that the taxon is extant in captivity or cultivation, although it is not known to still exist in nature.

? - indicates uncertainty about the assigned rank.

Note: Washington State references were used to assign global rarity status in each of the species of concern data tables. For those tables that lack an Oregon State rarity status, a state rarity status was not assigned for those species by the Oregon Natural Heritage Program.

D.2.5.2 Plants

Legal protections for species of concern differ between plant and animals. Although legal protections for federally listed or proposed plant species, insofar as they address plants found on federal property, are similar to that for animals, protection is limited on non-federal lands (i.e., state and private) to situations in which either federal funding or the requirement for a federal permit is involved. Legal protection for state-listed species in Washington is even more limited. There are no state of Washington laws that specifically recognize endangered or threatened plants or afford them any protection on any lands; however, WDNR's Natural Heritage Program does identify and track the status of species deserving of such status (WDNR 1994).

Table D.4 provides information about plant species of concern potentially found on or near the Hanford Site. There are currently no federal endangered, threatened, or proposed species, or species that are currently candidates for listing found at Hanford. Nineteen species, however, have been documented to be present on Hanford that are either sensitive, threatened, or endangered in the state of Washington (TNC 1996). Five of these species are federally listed by the USFWS as species of concern in the Columbia River Basin Ecoregion.

Figure D.23 shows approximate locations of subpopulations and populations of the plant species of concern that have been entered so far into the Ecosystem Monitoring Project's data base (see Table 4.2 for Level III species categories). Data are a combination of both TNC survey (J. Soll, correspondence and digital data, 1995, 1996, and 1998) and recent Ecosystem Monitoring Project survey results (recent survey information is reported in Cadwell 1994 and 1995). Location data was acquired either by GPS or by digitizing locations originally recorded on USGS topographic maps. All 1994 and earlier data are shown.

Figure D.23 is not intended to represent all areas where plant species of concern may be present; rather, the figure shows only general locations where the presence of individual plant subpopulations or populations have been documented. Even areas that have been surveyed potentially could contain other plant species of concern; for example, certain rare annual and/or early flowering plants that are sensitive to the drought conditions that were present during the early part of 1994 may have been missed during the TNC surveys (TNC 1995). Those areas searched by TNC during 1994, 1995, and 1997 are depicted in TNC (1995; Figure 4), Caplow and Beck 1996 (Figure 3), and Hall (1998), respectively. These reports also can be referenced for more detail about specific species.

Table D.15 provides information on newly identified plant species or varieties at Hanford. In total, survey results indicate that the Hanford Reach, ALE Unit, Gable Mountain and vicinity, and Umtanum Ridge all contain significant numbers of populations of Level III plant species of concern (Figure D.23). Much of the central core of Hanford still remains to be surveyed for plant species of concern. It is

Table D.4 Plant Species of Concern Potentially Found on or Near the Hanford Site

Scientific Name	Common Name	Federal Status[a]	Washington State Status (Priority Ranking as Applicable)[a]	Oregon State Status[a]	Global and Washington State Rarity Status[a]	Endemism[b]	Oregon State Rarity Status[a]	Washington/ [Oregon] Distribution by County[b,c]	Habitat Association on Hanford[d]	Hanford Abundance[e]	Resource Level of Concern at Hanford[f]
Allium robinsonii	Robinson's onion		Watch				SX	[GI, MO, SH, UM]	Shrub-steppe	Uncommon	II
Allium scillioides	Squill onion		Watch						Shrub-steppe	Uncommon	II
Ammannia robusts	Grand redstem		Review 1		G5			Most state	Riparian	Uncommon	
Arenaria franklinii var. *thompsonii*	Thompson's sandwort		Review 2	Candidate	G4 THQ, SRF	Regional	SH	BE, GR [GI]	Sand/shrub-steppe	Uncommon	II
Artemisia campestris borealis var. *wormskioldii*	Northern wormwood	Former candidate	Endangered, (1)	Endangered	G5 T1, S1	Regional	SX	GR, KL [SH]	Rocky riparian	Undocumented[g]	III
Artemisia lindleyana	Columbia River mugwort		Watch						Riparian	Common	II
Astragalus arrectus	Palouse milkvetch		Sensitive, (3)		G2G3, S2	Regional		Columbia Basin: CH, (GR), (KTS), KL, LI, WHI	Shrub-steppe	Not recently documented[h]	III
Astragalus columbianus	Columbia milkvetch	Former candidate	Threatened, (2)		G2, S2	Local		Southcentral WA: BE, KTS, YA	Shrub-steppe	Rare	III
Astragalus conjunctus var *rickardii*	Basalt milkvetch		Review 1						Shrub-steppe	Uncommon	II
Astragalus geyeri	Geyer's milkvetch		Sensitive, (3)		G5, S1?	Disjunct		GR	White Bluffs	Rare	III
Astragalus sclerocarpus	Stalked-pod milkvetch		Watch						Sand/shrub-steppe	Common	II
Astragalus speirocarpus	Medick milkvetch		Watch						Drainages/ shrub-steppe	Undocumented	II
Astragalus succumbens	Crouching milkvetch		Watch						Shrub-steppe	Uncommon	II
Balsamorhiza rosea	Rosy balsamroot		Watch				SH	[UM]	Rattlesnake Ridge	Common	II
Calyptridium roseum	Rosy pussypaws		Sensitive		G5, S1				Shrub-steppe	Rare	III

Table D.4 Plant Species of Concern Potentially Found on or Near the Hanford Site (continued)

Scientific Name	Common Name	Federal Status[a]	Washington State Status (Priority Ranking as Applicable)[a]	Oregon State Status[a]	Global and Washington State Rarity Status[a]	Endemism[b]	Oregon State Rarity Status[a]	Washington/ [Oregon] Distribution by County[b,c]	Habitat Association on Hanford[d]	Hanford Abundance[e]	Resource Level of Concern at Hanford[f]
Camissonia minor	Smallflower evening-primrose		Review 1		G4				Shrub-steppe	Rare	
Camissonia (=Oenothera) pygmaea	Dwarf evening-primrose		Threatened, (2)		G3, S1S2			Scattered: BE, DO, FR, GR	Sand/shrub-steppe	Rare	III
Carex densa	Dense sedge		Sensitive, (3)		G5, S1	Peripheral		(BE), (CK), WAH, (YA)	Riparian	Undocumented[i]	III
Castilleja exilis	Smallflower annual paintbrush		Review 1		G5				Shrub-steppe	Rare	
Centunculus minimus	Chaffweed		Review 1		G5					Rare	
Cirsium brevifolium	Palouse thistle		Review 1						Shrub-steppe	Undocumented	I
Collinsia sparsiflora var. *bruceae*	Few-flowered collinsia		Sensitive, (3)		G4T4, S1S2	Peripheral		KL, (SKA)	Riparian	Undocumented[j]	III
Cryptantha spiculifera	Snake River cryptantha		Sensitive		G3G4, S2	Peripheral		(AD), CH, FR, GR, KL, LI, OK, SP	Bluffs	Rare	III
Cryptantha leucophaea	Gray cryptantha		Sensitive, (3)		G2G3, S2S3		SH	Scattered: western Columbia Basin - BE, DO, FR, GR, KTS, WW, YA [GI]	Sand	Uncommon	III
Cryptantha scoparia	Miner's candle		Review 1		C4				Shrub-steppe	Rare	
Cuscuta denticulata	Desert dodder		Sensitive		G4, S1	Disjunct		BE	Shrub-steppe	Rare	III
Cyperus bipartitus (=C. rivularis)	Shining flatsedge		Sensitive, (3)		G5, S2	Peripheral		(AS), BE, GR, KI, KTS, KL, (WHI), YA	Columbia River, riparian	Uncommon	III
Eatonella nivea	White eatonella		Threatened, (2)		G4, S1	Disjunct		GR, KTS	Sand/shrub-steppe	Rare	III
Erigeron piperianus	Piper's daisy		Sensitive, (3)		G2, S2	Regional		Columbia Basin: AD, BE, FR, GR, KTS, KL, YA	Disturbances/ sand/shrub-steppe	Uncommon	III

Table D.4 Plant Species of Concern Potentially Found on or Near the Hanford Site (continued)

Scientific Name	Common Name	Federal Status[a]	Washington State Status (Priority Ranking as Applicable)[a]	Oregon State Status[a]	Global and Washington State Rarity Status[a]	Endemism[b]	Oregon State Rarity Status[a]	Washington/ [Oregon] Distribution by County[b,c]	Habitat Association on Hanford[d]	Hanford Abundance[e]	Resource Level of Concern at Hanford[f]
Eriogonum codium	Umtanum desert buckwheat		Endangered		G1, S1			BE	Shrub-steppe	Rare	III
Gilia leptomeria	Great Basin gilia		Review 1		G5				Shrub-steppe	Rare	
Hypericum majus	Canadian St. John's-wort		Sensitive		G5, S1?			Scattered: KI, PO, SKT	Riparian	Rare	III
Lesquerella tuplashensis	White Bluffs bladderpod		Endangered		G1, S1			FR	Shrub-steppe	Uncommon	III
Limosella acaulis	Southern mudwort		Sensitive, (3)		G5Q, S2	Disjunct		BE, CH, GR, KTS, WAH, WHA, YA	Columbia River, riparian	Uncommon	III
Lindernia dubia var. *anagallidea*	False pimpernel		Review 2		G5T4, S3			BE, CK, (KL), MA	Columbia River, riparian	Uncommon	III
Lipocarpha aristulata	Awned halfchaff sedge		Review 1		G5				Riparian	Uncommon	
Loeflingia squarrosa var *squarrosa*	Loeflingia		Threatened		G5T4, S1				Riparian	Rare	III
Lomatium tuberosum	Hoover's desert parsley	Former candidate	Threatened, (2)		G2, S2	Local		BE, GR, KTS, YA	Umtanum Ridge, talus	Rare	III
Mimulus suksdorfii	Suksdorf's monkey-flower		Sensitive, (3)		G4, S2	Peripheral		CH, GR, (KTS), (KL), (YA), BE	Sand/shrub-steppe	Rare	III
Nama densum var. *parviflorum*	Small-flowered nama		Review 1		G5T5				Shrub-steppe	Uncommon	
Nicotiana attenuata	Coyote tobacco		Sensitive, (3)		G4, S2			Scattered: BE, (CH), DO, FR, GR, (KTS), KL, YA	Gravel washes	Rare[h]	III
Oenothera caespitosa	Desert evening-primrose		Sensitive, (3)		G4, S1?	Peripheral		KTS, YA	Riparian/ islands/ uplands	Rare	III
Pectocarya linearis var. *penicillata*	Winged combseed		Review 1		G5				Shrub-steppe	Uncommon	
Pectocarya setosa	Bristly combseed		Sensitive, (3)		G5, S2	Peripheral		(CH), GR, YA	Sand/shrub-steppe	Rare	III

Table D.4 Plant Species of Concern Potentially Found on or Near the Hanford Site (continued)

Scientific Name	Common Name	Federal Status[(a)]	Washington State Status (Priority Ranking as Applicable)[(a)]	Oregon State Status[(a)]	Global and Washington State Rarity Status[(a)]	Endemism[(b)]	Oregon State Rarity Status[(a)]	Washington/ [Oregon] Distribution by County[(b,c)]	Habitat Association on Hanford[(d)]	Hanford Abundance[(e)]	Resource Level of Concern at Hanford[(f)]
Pellaea glabella var. *slimpex*	Smooth cliffbrake		Watch						Umtanum Ridge, moist canyons	Rare	II
Penstemon eriantherus var. *whitedii*	Fuzzy beardtongue		Monitor 3						White Bluffs	Rare	I
Rorippa columbiae	Columbia yellowcress	Former candidate	Endangered, (1)	Candidate	G3, S2		S3	Scattered: BE, GR, (KL), SKA [UM]	Columbia River, riparian	Common	III
Rotala ramosior	Lowland toothcup		Review 1		G5				Riparian	Uncommon	

(a) See Section D.2.5.1 for references and category definitions. Global and state rarity statuses are separated by a comma in the table.
(b) Endemism categories and county distributions from WDNR (1994). Endemism: local = a taxon restricted to a very small geographic area or specialized habitats within a somewhat larger geographical area; Regional = a taxon inhabiting a relatively large geographical area ranging from a mountain range to the Pacific Northwest; Disjunct = a taxon whose population(s) in Washington is widely separated from the main continuous populations; Peripheral = a taxon approaching the geographical limits of its continuous range in Washington. County abbreviations: AD = Adams; AS = Asotin; BE = Benton; CH = Chelan; CK = Clark; DO = Douglas; FR = Franklin; GR = Grant; KI = King; KTS = Kittitas; KL = Klickitat; LI = Lincoln; MA = Mason; OK = Okanogan; PO= Pond Oreille; SKT = Skagit; SKA = Skamania; SP = Spokane; WAH = Wahkiakum; WW = Walla Walla; WHI = Whitman; YA = Yakima. (County names or abbreviations in parentheses indicate that the taxon was historically collected in that county or that it has been reported from that county but its occurrence is unverified or questionable. In both cases, recent, verifiable information regarding the taxon's occurrence in the county in question is lacking.)
(c) County distributions are from The Nature Conservancy of Oregon. 1995. Oregon Natural Heritage Program, Rare Plant and Animal Data Base. The Nature Conservancy, Portland, Oregon. County abbreviations: GI = Gilliam; MO = Morrow; SH = Sherman; UM = Umatilla.
(d) Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases maintained by Pacific Northwest National Laboratory.
(e) Abundance categories developed and applied by M. Sackschewsky and W. Rickard from Pacific Northwest National Laboratory (pers. comm. 1995). Abundant = commonly found throughout the Hanford Site in diverse habitat types; Common = commonly found throughout appropriate, specific habitats; Uncommon = found only in some of the specific, appropriate habitats; Rare = only known from one to several locations on the Hanford Site; Undocumented/Not recently documented = has been historically reported from the Hanford Site, or is known to occur near the Hanford Site, but its present occurrence on the Site is unsubstantiated or doubtful.
(f) See Section 4.3 for definitions of resource levels of concern. Each level corresponds to a different set of management actions that are required to be taken in regard to those species included for consideration at that level. A particular species is defined by its association with one specific level of management concern.
(g) Known to occur within 25 km of the Hanford Site; however, recent surveys have not documented its occurrence on Hanford (see Cadwell 1994 for areas surveyed).
(h) Previously reported from Rattlesnake Hills (Sackschewsky et al. 1992); however, its presence has not been confirmed by recent surveys.
(i) Previously reported from the 100 Areas (Sackschewsky et al. 1992); however, it was probably misidentified (Sackschewsky pers. comm. 1995) and recent surveys have not documented its occurrence.
(j) Previously reported from Rattlesnake Hills (Sackschewsky et al. 1992); however, it was probably misidentified (Sackschewsky pers. comm. 1995) and recent surveys have not documented its occurrence.

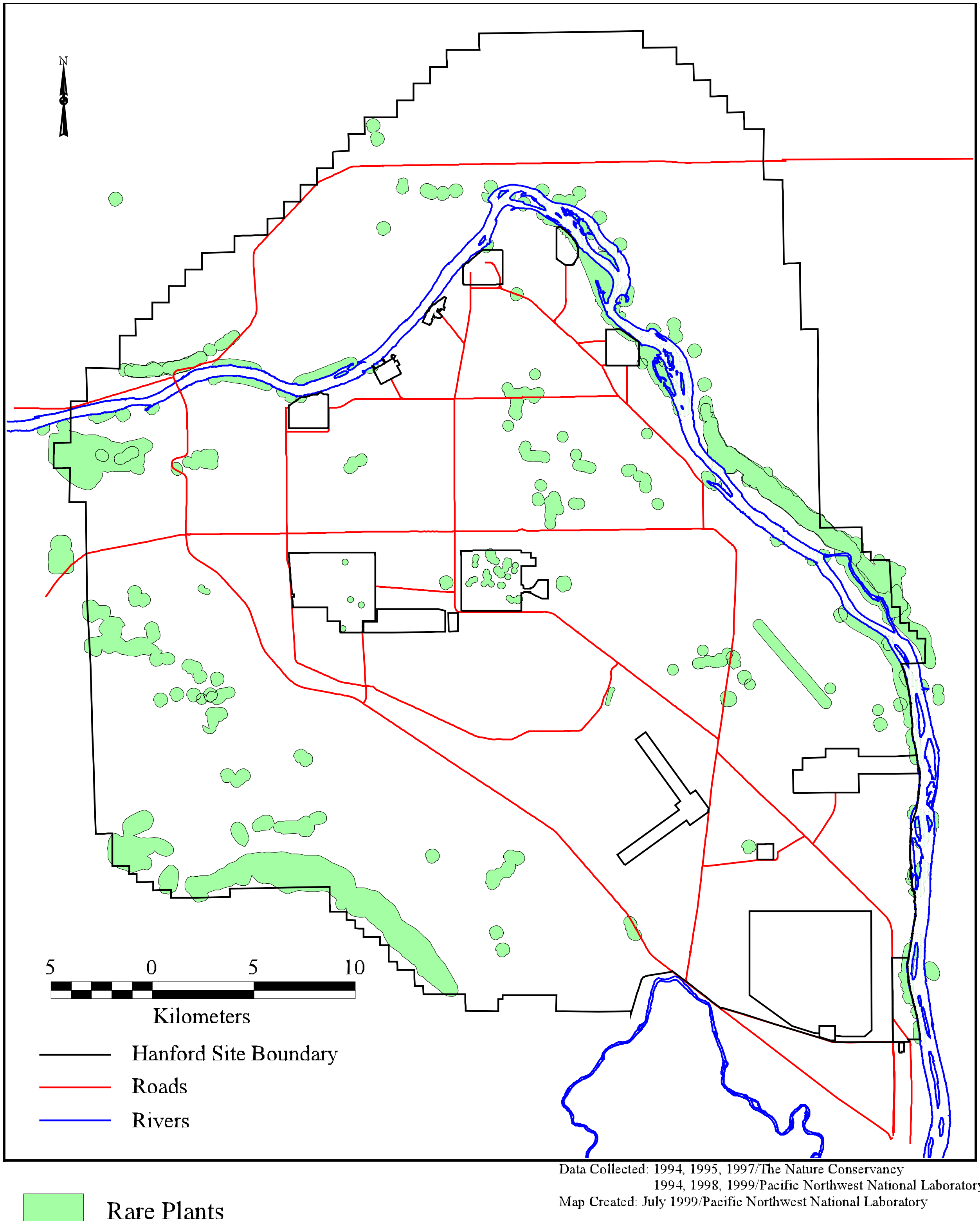


Figure D.23 Approximate Locations of Level III Plant Species of Concern probable that the Hanford Dune Field, for example, contains plant species of concern (TNC 1995). Islands within the Hanford Reach also deserve survey attention. Plant species of concern are best protected by protecting locations in which they occur or could potentially occur. In large measure this can be accomplished by protecting areas that contain intact native plant communities.

D.2.5.3 Invertebrates

Partial surveys for invertebrate species of concern have been accomplished within the last few years at the Hanford Site. Information on terrestrial invertebrates at Hanford is summarized in Table D.5. The most recent distribution information on terrestrial invertebrate species of concern is a result of TNC survey work (TNC 1995, 1996, 1998, 1999).

Insect survey work, other than for butterflies and moths, occurred mostly on the ALE Unit. Insect diversity is high with over 1,000 taxa identified so far, which is probably less than 10% of the total present (TNC 1996). Hanford's insect diversity is directly related to the extent and diversity of native habitat. Few insect pest species were collected on the ALE Unit, which would be another indication of its relatively undisturbed status (TNC 1996).

Umtanum Ridge and the shorelines of the Hanford Reach have been identified previously, because of their butterfly diversity, to be of particular importance for Washington butterfly conservation (Pyle 1989). Results from the TNC surveys indicate Rattlesnake Ridge also supports a fauna, similar to Umtanum Ridge, of uncommon butterflies (TNC 1995). Specific information on the butterfly and moth surveys can be found in Ensor (1996). Ensor also includes a map of areas searched (Ensor 1996; Figure 1).

A spring area on Umtanum Ridge also contains an endemic land snail not known from any other location (Frest and Johannes 1993). Information on this species is provided later in this section as is information on other new invertebrate species (all insects) recently discovered at Hanford. This list can be expected to grow as inventory work continues on the Hanford Site.

Information on aquatic invertebrates at Hanford is summarized in Table D.6. Aquatic invertebrate species of concern are currently limited to those found in the Hanford Reach. Detailed ecological and distributional information about the shortface lanx (*Fisherola nuttalli*) and Columbia pebblesnail (*Fluminicola columbiana*) in the Columbia River Basin can be found in Neitzel and Frest (1993). Little information is available on the ecology of the California floater (*Anodonta californiensis*).

Frest and Johannes (1993) speculated that the relatively sparse nature of Hanford's mollusc fauna (both freshwater forms and land snails) was due to the presence of only a few streams in a large area that possessed few continuous or seasonal connections. Moreover, they also speculated that the human modification of the spring/stream systems during the early part of the twentieth century may have caused certain species to be extirpated from the Hanford Site.

D.2.5.4 Fish

Gray and Dauble (1977) identify 43 species of fish as occurring within the Hanford Reach of the Columbia River. Five of these species are species of concern (Table D.7). One additional species not identified by Gray and Dauble (i.e., bull trout, *Salvelinus confluentus*) and two stocks of another species (i.e., spring/summer and fall runs of the Snake River chinook salmon, *(Oncorhynchus tshawytsch*), for which there is a related Columbia River stock (i.e., fall chinook salmon that spawn in the Hanford Reach), also are species of concern; however, they are rare migrants to the Hanford Reach (Table D.7). Management of fish species of concern within the Hanford Reach requires additional work on specific habitat requirements. The habitat association information provided in Table D.7, for those species that have specific habitat requirements identified, could still benefit from additional empirical information.

D.2.5.5 Amphibians and Reptiles

There are no comprehensive accounts of amphibians and reptiles at Hanford and their distribution and abundance are poorly understood (Fitzner and Gray 1991). Compared with more mesic areas (for amphibians) and xeric areas (such as the desert southwest of the U.S. for reptiles), the herpetofauna of Hanford is generally depauperate. Five species of concern occur on the Hanford Site (Table D.8). All species can be found in the upland shrub-steppe habitat; however, Woodhouse's toad (*Bufo woodhousii*) is generally found near water. The striped whipsnake (*Masticophis taeniatus*) is at the northern

Table D.5 Terrestrial Invertebrate Species of Concern Potentially Found on or Near the Hanford Site

Scientific Name	Common Name	Federal Status[a]	Washington State Status[a]	WDWF Priority Species (Criterion)[a]	Global and Washington State Rarity Status[a]	Habitat Association and Hanford Abundance[b]	Resource Level of Concern at Hanford[c]
Boloria (=Clossiana) selene atrocostalis	Silver-bordered fritillary		Candidate	YES (1)	G5, S3	Wetlands (1)	III
Callophrys sheridanii neoperplexa	Canyon green hairstreak		Monitor	NO	S5, S?	Shrub-steppe (2)	II
Cicindela columbica	Columbia River tiger beetle		Candidate	YES (1)	G2, S1	Riparian (3)	III
Harkenclenus titus immaculosus	Coral hairstreak		Monitor	NO		Upland areas (4)	II
Hesperia juba	Juba Skipper		Monitor	NO	G5, S?	Upland areas (5)	II
Hesperia nevada	Nevada skipper		Monitor	NO	G4G5, S?	Upland areas (6)	II
Limenitis (=Basilarchia) archippus lahontani	Nevada viceroy	Former candidate	Monitor	NO	G5, S?	Canyonlands (7)	II
Lycaena (= Epidemia) helloides	Purplish copper		Monitor	NO	G5, S?	River/stream bottoms (8)	II
Lycaena (= Chalceria) rubida perkinsorum	Perkins' copper		Monitor	NO	G5, S?	Shrub-steppe (9)	II
Mitoura siva	Juniper hairstreak		Candidate	YES (1)	G4, S?	Shrub-steppe (10)	III
Ochlodes sylvanoides bonnevilla	Bonneville skipper		Monitor	NO	G5, S?	Shrub-steppe (11)	II
Phyciodes tharos pascoensis	Pasco crescent		Monitor	NO	G5	Wetlands (12)	II

(a) See Section D.2.5.1 for references and category definitions. Global and state rarity statuses are separated by a comma in the table.
(b) Habitat associations obtained from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project databases maintained by Pacific Northwest National Laboratory, unless otherwise noted. These Hanford abundance categories are: rare, uncommon, and common, and their definitions, were adapted from Landeen et al. (1992) and applied by Lee Rogers (pers. comm. 1995) to these species based on incidental observations made during ecological studies conducted by the Ecology Group at Pacific Northwest National Laboratory. Rare = present in appropriate habitat only in small numbers, seldom observed; Uncommon = usually present in appropriate habitat but not always observed; Common = often observed in appropriate habitat.
1 = Moist meadows and bogs, near woodlands, sometimes wet meadows among plains or sagelands. Likely not present on the Hanford Site. Has not been collected on the Hanford Site to date.
2 = Sagebrush habitat in desert canyons. Rare on Hanford Site. Collected on the ALE Reserve (Ensor 1996).
3 = Known only from sandy beach areas along the Snake and Columbia Rivers and their tributaries. Has not been collected on the Hanford Site to date, but may occur there.
4 = Mountain canyons, scrubby and wooded areas, and brushy clearings. Has not been collected on the Hanford Site to date, but may occur there.
5 = Collected on the ALE Reserve in Snively Canyon and on the North Slope (Ensor 1996). The abundance of this species on the Hanford Site is unknown.
6 = High sagelands and forest edges, alpine slopes and high meadowland. Rare, on the Hanford Site it is known only from Rattlesnake Mountain. Collected on the ALE Reserve in Snifely Canyon (Ensor 1996).
7 = Areas bordering canyon creeks, streams, and rivers. It is seldom found far from its favorite food plans, willow and cottonwood. Common, on the Hanford Site it is usually found in association with willows. Collected on the ALE Reserve in Snively Canyon and on the North Slope (Ensor 1996).
8 = Mostly lowlands. Collected on the ALE Reserve in Snively Canyon and on the North Slope (Ensor 1996). The abundance of this species on the Hanford Site is unknown.
9 = Open dry areas, sagebrush, sandy watercourses, moderate to high elevations. Favors edges of meadows or streams in sagebrush associations. Uncommon on the Hanford Site. It is known from Rattlesnake Mountain and the North Slope (Ensor 1996).
10 = Arid lands, open scrubby woodland, rocky outcrops, and canyons. On Hanford it would most likely be found in dunes. Has not been collected on the Hanford Site to date, but may be present.
11 = Desert areas of the Northwest in scrub, on ridges, along roadsides, and in sagebrush. Common on Hanford.
12 = Moist meadows, moist fields, valley bottoms and streamsides. Likely not present on the Hanford Site. Has not been collected on the Hanford Site to date.
(c) See Section 4.3 for definitions of resource levels of concern. Each level corresponds to a different set of management actions that are required to be taken in regard to those species included for consideration at that level. A particular species is defined by its association with one specific level of management concern.

Table D.6 Aquatic Invertebrate Species of Concern Potentially Found Within or Near the Hanford Reach

Scientific Name	Common Name	Federal Status[a]	Washington State Status[a]	WDFW Priority Species (Criterion)[a]	Global and Washington State Rarity Status[a]	Oregon State Rarity Status[a]	Habitat Association[b]	Hanford Abundance[c]	Resource Level of Concern at Hanford[d]
Anodonta californiensis	California floater	Former candidate	Candidate	YES (1)	G4, S?		Lentic areas of the Columbia River[e]	Undocumented	III
Fisherola nuttalli	Shortface lanx	Former candidate	Candidate	YES (1)	G1G3, S2	S2?	Rapids edges or likely to be found in any area of the Hanford Reach that is not dewatered or subject to siltation	Common	III
Fluminicola columbiana	Columbia pebblesnail	Former candidate	Candidate	YES (1)	GU, S2	S?	Rapids edges or likely to be found in any area of the Hanford Reach that is not dewatered or subject to siltation	Rare	III

(a) See Section D.2.5.1 for references and category definitions. Global and state rarity statuses are separated by a comma in the table.
(b) Taken from Neitzel and Frest (1993) as modified by Duane Neitzel (pers. comm. 1996), unless otherwise noted.
(c) The abundance category, common, and its definition were adapted from Landeen et al. (1992) and applied by Dennis Dauble (pers. comm. 1995) to these species based on prior surveys and scientific studies conducted by the Ecology Group at Pacific Northwest National Laboratory. Common = often observed in appropriate habitat. The category rare was assigned by Duane Neitzel (pers. comm. 1996). Rare = only 1-2% of the Hanford Reach *Fluminicola* are *F. columbiana*.
(d) See Section 4.3 for definitions of resource levels of concern. Each level corresponds to a different set of management actions that are required to be taken in regard to those species included for consideration at that level. A particular species is defined by its association with one specific level of management concern.
(e) Dennis Dauble (pers. comm. 1996).

Table D.7 Fish Species of Concern Potentially Found Within or Near the Hanford Reach

Scientific Name	Common Name	Federal Status[a]	Washington State Status[a]	WDFW Priority Species (Criterion)[a]	Oregon State Status[a]	Global and Washington State Rarity Status[a]	Oregon State Rarity Status[a]	Habitat Association	Hanford Abundance[b]	Resource Level of Concern at Hanford[c]
Catostomus platyrhynchus	Mountain sucker		Monitor	NO		G5, S?		Mountain streams[d]	Rare	II
Cottus beldingi	Piute sculpin		Monitor	NO		G5, S?		Riffle areas of slight to moder-ate gradient streams[d]	Common	II
Cottus perplexus	Reticulate sculpin		Monitor	NO		G4, S?		Pools and riffles of generally small streams[d]	Uncommon	II
Lampetra ayresi	River lamprey	Former candidate		NO				Riverine[d]	Rare	I
Oncorhynchus tshawytscha	Snake River Chinook Salmon (Spring/Summer and Fall)	Endangered		NO	Threatened	G5, S?		Free-flowing portions of large rivers[e]	Rare	IV
Percopsis transmontana	Sand roller		Monitor	NO		G4, S?		Shallow, sandy flats and quiet backwater areas[f]	Uncommon	II
Salvelinus confluentus	Bull trout	Candidate		YES (2, 3)		G3, S?	S3	Pool areas of streams[d]	Accidental	III

(a) See Section D.2.5.1 for references and category definitions. Global and state rarity statuses are separated by a comma in the table.
(b) These categories: accidental, rare, uncommon, and common, and their definitions were adapted from Landeen et al. (1992) and applied by Dennis Dauble (pers. comm. 1995) to these species based on prior surveys and scientific studies conducted by the Ecology Group at Pacific Northwest National Laboratory. Accidental = appears very infrequently and well outside its normal range; Rare = present in appropriate habitat only in small numbers, seldom observed; Uncommon = usually present in appropriate habitat but not always observed; Common = often observed in appropriate habitat.
(c) See Section 4.3 for definitions of resource levels of concern. Each level corresponds to a different set of management actions that are required to be taken in regard to those species included for consideration at that level. A particular species is defined by its association with one specific level of management concern.
(d) Habitat associations are from Wydoski and Whitney (1979). The bull trout habitat association is based on that of the Dolly Varden (Salvelinus malma) to which it is closely related. For the Piute sculpin, slight to moderate gradient streams refers to streams of less than 1.8% gradient but generally greater than 6 m (about 20 ft) wide; conversely, the reticulate sculpin is generally found in streams less than 6 m wide (Wydoski and Whitney 1979).
(e) Habitat association is from Downs et al. (1993). Juvenile salmon occupy backwater sloughs and shoreline embayments.
(f) Sand rollers show an apparent diel behavior in their habitat selection (Gray and Dauble 1976). They are present on sandy bottoms at night (Gray and Dauble 1976) and in quiet backwaters during the day (Wydoski and Whitney 1979).

Table D.8 Herpetofaunal Species of Concern Potentially Found on or Near the Hanford Site

Scientific Name	Common Name	Federal Status[a]	Washington State Status[a]	WDFW Priority Species (Criterion)[a]	Global and Washington State Rarity Status[a]	Endemism[b]	Habitat Association[c]	Hanford Abundance[d]	Resource Level of Concern at Hanford[e]
Bufo woodhousii	Woodhouse's toad		Monitor	NO	G5, S3	Peripheral	Shrub-steppe, R	Common	II
Hypsiglena torquata	Night snake		Monitor	NO	G5, S4	Peripheral	Shrub-steppe, BS	Uncommon	II
Masticophis taeniatus	Striped whipsnake		Candidate	YES (1)	G5, S1	Peripheral	Shrub-steppe	Rare	III
Pituophis melanoleucus (=catenifer) catenifer	Pacific gopher snake		Monitor	NO	G5T5, S?	Peripheral	Shrub-steppe	Abundant	II
Sceloporus graciosus graciosus	Northern sagebrush lizard	Former candidate		NO	G5, S?	Peripheral	Shrub-steppe, S	Common	I

(a) See Section D.2.5.1 for references and category definitions. Global and state rarity statuses are separated by a comma in the table.
(b) None are endemics (Nussbaum et al. 1983); they seem to be relatively recent invaders from the south.
(c) General association with shrub-steppe is based on Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases maintained by Pacific Northwest National Laboratory. More specific habitat associations (i.e., BS = basalt outcroppings, R = riparian, S = sandy areas) are from Fitzner and Gray (1991).
(d) The abundance categories: rare, uncommon, common, and abundant were obtained from Fitzner and Gray (1991), however, definitions of common and uncommon were adapted from Landeen et al. (1992), as these authors provide more complete definitions. The "abundant" category is defined here. Rare = present in appropriate habitat only in small numbers; seldom seen or heard. Uncommon = usually present in appropriate habitat but not always seen. Common = often seen in appropriate habitat. Abundant = very often seen or heard in appropriate habitat. Hallock (1995) reported the abundance category designations the same as did Fitzner and Gray (1991) with one exception. She identifies the gopher snake as common.
(e) See Section 4.3 for definitions of resource levels of concern. Each level corresponds to a different set of management actions that are required to be taken in regard to those species included for consideration at that level. A particular species is defined by its association with one specific level of management concern.

extent of its range; however, it has been recorded from the Vantage area (Nussbaum et al. 1983) and after a long period without observation, it was reported on Hanford in 1996 west of State Highway 24 (B. Tiller, pers. comm., 1996).

D.2.5.6 Birds

Three types of information are provided for avian species of concern. First, Table D.9 provides information similar to what has been provided for other taxa in earlier tables. The species listed include all year-round resident avian species of concern plus migratory birds (as identified in the list of migratory bird species at 50 CFR 10.13) that either breed or winter at Hanford or pass through but are federally listed or candidates for listing. Second, for the same species included in Table D.9, Table D.10 provides ecological information on each species: occurrence, preferred habitat, and Hanford abundance. Third, Table D.11 provides information on the temporal occurrence of migratory birds at Hanford for all migratory birds that breed at Hanford or, for migratory species that do not breed at Hanford, are otherwise species of concern. By knowing when species tend to arrive and leave the Hanford Site, and when the sensitive periods of their life cycle (such as nesting) occur, activities at Hanford can be better planned to avoid impacts to these species.

Because most of the bird species that constitute Hanford's characteristic avifauna are migratory, direct impacts to these species potentially can occur away from Hanford (e.g., on the wintering area) as well as when they are present on Hanford. Indirect impacts, however, such as losses of habitat, can occur at any time of year at Hanford. Many species have a strong fidelity to return to the same location at which breeding was previously successful; however, breeding locations for other species can be dynamic. Excessive losses of appropriate habitat eventually can be detrimental to the persistence of populations at Hanford; however, specific habitat association and complete distribution information is lacking for many avian species of concern at Hanford.

Although detailed habitat requirements for individual species may be lacking, Smith (1994) was able to construct large-scale habitat association models for bird species breeding in eastern Washington (principally within the Columbia Basin ecoregion but also including the Methow and Okanogan Valleys) that could be used to predict species richness centers throughout the area. He addressed only those species associated with upland habitats; that is, shrub- or meadow-steppe. Smith predicted species richness for five different categories:

1. species for whom 80% of their Washington breeding range was within the eastern Washington study area (20 species)
2. species that nest principally in sagebrush (*Artemisia*) (six species)
3. species that nest principally in grassland areas within the shrub-steppe (nine species) (i.e., areas not dominated by tall shrubs)
4. species of concern (10 species; a subset of species that included those species with small or declining populations in eastern Washington)
5. species that are steppe obligates, either to sagebrush or to grassland areas within the shrub-steppe (21 species).

For all categories, Hanford ranked as one of the highest centers of predicted species richness (Smith 1994).

The preceding discussion illustrates the importance of Hanford for maintaining viable populations of shrub-steppe dependent birds within the Columbia Basin ecoregion, especially for sagebrush obligate species such as the sage sparrow (*Amphispiza belli*). Although specific sighting information is important to establish usage of particular habitats by specific species (and within industrial areas to indicate what potential impacts to species of concern a Site activity may cause), not all areas have been surveyed and usage can be dynamic. The approach taken in this management plan to address most avian species of concern is to identify the distribution and extent of the habitat most likely used by those species. Thus, conservation of most individual avian species of concern can be accomplished by conserving the habitats identified in Figure D.12, the Hanford habitats of concern.

Because of their listing status and because they are most vulnerable to impact at fixed locations, the ferruginous hawk (*Buteo regalis*) and bald eagle (*Haliaeetus leucocephalus*) require management focused on their individual requirements. As a response to the potential for impacts to federally and state listed species and federal candidate species

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status

Common Name	Federal Status[a]	Washington State Status[a]	WDFW Priority Species (Criterion)[a]	Oregon State Status[a]	Species Identified by Federal Regulation as Migratory[b]	Global and Washington State Rarity Status[a]	Oregon State Rarity Status[a]	Resource Level of Concern at Hanford[c]	Comments[d]
Aleutian Canada Goose	Threatened	Endangered	NO (see comments)	Endangered	M	G5T2, SZN		IV	Listing status applies to just this subspecies of the Canada goose. The subspecies is not separately identified as a priority species by WDFW.[a]
American Avocet			YES (2)		M	G5, S4B, SZN		II	Resident breeder
American Bittern			NO		M	G4, S4N, S4B		II	Resident breeder
American Coot			NO		M	G5, S5B, S5N		II	Resident breeder
American Crow			NO		M	G5, S5		II	Resident breeder
American Kestrel			NO		M	G5, S5B, S5N		II	Resident breeder
American Robin			NO		M	G5, S5B, S5N		II	Resident breeder
American White Pelican		Endangered	YES (1,2)	Sensitive/ vulnerable	M	G3, S1B, S2N		III	Oregon State status applies only to breeding populations.[a] Although observed in significant numbers on Hanford since 1990, no breeding/nesting activity has been recorded. Recently documented as having bred in the Wallula Gap area.[e]
American Wigeon			YES (2,3)		M	G5, S4B, S5N		II	Priority species criteria refers only to significant waterfowl breeding areas and to regular-large concentrations in winter of Family Anatidae.[a] Winter resident.
Arctic Tern		Monitor	YES (2)		M	G5, S2B, SZN		II	Priority species criteria refers only to breeding populations.[a] Observed during October.
Ash-throated Flycatcher		Monitor	NO		M	G5, S2B, SZN		II	Erratic occurrences on Hanford. Usually observed in June and September.
Bald Eagle	Threatened	Threatened	YES (1)	Threatened	M	G4, S3S4B, S4N	S3	IV	Nesting attempted; no successful reproduction recorded. Some night roost and potential nest locations require buffer zones to minimize disturbance[f]
Bank Swallow			NO	Sensitive/ undetermined status	M	G5, S4B, SZN		II	Regularly breeds on Hanford

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status[(a)]	Washington State Status[(a)]	WDFW Priority Species (Criterion)[(a)]	Oregon State Status[(a)]	Species Identified by Federal Regulation as Migratory[(b)]	Global and Washington State Rarity Status[(a)]	Oregon State Rarity Status[(a)]	Resource Level of Concern at Hanford[(c)]	Comments[(d)]
Barn Owl			NO		M	G5, S4		II	Resident breeder
Barn Swallow			NO		M	G5, S5B, S5N		II	Resident breeder
Barred Owl		Monitor	NO		M	G5, S5		II	Not believed to breed on Hanford. Apparently makes two short stops in April and September.
Barrow's Goldeneye			YES (2,3)	Sensitive/ peripheral or naturally rare	M	G5, S4B, S4N		II	Winter resident. Oregon State status applies only to breeding populations.[(a)]
Belted Kingfisher			NO		M	G5, S5		II	Resident breeder
Bewick's Wren			NO		M	G5, S5		II	Resident breeder
Black Tern	Former candidate	Monitor	YES (2)		M	G4, S4B, SZN		II	Priority species criteria refers only to breeding populations.[(a)] Not believed to breed on Hanford. Observed on Site from May-June and August-September.
Black-billed Magpie			NO		M	G5, S5		II	Resident breeder
Black-crowned Night Heron		Monitor	YES (2)		M	G5, S3B, S3N		II	Landeen et al. (1992) and Fitzner and Gray (1991) report this species as being present year round. Ennor (1991) reports arrival and departure dates of August and March, respectively. Observed breeding on islands across from 300 Area in 1994 and 1995.
Black-headed Grosbeak			NO		M	G5, S5B, SZN		II	Resident breeder
Black-necked Stilt		Monitor	YES (2)		M	G5, S3B, S3N		II	Priority species criteria refers only to breeding populations.[(a)] Observed from April-May and in August
Black-throated Sparrow			NO	Sensitive/ peripheral or naturally rare	M			II	Erratic occurrences on Hanford

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status[a]	Washington State Status[a]	WDFW Priority Species (Criterion)[a]	Oregon State Status[a]	Species Identified by Federal Regulation as Migratory[b]	Global and Washington State Rarity Status[a]	Oregon State Rarity Status[a]	Resource Level of Concern at Hanford[c]	Comments[d]
Brewer's Blackbird			NO		M	G5, S5		II	Resident breeder
Brewer's Sparrow			NO		M	G4, S4B, SZN		II	Resident breeder
Brown-headed Cowbird			NO		M	G5, S5B, S4N		II	Resident breeder
Bufflehead			YES (2,3)	Sensitive/ peripheral or naturally rare	M	G5, SZB, S5N		II	Winter resident. Oregon State status applies only to breeding populations.[a]
Bullock's (formerly Northern) Oriole			NO		M	G5, S4S5B, SZN		II	Resident breeder
Burrowing Owl	Former candidate	Candidate	YES (1)	Sensitive/ critical	M	G4, S3B, SZN	S?	III	Habitat also includes weedy fields of non-native annuals/areas recovering from fire/ other disturbance.[g]
California Gull			NO		M	G5, S4B, S5N		II	Resident breeder
Canada Goose			YES (2,3)		M	G5, S5B, S5N		II	Priority species criteria refer only to significant waterfowl breeding areas and regular-large concentrations in winter of Family Anatidae, excluding Canada geese in urban areas.[a] Resident breeding population plus separate wintering population.
Caspian Tern		Monitor	YES (2)		M	G5, S4S5B, SZN		II	Priority species criteria refers only to breeding populations.[a]
Clark's Grebe		Monitor	YES (2)		M	G5, S2B, SZN		II	Priority species criteria refers only to breeding populations.[a] Observed in fall (October).
Cliff Swallow			NO		M	G5, S5B, SZN		II	Resident breeder
Common Goldeneye			YES (2,3)		M	G5, SA, S5N		II	Winter resident

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status[a]	Washington State Status[a]	WDFW Priority Species (Criterion)[a]	Oregon State Status[a]	Species Identified by Federal Regulation as Migratory[b]	Global and Washington State Rarity Status[a]	Oregon State Rarity Status[a]	Resource Level of Concern at Hanford[c]	Comments[d]
Common Loon		Candidate	YES (1,2)		M	G5, S2B, S5N		III	Some present fall/winter; others resident year-round. Rare breeder on Site (two sightings of juveniles in the last 10 years).[e]
Common Merganser			YES (2,3)		M	G5, S4B, S5N		II	Priority species criteria refer only to significant waterfowl breeding areas and to regular-large concentrations in winter of Family Anatidae.[a] Resident breeder
Common Nighthawk			NO		M	G5, S4B, SZN		II	Spring/summer breeder
Eastern Kingbird			NO		M	G5, S4S5B, SZN		II	Spring/summer breeder
Common Poorwill			NO		M	G5, S4B, SZN		II	Spring/summer breeder
Common Raven			NO		M	G5, S5		II	Resident breeder
Dark-eyed Junco			NO		M	G5, S5B, S5N		II	Winter resident
Ferruginous Hawk	Former candidate	Threatened	YES (1)	Sensitive/ critical	M	G4, S2B, SZN	S3	III	Resident breeder. Habitat also includes dry upper slopes of ALE[g] canyons. Nest locations require buffer zones to minimize disturbance.[h]
Flammulated Owl		Candidate	YES (1)	Sensitive/ critical	M	G4, S3B, SZN		III	Observed during March
Forster's Tern		Monitor	YES (2)		M	G5, S3B?, SZN		II	Priority species criteria refers only to breeding populations.[a]
Franklin's Gull			NO	Sensitive/ peripheral or naturally rare	M	G5, SZN		II	

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status [a]	Washington State Status [a]	WDFW Priority Species (Criterion) [a]	Oregon State Status [a]	Species Identified by Federal Regulation as Migratory [b]	Global and Washington State Rarity Status [a]	Oregon State Rarity Status [a]	Resource Level of Concern at Hanford [c]	Comments [d]
Golden Eagle		Candidate	YES (1)		M	G4, S3B, S3N		III	May reside year-round in Tri-Cities;[g] occasionally seen on Hanford year-round.[g,i] Also observed in native bunchgrass areas recovering from fire/other disturbance, and on Rattlesnake/Saddle Mountain.[g]
Grasshopper Sparrow		Monitor	NO	Sensitive/ undetermined status	M	G5, S3B, SZN		II	Spring/summer breeder. Observed on ALE using native bunchgrass areas, weedy fields of non-native annuals, and areas recovering from fire/other disturbance.[g]
Great Blue Heron		Monitor	YES (2)		M	G5, S4S5		II	Regularly nests on the Hanford Site
Great Egret		Monitor	NO	Sensitive/ undetermined status	M	G5, S3B, SZN		II	Present from April to May/August to September. Rare breeder. Observed nesting with Great Blue Heron colony once or twice in the late 1980s.[j] See Fitzner and Gray (1991).
Great-horned Owl			NO		M	G5, S5		II	Resident breeder
Gyrfalcon		Monitor	NO		M	G5, S2N		II	Winter sighting. No recent records.
Harlequin Duck			YES (2,3)	Sensitive/ peripheral or naturally rare	M	G4, S3		II	Oregon State status applies only to breeding populations.[a]
Horned Grebe		Monitor	YES (2)	Sensitive/ peripheral or naturally rare	M	G5, S3B, S5N		II	Priority species criteria refers only to breeding populations.[a] Oregon State status applies only to breeding populations.[a]
Horned Lark			NO		M	G5, S5B, S5N		II	Resident breeder
House Finch			NO		M	G5, S5		II	Resident breeder
Killdeer			YES (2)		M	G5, S5B, S5N		II	Spring-summer breeder
Lark Sparrow					M	G5, S4B, SZN		II	Spring-summer breeder
Lazuli Bunting			NO		M	G5, S5B, SZN		II	Spring-summer breeder

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status[(a)]	Washington State Status[(a)]	WDFW Priority Species (Criterion)[(a)]	Oregon State Status[(a)]	Species Identified by Federal Regulation as Migratory[(b)]	Global and Washington State Rarity Status[(a)]	Oregon State Rarity Status[(a)]	Resource Level of Concern at Hanford[(c)]	Comments[(d)]
Lewis' Woodpecker		Candidate	NO	Sensitive/ critical	M	G4, S3B, SZN	S3, S4	III	Present late April to May/mid-August to mid-October. Observed in ALE riparian areas.[(g)]
Loggerhead Shrike	Former candidate	Candidate	YES (1)	Sensitive/ undetermined status	M	G4G5, S3B, SZN		III	Some year-round residents; others migrate. Observed in native bunchgrass areas, weedy fields of non-native annuals, areas recovering from fire/other disturbance, ALE riparian areas on ALE.[(g)]
Long-billed Curlew	Former candidate	Monitor	YES (3)		M	G5, S2B, S2N		II	Also observed in native bunchgrass areas, weedy fields with non-native annuals, and areas recovering from fire/other disturbance.[(g)] Spring/summer breeder.
Mallard			YES (2,3)		M	G5, S5B, S5N		II	Resident breeder
Marsh Wren			NO		M	G5, S4N, S5B		II	Resident breeder
Merlin		Candidate	YES (1)		M	G4, S3B, S4N		III	A few recent sightings in winter.[(j)]
Mourning Dove			NO		M	G5, S5B, S5N		II	Spring-summer breeder
Northern Flicker			NO		M	G5, S5		II	Resident breeder
Northern Goshawk	Former candidate	Candidate	YES (1)	Sensitive/ critical	M	G4, S3B, S3N		III	A few recent sightings.[(j)]
Northern Harrier			NO		M	G5, S4B, S4S5N		II	Resident breeder
Northern Shrike			NO		M	G5, S4N		II	Winter resident
Olive-sided Flycatcher	Former candidate		NO		M	G5, S4S5B, SZN		II	
Oregon Vesper Sparrow		Monitor	NO	Sensitive/ undetermined status	M	G5TU, S2S3B, SZN		II	Common in bluebunch wheatgrass on Rattlesnake Mountain where it regularly breeds.
Osprey		Monitor	YES (3)		M	G5, S4B, SZN		II	Present during September to October/April to May.
Peregrine Falcon	Endangered	Endangered	YES (1)	Endangered	M	G4, S1B, S3N	S1	IV	Present late November to January

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status [a]	Washington State Status [a]	WDFW Priority Species (Criterion) [a]	Oregon State Status[a]	Species Identified by Federal Regulation as Migratory [b]	Global and Washington State Rarity Status [a]	Oregon State Rarity Status [a]	Resource Level of Concern at Hanford [c]	Comments [d]
Prairie Falcon		Monitor	YES (3)		M	G5, S3B, S3N		II	Also observed in bunchgrass areas, weedy fields of non-native annuals, areas recovering from fire/other disturbance, Rattlesnake Mountain/Saddle Mountain, rivers, and dry upper slopes of ALE canyons.[g] Resident breeder.
Red-necked Grebe		Monitor	YES (3)	Sensitive/ critical	M	G5, S3B, S5N		II	Priority species criteria refers only to breeding populations.[a] Oregon State status applies only to breeding populations.[a]
Red-tailed Hawk			NO		M	G5, S5B, S5N		II	Resident breeder
Red-winged Blackbird			NO		M	G5, S5B, S5N		II	Spring/summer breeder
Ring-billed Gull			NO		M	G5, S5B, S5N		II	Spring/summer breeder
Rock Wren			NO		M	G5, S5B, SZN		II	Spring/summer breeder
Sage Grouse	Former candidate	Candidate	YES (1,3)	Sensitive/ vulnerable		G5, S3		III	
Sage Sparrow		Candidate	YES (1)		M	G5, S3B, SZN		III	Habitat also includes dry upper slopes of ALE canyons.[g]
Sage Thrasher		Candidate	YES (1)		M	G5, S3B, SZN		III	Habitat also includes ALE riparian areas.[g]
Sandhill Crane		Endangered	YES (1)	Sensitive/ vulnerable	M	G5, S1B, S3N		III	Early March-May/mid-September/early November. Habitat also includes Rattlesnake/ Saddle Mountain.[g] Rarely lands on Site.
Say's Phoebe			NO		M	G5, S5B, SZN		II	Spring/summer breeder
Sharp-tailed Grouse	Former candidate	Monitor	YES (1,3)			G4, S2	S?	II	Possibly present on ALE in early 1970s. Not documented on Hanford since then.[k]
Snowy Egret			NO	Sensitive/ vulnerable	M	G5, SZN		II	Oregon State status applies only to breeding populations.[a]
Snowy Owl		Monitor	NO		M	G5, S3N		II	

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status [a]	Washington State Status [a]	WDFW Priority Species (Criterion) [a]	Oregon State Status[a]	Species Identified by Federal Regulation as Migratory [b]	Global and Washington State Rarity Status [a]	Oregon State Rarity Status [a]	Resource Level of Concern at Hanford [c]	Comments [d]
Prairie Falcon		Monitor	YES (3)		M	G5, S3B, S3N		II	Also observed in bunchgrass areas, weedy fields of non-native annuals, areas recovering from fire/other disturbance, Rattlesnake Mountain/Saddle Mountain, rivers, and dry upper slopes of ALE canyons.[g] Resident breeder.
Red-necked Grebe		Monitor	YES (3)	Sensitive/ critical	M	G5, S3B, S5N		II	Priority species criteria refers only to breed-ing populations.[a] Oregon State status applies only to breeding populations.[a]
Red-tailed Hawk			NO		M	G5, S5B, S5N		II	Resident breeder
Red-winged Blackbird			NO		M	G5, S5B, S5N		II	Spring/summer breeder
Ring-billed Gull			NO		M	G5, S5B, S5N		II	Spring/summer breeder
Rock Wren			NO		M	G5, S5B, SZN		II	Spring/summer breeder
Sage Grouse	Former candidate	Candidate	YES (1,3)	Sensitive/ vulnerable		G5, S3		III	
Sage Sparrow		Candidate	YES (1)		M	G5, S3B, SZN		III	Habitat also includes dry upper slopes of ALE canyons.[g]
Sage Thrasher		Candidate	YES (1)		M	G5, S3B, SZN		III	Habitat also includes ALE riparian areas.[g]
Sandhill Crane		Endangered	YES (1)	Sensitive/ vulnerable	M	G5, S1B, S3N		III	Early March-May/mid-September/early November. Habitat also includes Rattlesnake/ Saddle Mountain.[g] Rarely lands on Site.
Say's Phoebe			NO		M	G5, S5B, SZN		II	Spring/summer breeder
Sharp-tailed Grouse	Former candidate	Monitor	YES (1,3)			G4, S2	S?	II	Possibly present on ALE in early 1970s. Not documented on Hanford since then.[k]
Snowy Egret			NO	Sensitive/ vulnerable	M	G5, SZN		II	Oregon State status applies only to breeding populations.[a]
Snowy Owl		Monitor	NO		M	G5, S3N		II	

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status [a]	Washington State Status [a]	WDFW Priority Species (Criterion) [a]	Oregon State Status[a]	Species Identified by Federal Regulation as Migratory [b]	Global and Washington State Rarity Status [a]	Oregon State Rarity Status [a]	Resource Level of Concern at Hanford [c]	Comments [d]
Song Sparrow			NO		M	G5, S5B, S5N		II	Resident breeder
Spotted (formerly Rufous-sided) Towhee			NO		M	G5, S5B, S5N		II	Spring/summer breeder
Swainson's Hawk	Former candidate	Monitor	NO	Sensitive/ vulnerable	M	G4, S3B, SZN	S3	III	Resident breeder. Also observed in native bunchgrass, weedy fields of non-native annuals, areas recovering from fire/other disturbance, and riparian areas.[g]
Tricolored Blackbird			NO	Sensitive/ peripheral or naturally rare	M		S2	II	Erratic occurrence on Hanford. Normally breeds from southern Oregon to Baja California.
Turkey Vulture		Monitor	NO		M	G5, S4B, SZN		II	Habitat also includes Rattlesnake/Saddle Mountain.[g]
Western Bluebird		Monitor	YES (3)	Sensitive/ vulnerable	M	G5, S3B, SZN		II	Migrant observed on Rattlesnake Mountain.[g]
Western Grebe		Monitor	YES (2)		M	G5, S3B, S5N		II	Priority species criteria refers only to breeding populations.[a] Primarily a winter resident/rare in summer.
Western Kingbird			NO		M	G5, S5B, SZN		II	Resident breeder
Western Meadowlark			NO		M	G5, S5B, S5N		II	Resident breeder
White-crowned Sparrow			NO		M	G5, S5B, S5N		II	Winter resident
Willow Flycatcher	Former candidate		NO		M	G5, S5B, SZN		II	

Table D.9 Avian Species of Concern Potentially Found on or Near the Hanford Site - Status (continued)

Common Name	Federal Status [(a)]	Washington State Status[(a)]	WDFW Priority Species (Criterion) [(a)]	Oregon State Status[(a)]	Species Identified by Federal Regulation as Migratory [(b)]	Global and Washington State Rarity Status [(a)]	Oregon State Rarity Status [(a)]	Resource Level of Concern at Hanford [(c)]	Comments [(d)]
Yellow-headed Blackbird			NO		M	G5, S5B, S4N		II	Resident breeder
Yellow-rumped Warbler			NO		M	G5, S5B, S4N		II	Winter resident.

(a) See Section D.3.5.1 for references and definitions. Global and state rarity statuses separated by commas. Often two state rarity statuses are listed. For long-distance migratory species whose non-breeding status may be different from breeding status; B and N indicate the status.
(b) 50 CFR 10.13. 1990. List of Migratory Bird Species. M = federally-listed migratory bird; no notation = not listed as federally protected migratory bird.
(c) See Section 3.3 for definitions. Each level corresponds to a set of management actions required for species at that level. A particular species is defined by its association with one specific level of management concern.
(d) Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases maintained by Pacific Northwest National Laboratory. Comments from these sources, unless otherwise stated.
(e) Breeding information from Lisa Fitzner (pers. comm. 1996).
(f) Day and nighttime bald eagle buffers around roosts: 800 m for activities within line of sight of visible roosts, 400 m for activities out of line of sight. Bald eagle buffers around perches: none at this time, other than those recommended above for night roosts that are used for perching/resting during the day. All buffer requirements from Fitzner and Weiss (1994).
(g) Additional habitat use information from The Nature Conservancy (1995).
(h) Ferruginous hawk buffers around nests are 1.0 km (Fitzner et al. 1994).
(i) Based on Landeen et al. (1992).
(j) Breeding and sighting information from William Rickard (pers. comm. 1996).
(k) Sighting information from John Rotenberry (pers. comm. 1995).

Table D.10 Avian Species of Concern Potentially Found on or Near the Hanford Site—Ecology

Common Name	Occurrence[(a)]					Preferred Habitat[(b)]							Hanford Abundance[(a)]				
	YR	SP	SU	F	W	FW	PG	RC	RT	SD	SM	WM	C	U	R	A	AC
Aleutian Canada Goose				●	●	●			●								●
American Avocet		●	●	●							●		●				
American Bittern		●	●	●		●					●				●		
American Coot	●					●					●					●	
American Crow	●						●		●							●	
American Kestrel	●						●		●	●		●				●	
American Robin	●						●		●							●	
American White Pelican	●					●					●		●				
American Wigeon		●		●	●	●					●	●					●
Arctic Tern				●		●					●						
Ash-throated Flycatcher		●		●					●						●		
Bald Eagle				●	●	●			●				●				
Bank Swallow		●	●	●		●					●					●	
Barn Owl	●								●				●				
Barn Swallow		●	●	●			●		●		●					●	
Barred Owl		●		●					●			●					●
Barrow's Goldeneye					●	●									●		
Belted Kingfisher	●								●					●			
Bewick's Wren	●								●					●			
Black Tern		●		●		●					●			●			
Black-billed Magpie	●						●		●	●						●	
Black-crowned Night Heron	●					●			●		●			●			
Black-headed Grosbeak		●	●	●					●					●			
Black-necked Stilt		●				●			●								●
Black-throated Sparrow		●								●						●	
Brewer's Blackbird		●	●	●			●		●			●	●				
Brewer's Sparrow		●	●	●						●			●				
Brown-headed Cowbird		●	●	●			●		●					●			
Bufflehead		●		●	●	●										●	
Bullock's (formerly Northern) Oriole		●	●	●			●		●				●				
Burrowing Owl	●									●						●	
California Gull		●	●	●		●					●					●	
Canada Goose	●					●					●	●	●				
Caspian Tern		●	●			●					●				●		

(a) Fitzner and Gray (1991). In some instances, Ennor (1991) is used to supplement Fitzner and Gray (1991). Although these species were determined to be present on the Hanford Site using Ennor (1991), the definitions of occurrence [and/or abundance; see footnote (c) below] are generally according to Fitzner and Gray (1991). Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, Landeen et al. (1992), and Stephen Weiss (pers. comm. 1996).
(b) Preferred habitats are from Ennor (1991). Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, TNC (1995), and Stephen Weiss (pers. comm. 1996).
(c) Abundance categories were obtained from Fitzner and Gray (1991); however, definitions of rare, uncommon, and common were adapted from Landeen et al. (1992) as these authors provide more complete definitions. The "accidental" category was obtained from Landeen et al. (1992). Accidental = appears very infrequently and well outside its normal range; Rare = present in appropriate habitat only in small numbers, seldom seen or heard; Uncommon = usually present in appropriate habitat but not always seen or heard; Common = often seen or heard in appropriate habitat; Abundant = very often seen or heard in appropriate habitat. Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, Ennor (1991), and Landeen et al. (1992).
(d) Possibly present on ALE in early 1970s. Not documented on Hanford since then (John Rotenberry, pers. comm. 1995). Farrand (1988) indicates that the sharp-tailed grouse is widespread but not conspicuous in grasslands, brush, and woodland edges.

Table D.10 Avian Species of Concern Potentially Found on or Near the Hanford Site—Ecology (continued)

Common Name	Occurrence[(a)]					Preferred Habitat[(b)]							Hanford Abundance[(a)]				
	YR	SP	SU	F	W	FW	PG	RC	RT	SD	SM	WM	C	U	R	A	AC
Clark's Grebe				●		●			●						●		
Cliff Swallow		●	●	●			●		●		●					●	
Common Goldeneye		●		●	●	●										●	
Common Loon	●					●								●			
Common Merganser	●					●										●	
Common Nighthawk			●	●			●			●		●				●	
Common Poorwill		●	●	●					●					●			
Common Raven	●								●	●		●				●	
Dark-eyed Junco		●		●	●		●		●			●				●	
Eastern Kingbird		●	●	●					●							●	
Ferruginous Hawk		●	●	●		●		●		●				●			
Flammulated Owl		●							●	●							●
Forster's Tern		●	●	●		●					●			●			
Franklin's Gull		●	●	●		●					●				●		
Golden Eagle	●							●	●	●				●			
Grasshopper Sparrow		●	●							●				●			
Great Blue Heron	●					●			●		●					●	
Great Egret		●	●			●			●		●				●		
Great-horned Owl	●						●		●				●				
Gyrfalcon				●	●			●	●	●		●					●
Harlequin Duck		●				●											●
Horned Grebe		●		●	●				●					●			
Horned Lark	●									●		●				●	
House Finch	●						●		●					●			
Killdeer	●						●				●	●				●	
Lark Sparrow		●	●	●			●		●	●			●				
Lazuli Bunting		●	●	●			●		●	●				●			
Lewis' Woodpecker		●	●	●			●		●						●		
Loggerhead Shrike	●						●		●	●			●				
Long-billed Curlew		●	●							●	●	●	●				
Mallard	●										●	●				●	
Marsh Wren	●										●					●	
Merlin		●		●	●		●		●	●					●		
Mourning Dove	●						●		●			●				●	
Northern Flicker	●						●		●				●				

(a) Fitzner and Gray (1991). In some instances, Ennor (1991) is used to supplement Fitzner and Gray (1991). Although these species were determined to be present on the Hanford Site using Ennor (1991), the definitions of occurrence [and/or abundance; see footnote (c) below] are generally according to Fitzner and Gray (1991). Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, Landeen et al. (1992), and Stephen Weiss (pers. comm. 1996).
(b) Preferred habitats are from Ennor (1991). Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, TNC (1995), and Stephen Weiss (pers. comm. 1996).
(c) Abundance categories were obtained from Fitzner and Gray (1991); however, definitions of rare, uncommon, and common were adapted from Landeen et al. (1992) as these authors provide more complete definitions. The "accidental" category was obtained from Landeen et al. (1992). Accidental = appears very infrequently and well outside its normal range; Rare = present in appropriate habitat only in small numbers, seldom seen or heard; Uncommon = usually present in appropriate habitat but not always seen or heard; Common = often seen or heard in appropriate habitat; Abundant = very often seen or heard in appropriate habitat. Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, Ennor (1991), and Landeen et al. (1992).
(d) Possibly present on ALE in early 1970s. Not documented on Hanford since then (John Rotenberry, pers. comm. 1995). Farrand (1988) indicates that the sharp-tailed grouse is widespread but not conspicuous in grasslands, brush, and woodland edges.

Table D.10 Avian Species of Concern Potentially Found on or Near the Hanford Site—Ecology (continued)

Common Name	Occurrence					Preferred Habitat							Hanford Abundance				
	YR	SP	SU	F	W	FW	PG	RC	RT	SD	SM	WM	C	U	R	A	AC
Northern Goshawk				●	●				●	●				●			
Northern Harrier	●								●		●	●	●				
Northern Shrike		●		●	●									●			
Olive-sided Flycatcher		●	●				●		●	●					●		
Oregon Vesper Sparrow		●	●	●						●			●				
Osprey		●		●		●			●		●			●			
Peregrine Falcon				●	●	●		●	●	●							●
Prairie Falcon	●							●	●	●					●		
Red-necked Grebe				●*		●								●			
Red-tailed Hawk	●								●	●			●				
Red-winged Blackbird		●	●	●			●		●		●	●				●	
Ring-billed Gull	●					●	●				●	●				●	
Rock Wren		●	●	●				●								●	
Sage Grouse	●									●					●		
Sage Sparrow		●	●							●			●				
Sage Thrasher		●	●	●						●					●		
Sandhill Crane		●		●								●		●			
Say's Phoebe		●	●	●			●			●		●		●			
Sharp-tailed Grouse																	
Snowy Egret		●		●					●		●	●			●		
Snowy Owl					●				●	●		●					
Song Sparrow	●								●			●				●	
Spotted (formerly Rufous-sided) Towhee		●	●	●			●		●					●			
Swainson's Hawk		●	●	●					●	●			●				
Tricolored Blackbird		●							●								●
Turkey Vulture			●						●	●		●					●
Western Bluebird		●		●			●		●	●					●		
Western Grebe		●		●	●	●			●					●			
Western Kingbird		●	●	●			●		●							●	
Western Meadowlark	●						●			●		●				●	
Western Wood-pewee																	
Yellow-headed Blackbird		●	●	●			●				●	●	●				
Yellow-rumped Warbler																	

YR = year-round
SP = spring
SU = summer
F = fall
W = winter

FW = freshwater, rivers, lakes, ponds, sloughs; PG = parks, gardens, urban habitats; RC = rocky cliffs, talus slopes, rimrock areas; RT = riparian thickets, woodlands, orchards; SD = sagebrush desert or steppe; SM = sandy shores, mudflats, cattail marshes; WM = wet meadows, fields, fencerows, roadsides.

C = common
U = uncommon
R = rare
A = abundant
AC = accidental

(a) Fitzner and Gray (1991). In some instances, Ennor (1991) is used to supplement Fitzner and Gray (1991). Although these species were determined to be present on the Hanford Site using Ennor (1991), the definitions of occurrence [and/or abundance; see footnote (c) below] are generally according to Fitzner and Gray (1991). Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, Landeen et al. (1992), and Stephen Weiss (pers. comm. 1996).
(b) Preferred habitats are from Ennor (1991). Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, TNC (1995), and Stephen Weiss (pers. comm. 1996).
(c) Abundance categories were obtained from Fitzner and Gray (1991); however, definitions of rare, uncommon, and common were adapted from Landeen et al. (1992) as these authors provide more complete definitions. The "accidental" category was obtained from Landeen et al. (1992). Accidental = appears very infrequently and well outside its normal range; Rare = present in appropriate habitat only in small numbers, seldom seen or heard; Uncommon = usually present in appropriate habitat but not always seen or heard; Common = often seen or heard in appropriate habitat; Abundant = very often seen or heard in appropriate habitat. Additional sources, used only infrequently, are from the Hanford Biological Resources Laboratory and Ecosystem Monitoring Project data bases, Ennor (1991), and Landeen et al. (1992).
(d) Possibly present on ALE in early 1970s. Not documented on Hanford since then (John Rotenberry, pers. comm. 1995). Farrand (1988) indicates that the sharp-tailed grouse is widespread but not conspicuous in grasslands, brush, and woodland edges.

Table D.11 Migratory Birds: Resident Breeders and Listed (or Candidates for Listing) Non-Residents—Temporal Distribution on the Hanford Site

Species	Migration Period/ Arrival[a]	Nesting Period[a]	Fledging Period[a]	Migration Period/ Departure[a]	Comments
Aleutian Canada Goose	September			February	Accidental migrant observed during fall/winter
American Avocet	Summer[b]			Fall[b]	
American Bittern	Spring[b]			Fall[b]	Resident breeder
American Coot					Resident breeder. Present year-round.
American Crow					Resident breeder. Present year-round.
American Kestrel					Resident breeder. Present year-round.
American Robin					Resident breeder. Present year-round.
American White Pelican					Resident year-round. Although this species has been observed on Hanford for the past 7 years, no breeding/nesting activity has been recorded.
Arctic Tern					Observed during October
Ash-throated Flycatcher					Observed during June and September
Bald Eagle	October (late)			April (early)	Nesting has been attempted, but no successful reproduction has been recorded.
Bank Swallow	April (mid)	May-June	June-July	September (mid)	Breeds on Hanford[b]
Barn Owl					Resident breeder. Present year-round.
Barn Swallow	Summer[b]			Fall[b]	
Barred Owl					Not believed to breed on Hanford. Apparently makes two short stops, one in April and one in September.[c]
Barrow's Goldeneye	November (mid)			April (mid)	Winter Resident
Belted Kingfisher					Resident breeder. Present year-round.
Bewick's Wren					Resident breeder. Present year-round.
Black Tern					Not believed to breed on Hanford. Present during two periods, May to June and August to September.
Black-billed Magpie					Resident breeder. Present year-round.

Table D.11 Migratory Birds: Resident Breeders and Listed (or Candidates for Listing) Non-Residents—Temporal Distribution on the Hanford Site (continued)

Species	Migration Period/ Arrival[a]	Nesting Period[a]	Fledging Period[a]	Migration Period/ Departure[a]	Comments
Black-crowned Night Heron	April (mid)	April-May	June-July	September (mid)	Notwithstanding these arrival and departure dates from Ennor (1991), Ennor and Fitzner and Gray (1991) report this species as being present year-round. Nests on island #18 across from 300 Area.
Black-headed Grosbeak	Summer[b]			Fall[b]	
Black-necked Stilt					Accidental migrant[d] observed from April to May and August.
Black-throated Sparrow					Accidental migrant. Otherwise present in small numbers along the White Bluffs in the summer of 1994.[e]
Brewer's Blackbird	Summer[b]			Fall[b]	
Brewer's Sparrow	Summer[b]			Fall[b]	
Brown-headed Cowbird	Summer[b]			Fall[b]	
Bufflehead	October (mid)			May (mid)	Winter Resident
Bullock's (formerly Northern) Oriole	Summer[b]			Fall[b]	
Burrowing Owl	March	April-May	June-July	September (early)	Notwithstanding the arrival and departure dates, some are present on Hanford year-round.
California Gull	Summer[b]			Fall[b]	
Canada Goose					Resident breeder. Present year-round.
Caspian Tern	April (early)			September (early)	Nests both upstream and downstream from the Hanford Reach, but not within the Hanford Reach.
Clark's Grebe	October				Migrant observed during fall
Cliff Swallow	Summer[b]			Fall[b]	
Common Loon					Some migrate and are present during fall-winter; some are resident year-round.
Common Merganser					Resident breeder. Present year-round.
Common Nighthawk	Summer[b]			Fall[b]	
Common Poorwill	Summer[b]			Fall[b]	
Common Raven					Resident breeder. Present year-round.
Eastern Kingbird	Summer[b]			Fall[b]	

Table D.11 Migratory Birds: Resident Breeders and Listed (or Candidates for Listing) Non-Residents—Temporal Distribution on the Hanford Site (continued)

Species	Migration Period/ Arrival[a]	Nesting Period[a]	Fledging Period[a]	Migration Period/ Departure[a]	Comments
Ferruginous Hawk	February (late)	April-June		October	Resident breeder
Flammulated Owl	March				Observed during March
Forster's Tern	April (early)	May-June	July-August	October (mid)	Nests on islands in the Columbia River.
Franklin's Gull					Present during spring, summer, and fall.[b]
Golden Eagle					Year round resident,[b,c] although the ECAP[a] reports it as a migrant arriving in October and leaving in March.
Grasshopper Sparrow	May (mid)	May-June	June-July	July (mid)	Resident during spring and summer
Great Blue Heron		April-May	May-June		Resident
Great Egret					Present during two periods, April to May and August to September. Bred south of 100-F Area in 1986.[b]
Great-horned Owl					Resident breeder. Present year-round.
Gyrfalcon					Accidental during winter[c,d]
Harlequin Duck					Observed in Spring (accidental)
Horned Grebe	September (late)			May (early)	
Horned Lark					Resident breeder. Present year-round.
House Finch					Resident breeder. Present year-round.
Killdeer					Resident breeder. Present year-round.
Lark Sparrow	Spring[b]			Fall[b]	
Lazuli Bunting	Summer[b]			Fall[b]	
Lewis' Woodpecker					Present during two periods, April(late)-May/August(mid)-October(mid).
Little Willow Flycatcher					Present during spring in May and June and during the fall in September.[b]
Loggerhead Shrike	March (early)	March (late)-July	May (early)	September	Some are year-round residents.
Long-billed Curlew	March (mid)	April		September (mid)	
Mallard					Resident breeder. Present year-round.

Table D.11 Migratory Birds: Resident Breeders and Listed (or Candidates for Listing) Non-Residents—Temporal Distribution on the Hanford Site (continued)

Species	Migration Period/ Arrival[a]	Nesting Period[a]	Fledging Period[a]	Migration Period/ Departure[a]	Comments
Marsh Wren					Resident breeder. Present year-round.
Merlin	September (late)			March (late)	
Mourning Dove					Resident breeder. Present year-round.
Northern Flicker					Resident breeder. Present year-round.
Northern Goshawk	October			March	
Northern Harrier					Resident breeder. Present year-round.
Olive-sided Flycatcher					Migrant that is present during two periods, May and August to September.
Oregon Vesper Sparrow	April (mid)	April-June	June-July	September	
Osprey					Present during two periods, September to October and April to May.
Peregrine Falcon	November (late)			January	
Prairie Falcon		April (mid)-May (early)	June (mid)-July (late)		Resident year-round
Red-necked Grebe	October (early)			December (mid)	
Red-tailed Hawk		April (early)-April (late)	July (mid)-August (mid)		Resident year-round
Red-winged Blackbird	Spring[b]			Fall[b]	Resident breeder
Ring-billed Gull					Resident breeder. Present year-round.
Rock Wren	Summer[b]			Fall[b]	
Sage Grouse					Rare with no known breeding populations on the Hanford Site.
Sage Sparrow	February (mid)	March-June		August (mid)	
Sage Thrasher	April	May		December	
Sandhill Crane					Present during two periods, March (early) to May and September (mid) to November (early). Rarely lands on Site.
Say's Phoebe	Summer[b]			Fall[b]	

Table D.11 Migratory Birds: Resident Breeders and Listed (or Candidates for Listing) Non-Residents—Temporal Distribution on the Hanford Site (continued)

Species	Migration Period/ Arrival[a]	Nesting Period[a]	Fledging Period[a]	Migration Period/ Departure[a]	Comments
Snowy Egret					Present during two periods, May to June and September, but no known breeding populations.
Snowy Owl	November (mid)			March (early)	Accidental.
Song Sparrow					Resident breeder. Present year-round.
Spotted (formerly Rufous-sided) Towhee	Summer[b]			Fall[b]	
Swainson's Hawk	April (early)	April (mid)-July (mid)	July (mid)- August (mid)	September (mid - late)	
Tricolored Blackbird					More likely to occur to the south in Oregon.
Turkey Vulture					Accidental migrant usually observed in summer.[b]
Western Bluebird					Occasional migrant during fall and spring, but breeds elsewhere.
Western Grebe	September			June	Primarily a winter resident, but occasionally present throughout the summer.
Western Kingbird	Summer[b]			Fall[b]	
Western Meadowlark					Resident breeder. Present year-round.
Western Wood-pewee	Spring			Fall	
Yellow-headed Blackbird	Summer[b]			Fall[b]	

(a) Arrival, Nesting, Fledging, and Departure periods/dates were obtained from the Ecological Compliance Assessment Project data base maintained by Pacific Northwest National Laboratory, unless otherwise indicated.
(b) Fitzner and Gray (1991).
(c) Ennor (1991).
(d) Landeen et al. (1992).
(e) TNC (1995).

that could occur during CERCLA[17] site characterization and cleanup, Westinghouse Hanford Company established guidelines that if followed would minimize potential impacts to these species [(Fitzner et al. 1994; although both ferruginous hawks and bald eagles are addressed in this document, bald eagle protection requirements that resulted via consultation with the USFWS under the Endangered Species Act (ESA) are officially documented in Fitzner and Weiss (1994)].

The nesting population of ferruginous hawks at Hanford represents roughly 20–25% of the breeding population in Washington State (Downs et al. 1993; Fitzner et al. 1994). At Hanford most of these hawks nest on transmission towers isolated from human activities (Fitzner et al. 1994), which may reflect more the hawk's preference to avoid any close association with humans and not necessarily a nest substrate preference. To avoid disturbing nesting ferruginous hawks, Fitzner et al. (1994) recommended avoidance of nest locations from March 1 through August 1 with a buffer distance of 1 km. Figure D.24 shows the locations of historic (i.e., 1977–1993) ferruginous hawk nest sites (data from PNNL's Ecosystem Monitoring Project data base). The circle radius represents the 1-km buffer zone around the nest site. Active or potentially active nest sites (i.e., historical nest sites should be avoided after March 1 until it is certain a particular location will not be used for nesting that breeding season) should be avoided as described above. Impacts to nest substrates that occur during the non-breeding season should be appropriately mitigated (e.g., if a historic nest platform is removed, an artificial platform should be erected elsewhere).

Bald eagles are legally protected under the ESA. The Hanford Site's Bald Eagle Site Management Plan (Fitzner and Weiss 1994) fulfills requirements under the ESA for eagle protection as well as meeting the intent of the Washington Administrative Code 232–12–292 that addresses bald eagle habitat protection rules.[17] Although unsuccessful nesting attempts have occurred, bald eagles primarily use the Hanford Site as a wintering area with an average of slightly over 40 eagles using the Site each year since the mid-80s (Fitzner and Weiss 1994). Areas to be protected include foraging, perching, and night roosting locations. Buffer zones are required by the Bald Eagle Site Management Plan specifically for one of the attempted nest sites and for six primary night roosting areas. Perching, secondary roosting, and foraging locations are to be evaluated on a case by case basis. Perch locations can either be in trees or on the ground; whereas, roost locations are all in trees. Primary night roosts are used communally (i.e., by several eagles at a time). Foraging areas tend to correspond with major concentrations of ground perch locations.

Bald eagle ground perch and tree perch and/or secondary night roost tree locations are shown in Figure D.24. No buffer zones are specified for these locations; however, these areas generally should be avoided if eagles are present (during the period November 15 to March 15). These locations were categorized and recorded by Eisner (1991). Observations were made during 1986–1987 and locations recorded via GPS during 1991. The categories of use in Figure D.24 are a reclassification of the data in Eisner's Appendix C (1991).

The Bald Eagle Site Management Plan (Fitzner and Weiss 1994) specifies six primary night roost locations. All of these locations require buffer zones to preclude disturbance of eagles or their roosting habitat. Additionally, three locations at which eagles have attempted nesting are identified. One of these locations currently requires a buffer zone. (The other two locations are not considered likely candidates for future eagle nesting attempts but will be monitored to determine if buffer zones will be necessary.) Figure D.25 shows the seven locations that require a disturbance buffer plus the locations of two other potential nest locations. With one exception, the buffer zone size is an 800-m radius circle around each location. As this is a line-of-sight-based requirement (Fitzner and Weiss 1994), this assumes each roost/nest location is visible from this distance from all points of the compass. The exception is the roost location at 100 K. Here, the buffer zone does not extend northeast beyond the fenceline between the roost and 100 K Area (the fence is within 100 m of the roost) (Fitzner and Weiss 1994). (This change in the buffer zone is not shown in Figure D.25.) The relaxation of the buffer

[17] The USFWS concurred through informal consultation pursuant to Section 7(a)(2) of the ESA that Department of Energy activities that are carried out consistent with the Hanford Site's Bald Eagle Site Management Plan are "not likely to adversely affect" the bald eagle [Potential impacts to the peregrine falcon also were addressed by this statement.].

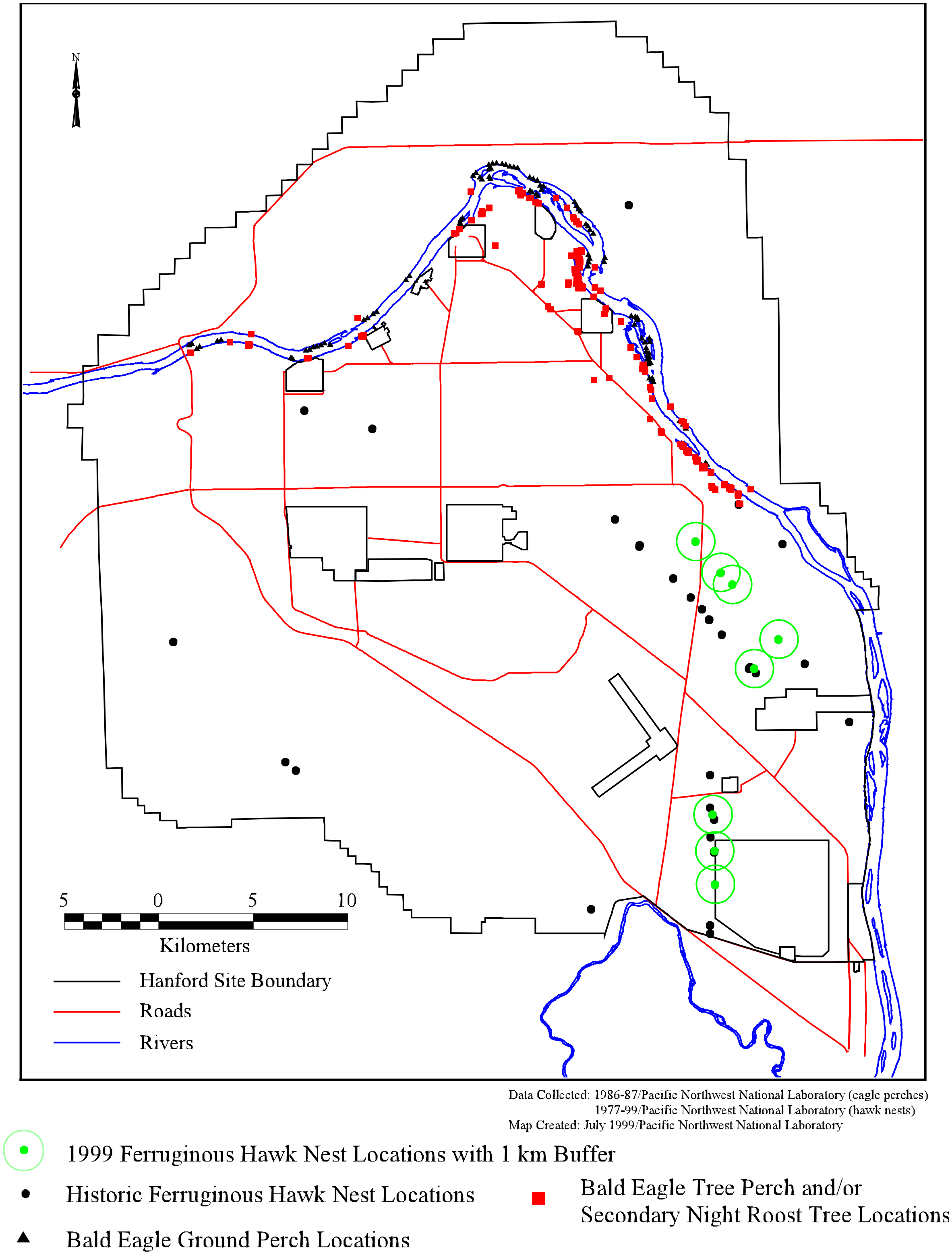
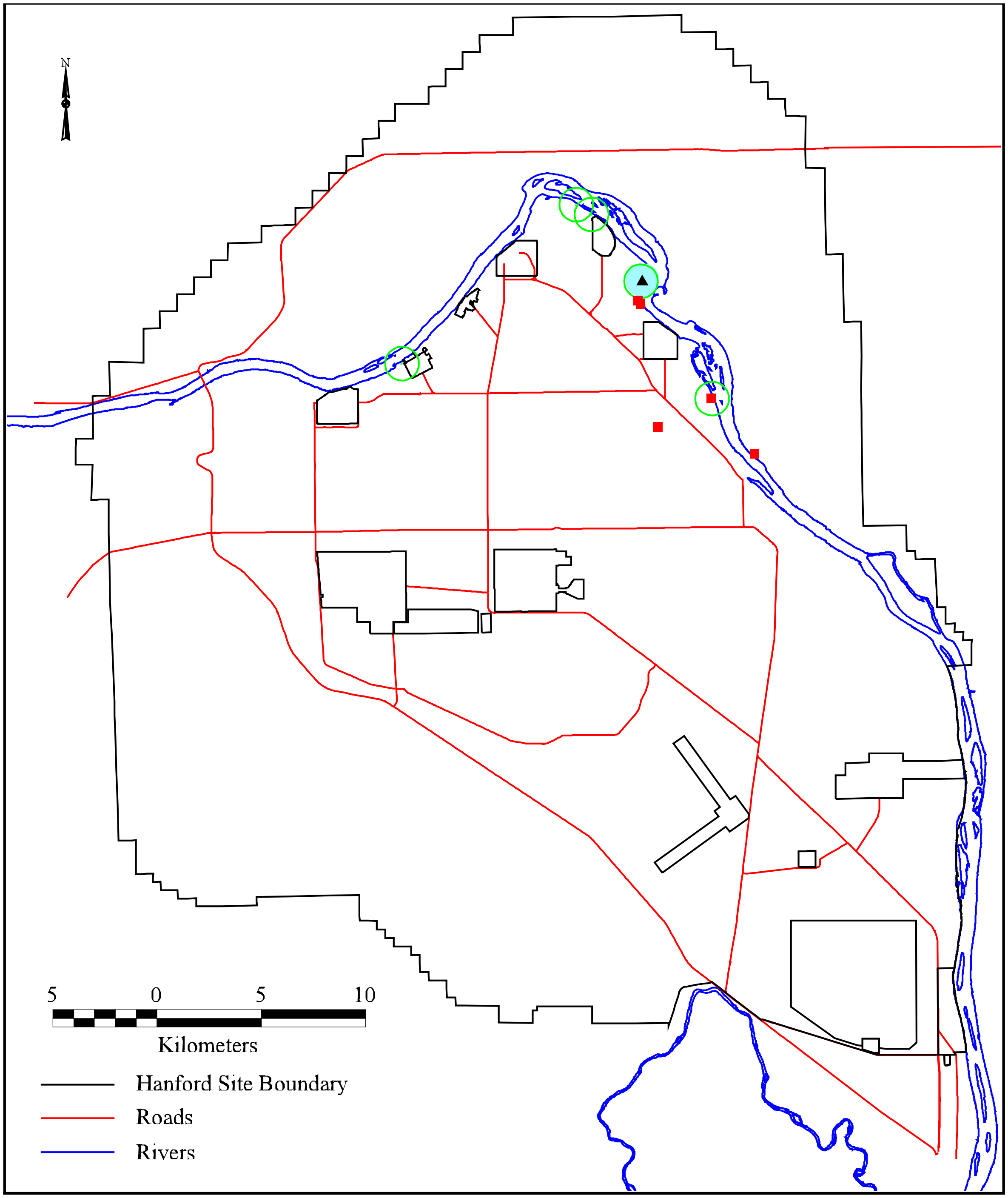


Figure D.24 Historic Ferruginous Hawk Nest Locations and Bald Eagle Perch and Secondary Night Roost Locations



Data Collected: 1986-99/Pacific Northwest National Laboratory
Map Created: July 1999/Pacific Northwest National Laboratory

1999 Bald Eagle Nest Location with Exclusion Zone

Bald Eagle Nesting Attempts (1991-1998)

Bald Eagle Primary Night Roosts with Exclusion Zone

Figure D.25 Bald Eagle Potential Nest and Primary Night Roost Locations zone requirements for this location is based on previous experience with the type of human activities that have occurred near the roost location and the seeming lack of a disturbance effect on the eagles. Provided the scale of activities remains consistent with those identified in Fitzner and Weiss (1994), the relaxation is allowed. Activities that could create a larger scale disturbance will require additional consultation with USFWS prior to the activity being allowed to occur (Fitzner and Weiss 1994).

To avoid direct impacts to the eagles themselves, the buffer zones have temporal limits of November 15 to March 15 for the primary night roosts and January 1 to August 15 for nest locations (the actual duration of the latter timeframe is dependent on whether birds continue the nesting cycle instead of abandoning the site; Fitzner and Weiss 1994). Although a variety of activities, precluded when eagles are present, can occur outside these temporal limits, permission to conduct activities within buffer zones does not extend to activities that would result in modifications to the habitat (at all times of the year). Activities that could result in adverse impacts to buffer zone habitat that may affect eagle usage (to include direct removal of vegetation or application of herbecides that causes vegetation mortality) or activities that could result in losses of potential nest trees or perch/roost trees require additional consultation with the USFWS (Fitzner and Weiss 1994).

D.2.5.7 Mammals

Forty species of mammals have been documented at Hanford at one time or another since its inception as a federal facility (Fitzner and Gray 1991). Some species, such as the pygmy rabbit (*Brachylagus idahoensis*), may be extirpated. Additional species have ranges that extend to the vicinity of the Hanford Site; therefore, it is possible that some of these species may be present on Hanford in suitable habitat. At present, there are 13 mammal species of concern that are potentially found on or near Hanford (Table D.12). Seven of these species are bat species, four of which have yet to be documented at Hanford. Two species, the Washington ground squirrel (*Spermophilus washingtoni*) and Ord's kangaroo rat (*Dipodomys ordii*), though not yet documented on Hanford, may be present, especially on the North Slope. The pygmy rabbit has not been observed on Hanford since the early 1980s (Fitzner and Gray 1991). Although suitable habitat is present, recent searches for pygmy rabbits on Hanford have not resulted in any positive indication that rabbits are present (Cadwell 1994). The remainder of the species listed in Table D.12 [sagebrush vole (*Lagurus curtatus*), northern grasshopper mouse (*Onychomys leucogaster*), and Merriam's shrew (*Sorex merriami*)] all occur on Hanford and are characteristic shrub-steppe species (Rickard et al. 1988).

D.2.5.8 Non-Taxonomic Species Category: Recreationally/ Commercially Important Species

Not all species that are important to be considered from a resource management perspective are addressed under a narrowly defined concept of species of concern. Some species that are important culturally (either recreationally, commercially, or to Native Americans) or ecologically as harbingers of environmental change deserve management attention at least at the level of status monitoring.

Table D.13 provides a tentative list of recreationally/ commercially important species for the Hanford Site. The list is by no means complete and is intended to be dynamic. The current table is composed mainly of species identified by WDFW as important recreational and/or commercial species (WDFW 1996). One of the other two species on the list, the fall chinook salmon (*Oncorhynchus tshawytscha*), is of vital cultural importance to Native Americans as well as of regional and national significance. Its cultural standing and regional/ national significance makes the fall chinook salmon a Level IV resource, despite the fact the particular stock that uses the Hanford Reach to spawn is unlisted. All other species listed in Table D.13 are considered Level I resources. Recreationally/ commercially important species that are otherwise identified in the taxa-specific, species of concern tables are not repeated in Table D.13.

Historically, fall chinook salmon spawned in the mainstem Columbia River from near The Dalles, Oregon, to the Pend Oreille River in Idaho; however, today the Hanford Reach of the Columbia River is the only significant mainstem spawning habitat remaining for upriver bright stocks of fall chinook salmon (Dauble and Watson 1990). The relative contribution of these upriver bright stocks to fall chinook salmon runs in the Columbia River increased from about 24% of the total in the early 1980s to 50–60% of the total in the 1990s; these

Table D.12 Mammal Species of Concern Potentially Found on or Near the Hanford Site

Scientific Name	Common Name	Federal Status[(a)]	Washington State Status[(a)]	WDFW Priority Species (Criterion)[(a)]	Oregon State Status[(a)]	Global and Washington State Rarity Status[(a)]	Oregon State Rarity Status[(a,b)]	Habitat Association
Antrozus pallidus	Pallid bat		Monitor	YES (2)	Sensitive/ vulnerable	G5, S3		A, C[(e)]
Brachylagus (=Sylvilagus) idahoensis	Pygmy rabbit	Former candidate	Endangered	YES (1)	Sensitive/ vulnerable	G5, S1		Dense stands of big sagebrush[(f)]
Spermophilus (=Citellus) washingtoni	Washington ground squirrel		Monitor	YES (1)	Sensitive/ critical	G2, S2	S2	Shrub- and meadow-steppe[(h)]
Dipodomys ordii	Ord's Kangaroo rat		Monitor	NO		G5, S?		Sandy soils in arid and semi-arid habitats[(i)]
Lagurus (=Lemmiscus) curtatus	Sagebrush vole		Monitor	NO		G5, S?		SS, R[(j)]
Myotis ciliolabrum (split from M. leibii)	Small-footed myotis	Former candidate	Monitor	YES (2)		G5, S?		C[(e)]
Myotis evotis	Long-eared myotis		Monitor	YES (2)		G5, S3		C, S[(e)]
Myotis thysanodes	Fringed myotis	Former candidate	Monitor	YES (2)	Sensitive/ vulnerable	G5T2, S?		C, A[(e)]
Myotis volans	Long-legged myotis	Former candidate	Monitor	YES (2)		G5, S3		A, S[(e)]
Myotis yumanensis	Yuma myotis	Former candidate		YES (2)		G5, S?		A, S[(e)]
Onychomys leucogaster	Northern grasshopper mouse		Monitor	NO		G5, S?		SS[(j)]
Plecotus townsendii pallescens	Pale Townsend's big-eared bat	Former candidate		YES (1, 2)	Sensitive/ critical			C, A, S[(e)]
Sorex merriami	Merriam's shrew		Candidate	YES (1)		G5, S3		SS[(j)]

(a) See Section D.3.5.1 for references and definitions. Global and state rarity statuses are separated by a comma in the table.
(b) Oregon distribution of the Washington ground squirrel by county: Gilliam, Morrow, and Umatilla counties. Data from the The Nature Conservancy of Oregon. 1995. Oregon Natural Heritage Program, Rare Plant, and Animal Database. The Nature Conservancy, Portland, Washington.
(c) The abundance categories: common and uncommon, were obtained from Fitzner and Gray (1991); however, definitions of common and uncommon were adapted from Landeen et al. (1992) as these authors provide more complete definitions. Common = often seen in appropriate habitat; Uncommon = usually present in appropriate habitat but not always seen. Rickard et al. (1988) identifies the northern grasshopper mouse as never very abundant.
(d) See section 3.3 for definitions of resource levels of concern. Each level corresponds to a different set of management actions that are required to be taken in regard to those species included for consideration at that level. A particular species is defined by its association with one specific level of management concern.
(e) Habitat associations are as follows (WDW 1993): A = anthropogenic (buildings); C = cliffs (may include talus); S = snags, cavities, or under bark; T = tree, roosts on tree and relies on camouflage.
(f) A complete description of pygmy rabbit habitat requirements is provided in WDFW (1995).
(g) Fitzner and Gray (1991) reported a population of pygmy rabbits on ALE prior to 1984 but indicated there have been no sitings since. Some recent surveys been conducted at Hanford to ascertain whether pygmy rabbits are present (Cadwell 1994). To date, there is no evidence of the presence of pygmy rabbits on Hanford.
(h) Although Washington ground squirrels may be associated with sagebrush, Betts (1990) found them in areas with little or no shrub cover and high herbaceous cover. There are no known records of the Washington ground squirrel on the Hanford Site; however, Washington ground squirrels are found near Hanford in Franklin, Adams, and Grant Counties (Betts 1990).
(i) Habitat association information is from Burt and Grossenheider (1976). Fitzner and Gray (1991) have not documented the Ord's kangaroo rat as occurring on the Hanford Site; however, its potential range extends to southcentral Washington (Burt and Grossenheider 1976).
(j) Habitat associations are from Fitzner and Gray (1991) and Rickard et al. (1988): SS = shrub-steppe; R = riparian. The sagebrush vole has a close association with big sagebrush (Rickard 1960). On Hanford, capture results by O'Farrell (1972, 1975) recorded sagebrush voles from only the big sagebrush/bluebunch wheatgrass association; whereas O'Farrell (1975) captured northern grasshopper mice only within the big sagebrush/Sandberg's bluegrass association (the latter is at lower elevations and contains sandier soil than the former). Gano and Rickard (1982), however, reported capturing northern grasshopper mice within a bitterbrush community that also contained sandy soils. Merriam's shrew is generally associated with drier habitats than most shrews and seems to be found in habitat where sagebrush voles are located; however, Wunder et al. (1994) found them to be most abundant within high elevation threetip sagebrush (*Artemisia tripartita*) sites on the Yakima Training Center.
(k) One population has been observed in the Process Pipe Tunnel between the 190-DR Warehouse and the 105-DR Reactor (Becker 1993).

Table D.13 Recreationally/Commercially Important Species Potentially Found on or Near the Hanford Site

Scientific Name	Common Name	WDFW Priority Species (Criterion)[(a)]	Distribution and/or Habitat Association on Hanford[(b)]	Hanford Abundance[(b)]
Birds				
Alectoris chukar	Chukar	Yes (3)	Upper elevations	Abundant
Phasianus colchicus	Ring-necked pheasant	Yes (3)	Riparian areas	Abundant
Mammals				
Lepus townsendii	White-tailed jackrabbit	Yes (3)	Upper elevations of ALE	Uncommon
Mustela vison	Mink	Yes (3)	Riparian along Columbia River	Uncommon
Cervus elaphus nelsoni	Rocky Mountain elk	Yes (3)	ALE	Common
Odocoileus hemionus hemionus	Rocky Mountain mule deer	Yes (3)	Entire Site	Common
Fish				
Acipenser transmontanus	White sturgeon	Yes (2,3)	Main channel/deep pools Columbia River	Abundant year-round
Ictalurus punctatus	Channel catfish	Yes (3)	Slack areas near the upper portion of McNary Pool	Common in spring and summer
Oncorhynchus tshawytscha	Fall chinook salmon	Yes (2,3)	Life-stage dependent: redds are located in the main channel of the Hanford Reach; juveniles use the whole Columbia River	Abundant
Oncorhynchus kisutch	Coho salmon	Yes (2,3)	Main channel Columbia River	Uncommon
Oncorhynchus mykiss	Rainbow trout/steelhead	Yes (3)	Main channel Columbia River	Abundant spring through fall
Oncorhynchus nerka	Sockeye salmon	Yes (2,3)	Main channel Columbia River	Juveniles common spring and adults common summer
Micropterus salmoides	Largemouth bass	Yes (3)	Sloughs of the Hanford Reach	Common
Micropterus dolomieui	Smallmouth bass	Yes (3)	Sloughs of the Hanford Reach	Abundant
Stizostedion vitreum	Walleye	Yes (3)	Main channel Columbia River	Common

(a) WDFW (1996). See Section D.2.5.1 for definition of criteria.
(b) All habitat association, distribution, and abundance information for birds and mammals are from Fitzner and Gray (1991). Habitat association, distribution, and abundance information for fish were provided by Dennis Dauble (pers. comm. 1995) and were based on prior surveys and scientific studies conducted by the Ecology Group at Pacific Northwest National Laboratory.

stocks also have contributed to a higher percentage of the commercial, tribal, and sport fishing catch since 1980 (Dauble and Watson 1990; NPS 1994).

Aerial counts of fall chinook salmon redds (as the gravel nests are termed) have been conducted since 1948 at Hanford to provide an index of relative abundance among spawning areas and years. Redd counts peaked during 1987 at 8630 redds (Dauble and Watson 1990). Counts have fluctuated since that time with the latest count 5619 redds in 1994 (Cadwell 1995). Redd counts are minimum estimates of nest building as redds that occur in deeper water are not counted during aerial surveys (Dauble and Watson 1990, NPS 1994). For a 41 year record, redd counts from the Vernita Bar and Upper Locke Island areas averaged 33% and 25% of the total, respectively (Dauble and Watson 1990). Figure D.26 shows the general locations of the major fall chinook salmon spawning areas within the Hanford Reach. These locations were digitized from aerial photos that were taken on November 13, 1991, major spawning areas and patched onto the USGS river map . The depicted locations differ slightly from those shown in Dauble and Watson (1990: Figure 3.1). Areas 4–7 of Dauble and Watson are shown on Figure D.26 as one continuous area concentrated near Locke Island. Area 1 of Dauble and Watson is subdivided into four areas on Figure D.26.

D.2.5.9 Non-Taxonomic Species Category: Ecologically Important Species

Sometimes it is the responses of the more ubiquitous species to environmental change that best serve as the indicators of ecological stress. Those species that are characteristic of a particular habitat and are typically relatively abundant in that habitat can be readily used as monitors of change. Table D.14 provides an initial list of such ecologically important species. A more definitive list of species/taxa will be developed in concurrence with the development of the monitoring strategy for the Hanford Site. In general, species monitoring will be accomplished in conjunction with data collection that characterizes and monitors changes in habitats of concern on Hanford. All of the species/taxa identified in Table D.14 are considered Level I resources (i.e., require status monitoring). Other ecologically important species, that are also species of concern, are included in the tables that address specific taxa and are not generally repeated here. (The bird species listed, because each also qualifies as a federally-recognized migratory bird, are an exception.)

Table D.14 lists relatively abundant or widely distributed species/taxa that are proposed for monitoring in the following four general habitat classes on the Hanford Site: shrub-steppe, desert streams, the riparian corridor along the Hanford Reach, and the aquatic environment of the Hanford Reach. In general, these species/taxa were selected because of their ubiquity in the specified habitat and their position in the food chain. For example, long-term declines in species at the base of the food chain or at the top of the food chain are likely to be indicative of a decline in the overall health of the specified habitat. Brief descriptions in regard to the basis for selecting the species identified in Table D.14 are provided by habitat class in the paragraphs that follow.

Darkling beetles (family Tenebrionidae) are among the most conspicuous of the ground-dwelling insects at Hanford (Rickard et al. 1988). Their abundance varies according to season of the year, habitat, and microclimate; generally, their abundance is greater in warmer and drier locations and in areas dominated by native vegetation (Rogers et al. 1988). Thus, changes in the abundance or species composition of darkling beetles may well be an indicator of change within shrub-steppe communities. Species likely to be particularly good indicators of shrub-steppe condition include *Eleodes hispilabris*, *E. obscura*, *E. nigrina*, *E. granulata*, *E. humeralis*, *Eusattus muricatus*, *Stenomorpha puncticollis*, and *Philolithus densicollis*.

The ecological role of darkling beetles is closely tied to their particular life stage. Larval populations are primarily detritivores and live in the litter layer near the soil surface. Their feeding activities help to cycle nutrients between the plant and soil components. Adults also feed primarily on detritus, though some species will feed on green plant material. The adults also are an important component in the diets of a variety of predatory mammals that range in size from the grasshopper mouse (*Onychomys leucogaster*) to the coyote (*Canis latrans*). They also may serve as prey for a variety of the raptorial bird species that occupy the shrub-steppe.

The Great Basin pocket mouse (*Perognathus parvus*) is granivorous. This species is widely distributed and abundant across the entire shrub-steppe of the

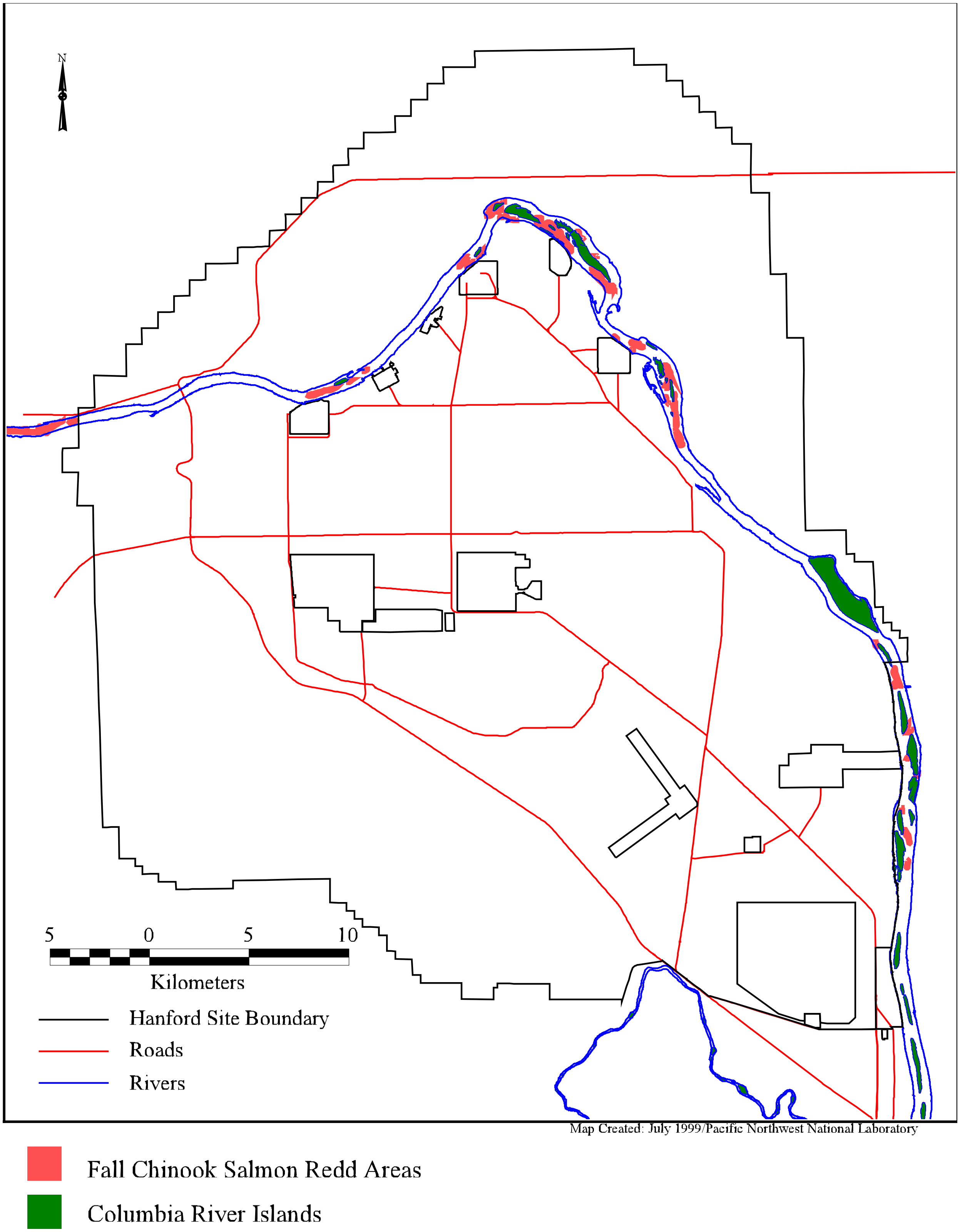


Figure D.26 Fall Chinook Spawning Areas

Table D.14 Initial List of Ecologically Important Species Found on the Hanford Site

Habitat Class/Location/Scientific Name or Taxonomic Group	Common Name or Taxonomic Group
Shrub-Steppe	
Invertebrates	
Tenebrionidae spp.	Darkling beetles
Reptiles	
Uta stansburiana	Side-blotched lizard
Birds	
Circus cyaneus	Northern harrier
Mammals	
Perognathus parvus	Great Basin pocket mouse
Desert Streams (and associated Springs)	
Dry Creek (Rattlesnake Spring)	
Invertebrates	
Baetis spp.	Mayfly
Simulium spp.	Black fly
Amphibians	
Scaphiopus intermontanus	Great Basin spadefoot toad larvae
Snively Creek (Snively and Lower Snively Springs)	
Invertebrates	
Amphipoda	Scuds
Baetis spp.	Mayfly
Simulium spp.	Black fly
Riparian Habitat along Hanford Reach	
Birds	
Bubo virginianus	Great horned owl
Falco sparverius	American kestrel
Tyrannus tyrannus	Eastern kingbird
Mammals	
Sylvilagus nuttalli	Nuttall's cottontail
Aquatic (Hanford Reach)	
Invertebrates	
Chironomidae spp.	Midge fly
Pacifasticus leniusculus	Crayfish
Hydropsyche spp.	Caddisfly
Fish	
Catostomus macrocheilus	Largescale sucker

Hanford Site. Densities of this species are higher in shrub-grass habitats where native bunchgrasses are more prevalent than in cheatgrass (*Bromus tectorum*) monocultures (Brandt and Rickard 1994). The pocket mouse also has a higher survival rate in shrub-dominated stands than it does in cheatgrass-dominated stands (Brandt and Rickard 1994; Gano and Rickard 1982). Thus, changes in numbers of the Great Basin pocket mouse would likely be indicative of changes in the species composition of shrub-steppe plant communities and would also likely be reflected in changes in population numbers of the many raptors on Site, such as the northern harrier (*Circus cyaneus*), for which the pocket mouse represents a significant prey item. The northern harrier is a year-round resident of Hanford and is common over the entire Site.

The side-blotched lizard (*Uta stansburiana*) is abundant and widely distributed at low elevations (Rickard 1968) across Hanford. It is likely a major prey item of snakes and raptors on Site.

Black fly (*Simulium* spp.) and mayfly (*Baetis* spp.) larvae are predominately detritivores. These genera are the most abundant of the benthic insects in both of the the ALE Unit upland stream systems (Gaines et al. 1992). Adult black flies and mayflies provide an important food source for insectivorous birds (C. Cushing, pers. comm., 1995). Amphipods are omnivorous and are numerous only in Snively Creek (Gaines et al. 1992). Amphipods are eaten by carnivorous insect larvae, such as the dragonfly and damselfly. Adult dragonflies and damselflies also constitute an important prey base for insectivorous birds (C. Cushing, pers. comm., 1995).

Great Basin spadefoot (*Scaphiopus intermontanus*) larvae are numerous only in Dry Creek. These larvae are significant consumers of primary productivity and detritus.

Nuttall's cottontail (*Sylvilagus nuttalli*) is ubiquitous and abundant in the riparian corridor of the Hanford Reach and is an important food source for the great horned owl (*Bubo virginianus*) and American kestrel (*Falco sparverius*). The great horned owl and kestrel are also ubiquitous and abundant in the riparian corridor and forage nocturnally and diurnally, respectively. Kestrels use nest boxes, which would greatly facilitate study of this species. The Eastern kingbird (*Tyrannus tyrannus*) is insectivorous and is also ubiquitous and abundant throughout the riparian corridor (W. Rickard, pers. comm., 1995).

Caddisflies (*Hydropsyche* spp.) are abundant in the main channel and shorelines of the Hanford Reach of the Columbia River. Caddisflies require flowing water and thus occur much less frequently in slough and backwater areas. Midge flies of the family Chironomidae are a common detritivore of the Hanford Reach. Both caddisflies and midges are an important food source for carnivorous fish, such as whitefish (*Prosopium williamsonii*), juvenile salmonids, and smallmouth bass (*Micropterus dolomieui*). Adult caddisflies are important prey for insectivorous birds. Crayfish (*Pacifasticus leniusculus*) are scavengers and commonly occur in the main channel of the Hanford Reach where the substratum is open enough to provide cover. Crayfish are an important prey base for white sturgeon (*Acipenser transmontanus*), largemouth bass (*Micropterus salmoides*), and smallmouth bass (C. Cushing, pers. comm., 1995). The largescale sucker (*Catostomas macrocheilus*) consumes periphyton, aquatic insect larvae, and detritus (Dauble 1986). The species is abundant and present year-round in the Hanford Reach.

D.2.5.10 Species New to Science, New to Washington State, or New to Hanford

As a result of mainly the TNC biodiversity surveys of 1994 (TNC 1995) 1995 (TNC 1996), and 1997 (TNC 1998, 1999), several species new to science, new to Washington State, or new to the Hanford Site have been discovered recently. The taxa affected are plants and invertebrates (with two exceptions, the rest of the latter are insects). Tables D.15 (plants) and D.16 (invertebrates) provide summary information on these new species. Species new to Hanford are listed only if they have some current status recognition as a species of concern at the state or federal level (i.e., monitor, sensitive, candidate, etc.). Except for the species that are new to Hanford, all other species in Tables D.15 and D.16 have not received a final determination as to what resource level of concern they should be assigned. This must await a determination of their listing status at the federal and/or state level. A conservative approach to their management will help preclude adverse impacts to species that may be eligible for federal and/or state listing.

Because the biodiversity inventories of the Hanford Site are not complete, there is still the possibility that many more species await discovery at Hanford.

Table D.15 Plant Species New to Science, New to Washington State, or New to the Hanford Site

Scientific Name	Common Name	Federal Status	Washington State Status[b]	Habitat Association	Location on Hanford	Global and Washington State Rarity Status[b]	Hanford Abundance
Plant Species (Variety) New to Science							
Astragalus conjunctus var. *rickardii*	Basalt milkvetch	Undetermined	Review 1	Bunchgrass areas within big sagebrush/bluebunch wheatgrass and threetip sagebrush/Idaho fescue plant communities	Rattlesnake Mountain	Undetermined	Uncommon
Eriogonum coduim	Umtanum desert buckwheat	Undetermined	Endangered	Exposed rocky sites in big sagebrush/bluebunch wheatgrass	Umtanum Ridge	G1, S1	Rare
Lesquerella tuplashensis	White Bluffs bladderpod	Undetermined	Endangered	Big sagebrush/Sandberg's bluegrass - Indian ricegrass	White Bluffs	G1, S1	Uncommon
Plant Species (Variety) New to Washington State							
Calyptridium rosea	Calyptridium		Sensitive	Big sagebrush/Sandberg's bluegrass	Gable Mountain area	G5, S1	Rare
Gilia leptomeria	Gilia		Review 1	Big sagebrush/Sandberg's bluegrass	Gable Mountain, Vernita Bluffs, and Umtanum Ridge	G5	Rare
Loeflingia squarrosa var. *squarrosa*	Loeflingia		Threatened	Big sagebrush/Sandberg's bluegrass	Gable Mountain area	G514, S1	Rare
Plant Species New to Hanford							
Mimulus suksdorfii	Suksdorf's monkey-flower		Sensitive	Sand/Shrub-steppe	Gable Mountain area	G4, S2	Rare

(a) Table information is from TNC (1995, 1996, and 1998). Species new to science, new to Washington, or new to the Hanford Site were located on Hanford by The Nature Conservancy (TNC) during its biodiversity inventory of the Fitzner/Eberhardt Arid Lands Ecology Reserve, North Slope, and central core of Hanford during 1994, 1995, and 1997. Information on epithets, federal and state statuses, locations on Hanford, global and state rarity statuses, and more specific habitat association data will be added to this table when such information becomes available. In most cases, species new to science, new to Washington, or new to the Hanford Site were collected in relatively small numbers at relatively few locations. Thus, most are considered rare.
(b) See Section D.3.5.1 for references and category definitions. Global and state rarity statuses are separated by a comma in the table.

Table D.16 Insect Species New to Science, New to Washington State, or New to the Hanford Site

Order	Family	Genus Identity only or Complete Species Epithet	No. New Species or Subspecies/ Common Name	Federal Status[a]	Washington State Status[a]	Habitat Association	Global and Washington State Rarity Status[a]	Hanford Abundance
Insect Species New to Science[b]								
Coleoptera (beetles)	Scarabaeidae	*Glaresis*	1 new species	Undetermined	Undetermined	Shrub-steppe		Rare
Diptera (flies)	Asilidae	*Efferia*	2 new species	Undetermined	Undetermined	Shrub-steppe		Rare
Homoptera (leafhoppers)	Cicindellidae	*Aceratagallia*	3 new subspecies	Undetermined	Undetermined	Shrub-steppe		Rare
Homoptera (leafhoppers)	Cicindellidae	*Auridius*	1 new subspecies	Undetermined	Undetermined	Shrub-steppe		Rare
Homoptera (leafhoppers)	Cicindellidae	*Errhomus*	1 new subspecies	Undetermined	Undetermined	Shrub-steppe		Rare
Hymenoptera (ants, bees, and wasps)	Andrenidae	*Andrena*	1 new species	Undetermined	Undetermined	Shrub-steppe		Rare
Hymenoptera (ants, bees, and wasps)	Andrenidae	*Perdita*	2 new species	Undetermined	Undetermined	Shrub-steppe		Rare
Hymenoptera (ants, bees, and wasps)	Colletidae	*Colletes*	1 new species	Undetermined	Undetermined	Shrub-steppe		Rare
Mollusc Species New to Science[c]								
Pulmonata	Polygyridae	*Cryptomastix*	1 new species			Areas surrounding springs and basalt talus		Rare
Arthropod Species New to Washington[b,d]								
Hymenoptera	Torymidae	*Diomerus zabriskiei*	Tormids		Undetermined	Shrub-steppe		Rare
Hymenoptera	Torymidae	*Monodontomerus viridiscapus*	Tormids		Undetermined	Shrub-steppe		Rare
Hymenoptera	Torymidae	*Pseuderimerus mayetiolae*	Tormids		Undetermined	Shrub-steppe		Rare

Table D.16 Insect Species New to Science, New to Washington State, or New to the Hanford Site (continued)

Order	Family	Genus Identity only or Complete Species Epithet	No. New Species or Subspecies/ Common Name	Federal Status[a]	Washington State Status[a]	Habitat Association	Global and Washington State Rarity Status[a]	Hanford Abundance
Arthropod Species New to Washington[b,d] (continued)								
Hymenoptera (continued)	Torymidae	*Pseudotorymus lazulellus*	Tormids		Undetermined	Shrub-steppe		Rare
Hymenoptera	Torymidae	*Torymus aeneoscapus*	Tormids		Undetermined	Shrub-steppe		Rare
Hymenoptera	Torymidae	*Torymus capillaceus albitarsis*	Tormids		Undetermined	Shrub-steppe		Rare
Hymenoptera	Torymidae	*Torymus kinseyi*	Tormids		Undetermined	Shrub-steppe		Rare
Hymenoptera	Torymidae	*Zaglyptonotus schwarzi*	Tormids		Undetermined	Shrub-steppe		Rare
Podocopida	Cyprididae	*Stenocypris bolieki*	Seed shrimp			Spring/stream		Undetermined
Insect Species New to Hanford[b]								
Lepidoptera (butter-flies and moths)	Nymphalidae	*Cercyonis pegala ariane*	Large wood nymph	Former candidate		Shrub-steppe	G5	Rare
Lepidoptera (butter-flies and moths)	Hesperiidae	*Hesperia juba*	Juba skipper		Monitor	Upland areas[e]	G5, S?	Rare
Lepidoptera (butter-flies and moths)	Hesperiidae	*Hesperia nevada*	Nevada skipper		Monitor	Shrub-steppe	G4G5, S?	Rare
Lepidoptera (butter-flies and moths)	Hesperiidae	*Ochlodes sylvanoides bonnevilla*	Bonneville skipper		Monitor	Shrub-steppe	G5, S?	Rare

(a) See Section D.3.5.1 for references and category definitions. Global and state rarity statuses are separated by a comma.
(b) Unless otherwise indicated, table information is from Jonathon Soll (Correspondence and personal communication in regard to preliminary findings about insects by The Nature Conservancy of Washington from its 1994 and 1995 biodiversity inventories of the Hanford Site, 1995). Insect species new to science, new to Washington, or new to the Hanford Site were located on Hanford by The Nature Conservancy (TNC) during its biodiversity inventories of the Fitzner/Eberhardt Arid Lands Ecology Reserve and North Slopeduring 1994 and 1995. Information epithets, federal and state statuses, global and Washington state rarity statuses, locations on Hanford, and more specific habitat association data will be added to this table when such information becomes available. Insect species new to science, new to Washington, or new to the Hanford Site were collected in relatively small numbers at relatively few locations. Thus, all these are considered rare.
(c) One new species of the genus *Cryptomastix* has been located on the Hanford Site (Frest and Johannes 1993). This new species is endemic to Hanford and is known from only one spring area on Umtanum Ridge.
(d) Information on *Stenocypris bolieki* is from Colbert Cushing (pers. comm., 1996).
(e) Collected in 1994 on the Fitzner/Eberhardt Arid Lands Ecology Reserve in Snively Canyon and on the North Slope (TNC 1995).

Even already collected material may yield additional species new to science. For insects especially, specimens collected in 1994 or 1995 have not been fully evaluated taxonomically. A finding of several additional species new to science can be expected once taxonomic evaluations are complete. For now, the species listed in Tables D.15 and D.16 provide another indication of the uniqueness of Hanford's flora and fauna, as well a demonstration that the maintenance of high levels of native biodiversity relies on healthy, native ecosystems.

D.2.5.11 Summary of Federally and Washington/Oregon State Listed and Candidate Species

Table D.17 provides a summary of the federal and Washington/Oregon State listing or candidate status for species potentially found on or near the Hanford Site. Also included in the table is information on the abundance of the particular species at Hanford.

As indicated by Table D.17, there are three federally endangered, two federally threatened, and one federal candidate species that potentially are found on or near the Hanford Site. Steelhead trout and bald eagle are common (Figure D.27 shows steelhead trout spawning areas, which are also depicted in the composite map of Level IV habitats of concern [Figure 4.6]). The other four species are either rare or accidental visitors to the Site. There are seven state of Washington endangered species potentially found on or near the Hanford Site. Two of these, the American white pelican (*Pelecanus erythrorhynchos*) and Columbia yellowcress (*Rorippa columbiae*), are common to the Site; the remainder are either undocumented [i.e., northern wormwood (*Artemisia campestris borealis* var. *wormskioldii*)], extirpated (i.e., pygmy rabbit), accidental [i.e., Aleutian canada goose (*Branta canadensis leucopareia*) and perrigrine falcon (*Falco peregrinus*)], or uncommon migrant visitors [i.e., sandhill crane (*Grus canadensis*)]. There are six Washington State threatened species at Hanford; four of these are rarely found plants. The other two threatened species are the bald eagle and ferruginous hawk. In contrast to the preceding relatively low numbers, there are 13 Washington State sensitive plant species (nine of which have been recently documented to be present on Site) and 19 Washington State candidate animal species (only three of which have never been documented on Site or in the Hanford Reach) that are potentially found on or near Hanford.

Table D.17 reflects recent USFWS changes to federal candidate species designations and definitions.[18] Previously, species contained in candidate categories 1 and 2 were considered candidates for listing. Category 1 candidate species were those taxa the USFWS had sufficient information on biological vulnerability and threat(s) to support a proposed rule to list but listing was precluded by other USFWS priorities or funding limitations. Category 2 candidate species were those taxa that USFWS information indicated that proposing to list was possibly appropriate, but for which sufficient data on biological vulnerability and threat were not currently available to support proposed rules. By its February 28, 1996, actions the USFWS discontinued the use of the category 2 candidate designation (and category 3 as well). Previous category 2 species are no longer considered candidate species by the USFWS. Also, in a separate but parallel action the USFWS reevaluated the status of many of the former category 1 species. Ninety six of these species, among them a Hanford resident species—Columbia milkvetch (*Astragalus columbianus*), were removed from candidate status either because they were already extinct, had unresolved taxonomic questions, were more widespread than previously thought, or had insufficient information on file to justify issuing a proposed rule (61 FR 7457).

Only those former category 1 species not removed from the candidate list by the separate action described above are now considered by USFWS to be candidate species (61 FR 7595). The Hanford Site retains one federal candidate species—the bull trout, an occasional but accidental visitor to the Hanford Reach. Before the current action by USFWS, there were three category 1 and 23 category 2 candidate species potentially found on or near the Hanford Site. In accompanying press releases to the federal register notices, the USFWS indicated it remains concerned about many of the

[18] U.S. Fish and Wildlife Service. February 28, 1996. Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that are Candidates for Listing as Endangered or Threatened Species. 61 FR 7595. U.S. Fish and Wildlife Service. February 28, 1996. Endangered and Threatened Species; Notice of Reclassification of 96 Candidate Taxa. 61 FR 7457.

Table D.17 Summary of Listing and Candidate Status Information for Species Potentially Found on or Near the Hanford Site

Scientific Name	Common Name	Federal Status[(a)]	Washington (Oregon) State Status[(a)]	Hanford Abundance[(b)]
Plants				
Arenaria franklinii var. *thompsonii*	Thompson's sandwort		(Candidate)	Uncommon
Artemisia campestris borealis var. *wormskioldii*	Northern wormwood	Former candidate	Endangered (endangered)	Undocumented
Astragalus arrectus	Palouse milkvetch		Sensitive	Not recently documented
Astragalus columbianus	Columbia milkvetch	Former candidate	Threatened	Rare
Astragalus geyeri	Geyer's milkvetch		Sensitive	Rare
Camissonia (=Oenothera) pygmaea	Dwarf evening-primrose		Threatened	Rare
Carex densa	Dense sedge		Sensitive	Undocumented
Collinsia sparsiflora var. *bruceae*	Few-flowered collinsia		Sensitive	Undocumented
Cryptantha leucophaea	Gray cryptantha		Sensitive	Uncommon
Cyperus bipartitus (=C. rivularis)	Shining flatsedge		Sensitive	Uncommon
Eatonella nivea	White eatonella		Threatened	Rare
Erigeron piperianus	Piper's daisy		Sensitive	Uncommon
Limosella acaulis	Southern mudwort		Sensitive	Uncommon
Lindernia dubia var. anagallidea	False pimpernel		Sensitive	Uncommon
Lomatium tuberosum	Hoover's desert parsley	Former candidate	Threatened	Rare
Mimulus suksdorfii	Suksdorf's monkey-flower		Sensitive	Rare
Nicotiana attenuata	Coyote tobacco		Sensitive	Not recently documented
Oenothera cespitosa	Dwarf evening-primrose		Sensitive	Rare
Pectocarya setosa	Bristly combseed		Sensitive	Rare

Table D.17 Summary of Listing and Candidate Status Information for Species Potentially Found on or Near the Hanford Site (continued)

Scientific Name	Common Name	Federal Status[(a)]	Washington (Oregon) State Status[(a)]	Hanford Abundance[(b)]
Rorippa columbiae	Columbia yellowcress	Former candidate	Endangered (candidate)	Common
Terrestrial Invertebrates				
Boloria (=Clossiana) selene atrocostalis	Silver-bordered fritillary		Candidate	Undocumented
Cicindela columbica	Columbia River tiger beetle		Candidate	Undocumented
Mitoura siva	Juniper hairstreak		Candidate	Undocumented
Aquatic Invertebrates				
Fisherola nuttalli	Shortface lanx	Former candidate	Candidate	Common
Fluminicola columbiana	Columbia pebblesnail	Former candidate	Candidate	Rare
Fish				
Oncorhynchus mykiss	Upper Columbia River steelhead trout	Endangered	Candidate	Common
Oncorhynchus tshawytscha	Snake River chinook salmon (spring/summer and fall)	Endangered		Rare
Salvelinus confluentus	Bull trout	Candidate		Accidental
Reptiles				
Masticophis taeniatus (=catenifer) catenifer	Striped whipsnake		Candidate	Rare
Birds				
Accipiter gentilis	Northern goshawk	Former candidate	Candidate (sensitive/critical)	Uncommon
Amphispiza belli	Sage sparrow		Candidate	Common
Aquila chrysaetos	Golden eagle		Candidate	Uncommon
Athene cunicularia	Burrowing owl	Former candidate	Candidate (sensitive/critical)	Abundant
Branta canadensis leucopareia	Aleutian canada goose	Threatened	Endangered (endangered)	Accidental
Buteo regalis	Ferruginous hawk	Former candidate	Threatened (sensitive/critical)	Uncommon

Table D.17 Summary of Listing and Candidate Status Information for Species Potentially Found on or Near the Hanford Site (continued)

Scientific Name	Common Name	Federal Status[(a)]	Washington (Oregon) State Status[(a)]	Hanford Abundance[(b)]
Buteo swainsoni	Swainson's hawk	Former candidate	Candidate (sensitive/vulnerable)	Common
Centrocercus urophasianus	Sage grouse	Former candidate	Candidate (sensitive/vulnerable)	Rare
Falco peregrinus	Peregrine falcon	Endangered	Endangered (endangered)	Accidental
Gavia immer	Common loon		Candidate	Uncommon
Grus canadensis	Sandhill crane		Endangered (sensitive/vulnerable)	Uncommon
Haliaeetus leucocephalus	Bald eagle	Threatened	Threatened (threatened)	Common
Lanius ludovicianus	Loggerhead shrike	Former candidate	Candidate (sensitive/ undetermined status)	Common
Melanerpes lewis	Lewis' woodpecker		Candidate (sensitive/critical)	Rare
Oreoscoptes montanus	Sage thrasher		Candidate	Rare
Otus flammeolus	Flammulated owl		Candidate (sensitive/critical)	Accidental
Pelecanus erythrorhynchos	American white pelican		Endangered (sensitive/vulnerable)	Common
Sialia mexicana	Western bluebird		Candidate (sensitive/vulnerable)	Rare
Mammals				
Brachylagus (=Sylvilagus) idahoensis	Pygmy rabbit	Former candidate	Endangered (sensitive/vulnerable)	Extirpated
Spermophilus (=Citellus) washingtoni	Washington ground squirrel		Monitor (sensitive/critical)	Undocumented
Plecotus townsendii pallescens	Pale Townsend's big-eared bat	Former candidate	(sensitive/critical)	Undocumented
Sorex merriami	Merriam's shrew		Candidate	Uncommon

(a) See Section D.3.5.1 for listing and candidate category definitions.
(b) See species of concern data tables for each taxa for references for abundance data.

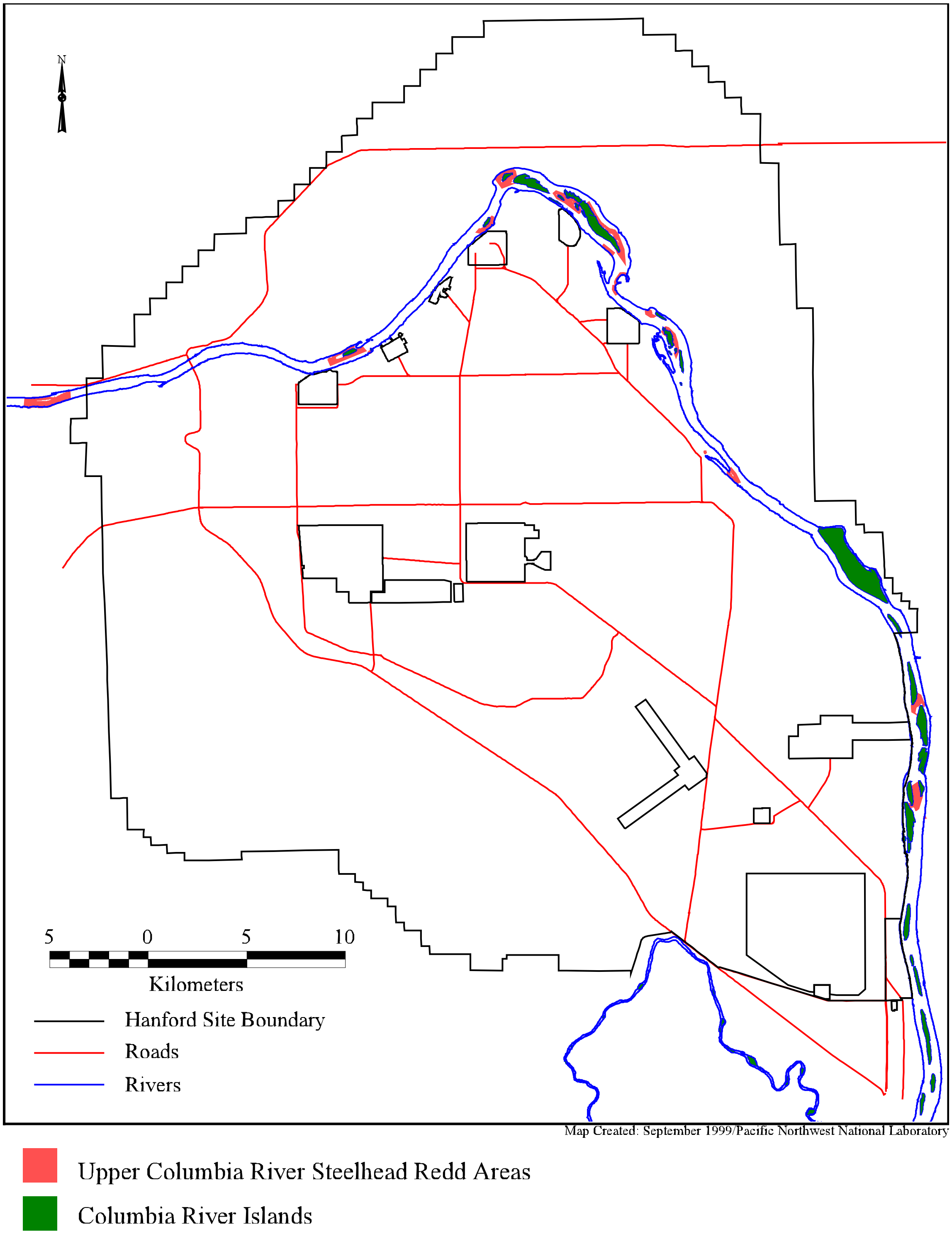


Figure D.27 Steelhead Spawning Areas former category 2 species.[19] Additionally, part of its rationale for discontinuing the category 2 list was that it duplicated species status tracking efforts by state fish and wildlife agencies and Natural Heritage Programs. The USFWS intends to continue to work with the states and others (e.g., TNC) to gather information about the former category 2 species and to continue to assess their conservation status.[20]

Conservation actions for federal candidate and other species of concern are often the most effective and least expensive means for conserving species. Actions taken now can preclude future listings. The BRMaP will retain information on the former federal candidate species. Many, but not all, of these species are identified in Table D.17. Many of the former federal candidate species are identified by the states of Washington and/or Oregon as species of concern at a candidate level or above. The state listings now take on additional conservation importance in the aftermath of the USFWS action. Additionally, state Natural Heritage Program and TNC data bases can be expected to now take on greater importance as sources of information for determining the status of a particular species of concern.

D.2.5.12 Relationship of Species of Concern Categories to WDFW Priority Species Criteria

A priority species is a fish or wildlife species that requires protective measures and/or management guidelines to ensure its perpetuation (WDFW 1996). The WDFW's Habitat Program establishes three criteria by which a fish or wildlife species will be considered a priority species in the State of Washington (see Section D.2.5.1 for definitions). In addition to these criteria, a further constraint on designating a species a priority species is that species are often considered a priority only within known limiting habitats (e.g., breeding areas) or within areas that support a relatively high number of individuals (e.g., regular large concentrations) (WDFW 1996). These "priority areas" are identified for each priority species (WDFW 1996).

To address the state of Washington's interest in priority fish and wildlife species that occur at Hanford, the different priority species criteria have been matched in BRMaP with a corresponding resource level of concern. The results are depicted in Table D.18.

With two exceptions, all species that are known to occur on Hanford and are identified as a priority species in WDFW (1996) have been accounted for in either resource level I, II, or III. Two species, the bald eagle and peregrine falcon, are identified as Level IV resources because of their federal listing status. The WDFW criteria do not directly address federal endangered or threatened status and leave the significance of federal candidate status open to interpretation on a species by species basis (WDFW 1996; see definition of Criterion 1 in Section D.2.5.1). Because DOE-RL is part of a federal agency, it is incumbent on them to address federal status more directly than does WDFW. Thus, the definition of Criterion 1 (state listed and candidate species) best matches up with level III and not with Level IV, which elevates the management importance of federal threatened and endangered species relative to state threatened and endangered species (see Table 3.2).

Many of the Criterion 2 species that WDFW lists and that frequent Hanford are also migratory birds. Because BRMaP identifies migratory birds as Level II resources (Table 3.2), Criterion 2 (vulnerable aggregations) matches best with Level II. Several species of bats and several food fish also

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19 U.S. Fish and Wildlife Service news release and question and answer sheets in regard to candidate species, dated February 27, 1996.

20 At the level of their individual state office, the USFWS is now tracking many of the former category 2 candidate species, as well as some of those former category 1 species that had their status recently reevaluated and were not retained in the new candidate list, as "species of concern" (L. Propp, pers. comm., 1996). The conversation standing of these species is still of concern to the Service; however, status information is needed. No regional or national species of concern lists are being maintained; each state office maintains its own list. Washington has two species of concern lists: one for east of the crest Cascade Range and one for west of the crest. The eastern list, issued May 21, 1996, includes all of the former candidate species listed in Table D.17 with the exception of the shortface lanx. Additionally, 11 other former candidate species that are potentially found on or near the Hanford Site, but which are not identified as either listed species or candidates for listing by the state of Washington, are not tracked by the USFWS as species of concern. Thus, a total of 25 species that potentially occur at Hanford are not identified by USFWS as species of concern.

Table D.18 Relationship Between BRMaP's Resource Levels of Concern and WDFW's Priority Species Criteria

BRMaP Resource Level of Concern	WDFW Priority Species Criteria
I	Criterion 3
II	Criterion 2
III	Criterion 1
IV	N/A

are identified as priority species under Criterion 2. Because the bat species, with one exception, also are identified as state monitor species (Level II, see Table 3.2), Criterion 2 again matches best with Level II. The pale Townsend's big-eared bat subspecies (*Plecotus townsendii pallescens*) is not yet on WDFW's species of special concern list; however, the species is identified as sensitive/critical by Oregon. The subspecies is identified as a Level III resource. The fish species also are identified under Criterion 3 (species of recreational, commercial, and/or tribal importance). Other than the fall chinook salmon (Level IV), these species are retained at Level I because their prioritization by WDFW is based on their role as food fish.

Most remaining Criterion 3 species that WDFW lists (not including those species listed under multiple criteria) are identified in WDFW (1996) as game species. Moreover, many of these species are non-native, introduced species. Therefore, for those species present on Hanford that qualify as priority species under only Criterion 3, resource level of concern I is the best match for establishing an appropriate degree of management attention.

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Appendix E

Areas of Potential Future Research Needed to Support Hanford's Ecosystem Management Approach

Appendix E briefly describes opportunities for potential areas of research.

Contents

Because vast amounts of the Hanford Site have remained relatively undisturbed by direct human activities, the Site offers unique opportunities for research, especially in the areas of habitat use by wildlife, habitat restoration, and the dynamics of shrub-steppe and unimpounded riverine communities. An ecosystem management approach stresses the need to base management decisions on the best science available. Moreover, to implement adaptive management as a governing principle of ecosystem management, areas of uncertainty and gaps in knowledge should be identified. From this, a strategy can be outlined that, in concert with funding and staffing availability, identifies research areas whose resultant data can lead to improvements in management actions. Although theoretical or nonmanagement-driven research has its own merits, the research recommendations identified in BRMaP are needed for specific biological resource management needs.

Some examples of potential areas of research are:

- A comparison of habitat use by wildlife species between sagebrush habitat with cheatgrass as the predominant understory plant and sagebrush habitat with native bunchgrasses and forbs as the predominant understory. Does the presence of cheatgrass reduce wildlife usage over the long-term?
- A determination of the location, significance, and function of important plant, fish, and wildlife dispersal and movement corridors within Hanford and between Hanford and other areas.
- An evaluation of the effects of habitat fragmentation in a shrub-steppe ecosystem.
- An evaluation of spiny hopsage (*Grayia spinosa*) seedling recruitment requirements. (Spiny hopsage has shown little or no recruitment into the population since site activities began or earlier.)
- The continued refinement of vegetation association and habitat mapping on Hanford to support management objectives. This also could include the refinement of protected plant, fish, and wildlife species distribution maps.
- The development and testing of habitat suitability models for key Hanford species (especially those associated with predominantly native vegetation whether with shrubs or not) and the determination of vegetation patterns (e.g., density, diversity) of undisturbed shrub-steppe habitat to help define mitigation requirements and establish restoration goals.
- An evaluation and development of habitat improvement methods. Habitats with different levels of disturbance should be evaluated.
- Identification of critical habitat for sand roller and piute sculpin. This includes identifying those physical features, such as water depth and velocity, substrate characteristics, that may play a role in defining critical habitat.
- An evaluation of the impacts of environmental contaminants, especially chromium, on the viability of fall chinook salmon eggs and larvae within the inter-gravel spaces (hyporheic zone) of the Hanford Reach. Potential impacts to fall chinook salmon from localized impacts from Hanford groundwater and contaminant discharge to the river was recently assessed by Geist et al. (1994).[1] The authors concluded that additional characterization is required, particularly to determine conditions in the groundwater-surface water interface (pore water) where spawning takes place.[2]

- The continued inventory of Hanford's biological diversity with the goal of filling in the data gaps for poorly studied groups and locations (alpha diversity).
- An evaluation of the changes in species composition across different plant associations within shrub-steppe habitat (beta diversity). This information can help determine where management of the Hanford ecosystem must be focused in order to maintain the greatest diversity of native species and habitats on Hanford.

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1 Geist, D. R., T. M. Poston, and D. D. Dauble. 1994. Assessment of Potential Impacts of Major Groundwater Contaminants to Fall Chinook Salmon (*Oncorhynchus tshawytscha*) in the Hanford Reach, Columbia River. PNL-9990, Pacific Northwest Laboratory, Richland, Washington.

2 Hope, S. J., and R. A. Peterson. 1996. Pore Water Chromium Concentrations at 100-H Reactor Area Adjacent to Fall Chinook Salmon Spawning Habitat of the Hanford Reach, Columbia River. BHI-00345, Rev. 1, Bechtel Hanford Inc., Richland, Washington.