Planning for Connectivity

A guide to connecting and conserving wildlife within and beyond America's national forests

DEFENDERS OF WILDLIFE

THE CENTER FOR LARGE LANDSCAPE CONSERVATION

WILDLANDS NETWORK
RECONNECTING NATURE IN NORTH AMERICA

Yellowstone to Yukon
Conservation Initiative

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Planning for Connectivity is a product of The Center for Large Landscape Conservation, Defenders of Wildlife, Wildlands Network and Yellowstone to Yukon Conservation Initiative. This guide focuses on requirements established under the National Forest System land management planning rule to manage for ecological connectivity on national forest lands and facilitate connectivity on planning acrosss land ownerships. The purpose of the guide and its parent publication, *Planning for Diversity*, is to help people inside and outside of the Forest Service who are working on forest plan revisions navigate these complex diversity and connectivity requirements.

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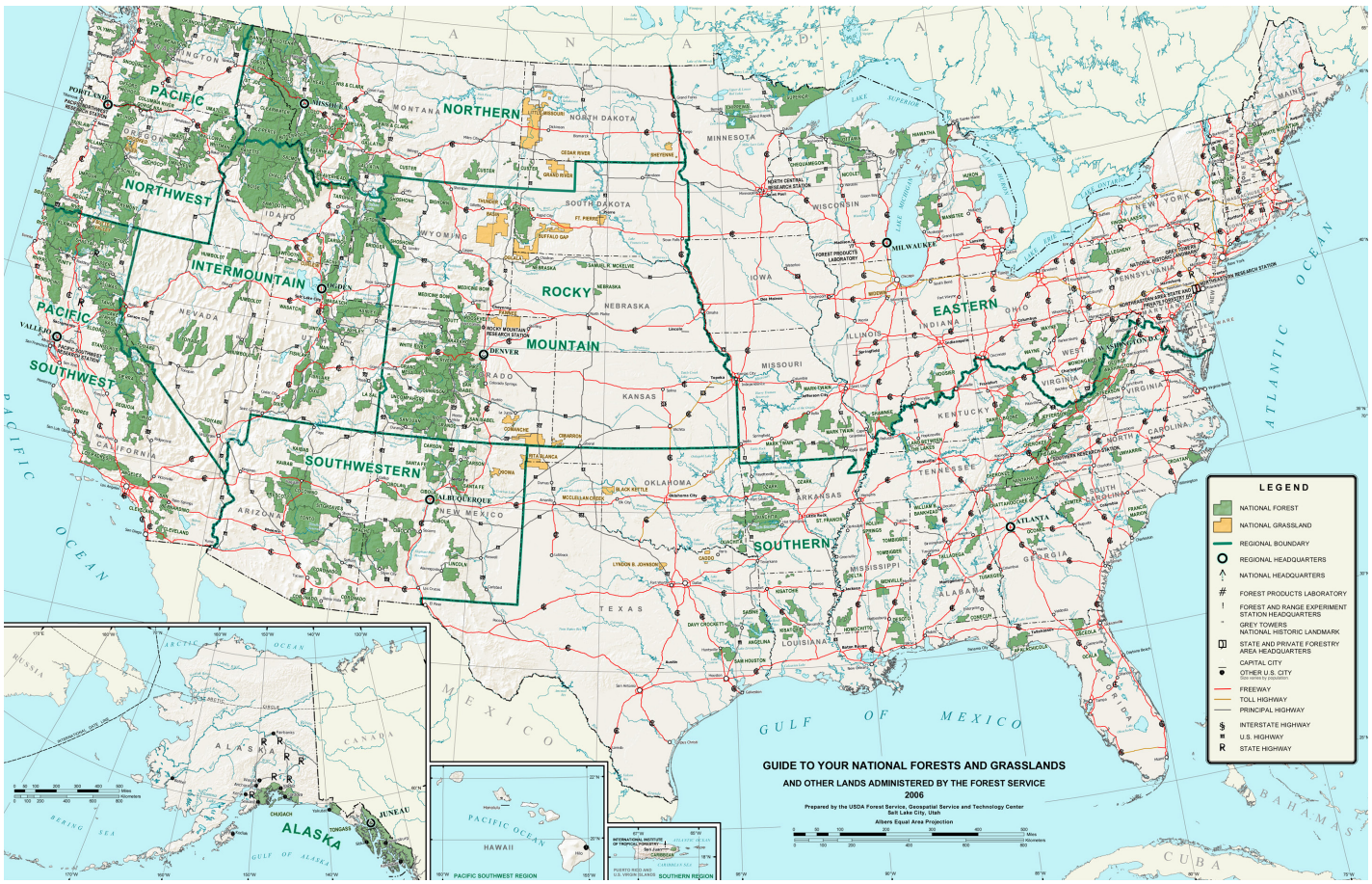
INTRODUCTION

The United States Forest Service manages more than 193 million acres—over 8 percent of all U.S. lands—an area about the size of Texas and twice the size of the National Park System. The National Forest System comprises 154 national forests and 20 national grasslands and one national prairie (collectively referred to as "national forests" in this guide). Located in 42 states, Puerto Rico and the U.S. Virgin Islands, these public lands are essential to the conservation of wildlife habitat and diversity. National forests encompass three-quarters of the major U.S. terrestrial and wetland habitat types—including alpine tundra, tropical rainforest, deciduous and evergreen forests, native grasslands, wetlands, streams, lakes and marshes. This variety of ecosystems supports more than 420 animals and plants listed under the Endangered Species Act (ESA) and an additional 3,250 other at-risk species.

To guide the management of each national forest, the Forest Service is required by law to prepare a land management plan (forest plan). Forest plans detail strategies to protect habitat and balance multiple uses to ensure the persistence of wildlife, including at-risk and federally protected species.

In April 2012, the Forest Service finalized regulations implementing the National Forest Management Act (NFMA). These regulations, commonly referred to as the "2012 Planning Rule" established a process for developing and updating forest plans and set conservation requirements that forest plans must meet to sustain and restore

The National Forest System



the diversity of ecosystems, plant and animal communities and at-risk species found on these public lands (36 C.F.R. §§ 219.1-219.19, abbreviated throughout this report by omitting "36 C.F.R. §").

The forest planning rule includes explicit requirements for managing for ecological connectivity on national forest lands and facilitating connectivity planning across land ownerships—the first such requirements in the history of U. S. public land management. The pending revisions of most forest plans provide a significant opportunity to protect and enhance the diversity of habitat and wildlife on national forest lands by developing forest plans that promote the conservation and restoration of ecological connectivity.

This guide is designed to help people, working within and outside of the Forest Service, develop effective connectivity conservation strategies in forest plans developed under the 2012 Planning Rule. It summarizes the role of connectivity within the conservation framework of the rule and offers guidance and examples of how to conduct connectivity planning in the land management planning process.

The guide is a collaboration of Defenders of Wildlife, The Center for Large Landscape Conservation, Wildlands Network and Yellowstone to Yukon Conservation Initiative and is our collective interpretation of the connectivity requirements of the 2012 Planning Rule. The guide is intended to add value to official agency policies developed to support implementation of the rule. In January 2015, the Forest Service published Final Agency Directives for Implementation of the 2012 Planning Rule (FSM 1900 Planning, FSH 1909.12). While this guide and those directives may in some cases describe different approaches to implementing the connectivity requirements of the planning rule, we believe our interpretations are consistent with the planning rule and NFMA and hope the guide is viewed as a useful companion set of recommendations from the perspective of conservation organizations experienced in national forest planning, connectivity science and policy.

The guide covers the unique connectivity aspects of the planning rule, a rule that addresses complex ecosystem and species conservation processes and has many specific requirements.

How to Use This Guide

Planning for Connectivity presents guidance and best practices for connectivity planning, including examples from case studies in forest planning. Resources associated with the case studies are listed in the references section. We suggest using this guide in tandem with *Planning for Diversity*, a companion publication that addresses the overarching conservation framework of the 2012 Planning Rule. *Planning for Diversity*, additional resources on diversity and connectivity science and planning and a collection of forest planning case studies are available online at www.defenders.org/forestplanning.

THE IMPORTANCE OF CONNECTIVITY

It is useful to think of connectivity contributing to both the structure and function of ecosystems and landscapes. Structural connectivity is the physical relationship between patches of habitat or other ecological units; functional connectivity is the degree to which landscapes actually facilitate or impede the movement of organisms and processes of ecosystems (Ament et al. 2014).

The structure or pattern of an ecosystem or landscape can be defined as the arrangement, connectivity, composition, size and relative abundance of patches that occur within an area of land at a given time. Patches are surface areas that differ from their surroundings in nature or appearance (Turner et al. 2001). They can be characterized by vegetation type, seral stage, habitat type or other features relevant to a species and also by the condition of surrounding lands, which can significantly affect the biological character of a habitat patch.

Fragmentation, the breaking up of habitat or cover type into smaller disconnected patches (Turner et al. 2001), may result from natural or anthropogenic disturbances that introduce barriers to connectivity. In natural landscapes, patches that differ from the surrounding area would likely be areas disturbed by fire, flood, blowdown or other natural processes. In managed landscapes, habitat or cover can be fragmented by human caused disturbances such as road-building or removal of vegetation. In natural and managed fragmented landscapes, patches can be thought of as the remaining undisturbed areas. The greatest conservation needs are usually associated with maintaining or restoring connectivity among patches.

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The arrangement of patches of vegetation defines the pattern of a landscape like this one in Medicine Bow National Forest.

Other terms related to connectivity and wildlife movements include (Ament et al 2014):

- **Corridor.** A distinct component of the landscape that provides connectivity (think of it as a linear patch).
- **Linkage area or zone**. Broader regions of connectivity important to maintain ecological processes and facilitate the movement of multiple species.
- **Permeability.** The degree to which landscapes are conducive to wildlife movement and sustain ecological processes.

The 2012 Planning Rule defines connectivity as:

> *Ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the exchange of flow, sediments, and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long distance range shifts of species, such as in response to climate change* (219.19).

The planning rule definition reflects both structural and functional aspects of connectivity. The rule's reference to spatial scales and "landscape linkages" suggests a structure of connected patches and ecosystems. Functional connectivity is also part of the definition: water flows, sediment exchange, nutrient cycling, animal movement/dispersal, species climate adaptation and genetic interchange are all ecological processes that are sustained by connectivity.

Any comprehensive strategy for conserving biological diversity requires maintaining habitat across a variety of spatial scales and includes the maintenance of connectivity, landscape heterogeneity and structural complexity (Lindenmayer and Franklin 2002). Connectivity is especially important for enabling adaptation to changing stressors, including climate change. The challenge of climate change was a driving factor in the development of the 2012 Planning Rule (77 Fed. Reg. 21163). A review of 22 years of recommendations for managing biodiversity in the face of climate change found improving landscape connectivity is the most frequently recommended strategy for allowing biodiversity to adapt to new conditions (Heller and Zaveleta 2009).

Wildlife species are becoming increasingly isolated in patches of habitat surrounded by a human-dominated landscape. Exacerbating this fragmentation is the effect of exurban development that continues to encroach on Forest Service lands (Hansen et al. 2005; Stein et al. 2007). The distribution of many wildlife populations continues to shrink as a result. Aquatic and terrestrial landscape patterns have been substantially altered, reducing or eliminating ecological connectivity for many wildlife populations. Physical barriers with human development further reduce connectivity. Changes in habitat, such as the simplification of complex forest vegetation, can also make critical areas for movement less permeable to some species. Scientists recognize that preserving or enhancing connectivity can be a practical tool for conserving biodiversity in such circumstances (Worboys et al. 2010).

THE 2012 FOREST PLANNING RULE

The 2012 Planning Rule is a federal regulation implementing NFMA (1600 U.S.C. § 1600 et seq.). NFMA was enacted in 1976 in large part to elevate the value of ecosystems, habitat and wildlife on our national forests to the same level as timber harvest and other uses. NFMA codified an important national priority: forest plans must provide for the diversity of habitat and animals found on national forests.

NFMA established a process for integrating the needs of wildlife with other multiple uses in forest plans. Most importantly, the law set a substantive threshold Forest Service actions must comply with for sustaining the diversity of ecosystems, habitats, plants and animals on national forests. However, the law gave discretion to the Forest Service, through the development of forest planning regulations and forest plans, to define that threshold.

THE PLANNING PROCESS

According to NFMA, forest plans are to be revised on a 15-year cycle. The planning rule provides a process for developing, revising or amending plans that is adaptive and science-based, engages the public and is designed to be efficient, effective and within the agency's ability to implement (77 Fed. Reg. 21162).

The planning rule establishes a three-phase process:

1. **Assessment**. The assessment identifies and evaluates information relevant to the development of a forest plan. The assessment is used during plan revision to evaluate what needs to change in the current plan, including what is needed to meet the requirements of the planning rule.
2. **Development.** During the plan development stage, the Forest Service develops and finalizes the forest plan and plan monitoring program. A draft proposal is developed and management alternatives are evaluated through the process established by the National Environmental Policy Act (42 U.S.C. § 4321 et seq.).
3. **Implementation/monitoring.** After finalizing the forest plan, the agency begins to implement the plan, including the development and implementation of management projects. Projects must be consistent with the forest plan and implementation of the plan must be evaluated through a monitoring program. Monitoring information is then evaluated to determine if aspects of the forest plan should be changed.

In addition, the Forest Service must use the best available scientific information to inform the planning process (219.3) throughout all three phases.

The planning rule describes these phases as iterative, complementary and sometimes overlapping. The intent is to provide a planning framework that is responsive to new information and changing conditions.

FOREST PLAN COMPONENTS

Forest plans guide subsequent project and activity decisions, which must be consistent with the forest plan. Forest plans do this through the use of plan components, the basic building blocks of forest plans. Plan components (Table 1) shape implementation of the forest plan and are the means of meeting the requirements of the 2012 Planning Rule.

Two fundamental types of plan components are associated with the diversity requirements of the rule: landscape components and project components.

Landscape components relate to the vision and priorities for the plan area, a landscape larger than individual project areas. These components are outcome-oriented, describe how the Forest Service would like the plan area to look and function and include desired conditions and objectives. Projects to be initiated under the forest plan are designed to contribute to achieving one or more of these outcomes. It is important that desired conditions and objectives be specific enough to establish a purpose and need for the projects designed to help achieve them.

Project components pertain to how individual projects are designed and implemented under the forest plan. They include standards, guidelines and suitability determinations that prohibit specific uses. They can preclude or regulate particular management options, dictate the outcome specifications for project areas or establish procedures

Table 1. Plan components under the 2012 Planning Rule

Plan Component	Description (219.7(e))
Desired Conditions (Landscale-level)	A description of specific social, economic and/or ecological characteristics of the plan area (or a portion of the plan area) toward which management of the land and resources should be directed. Desired conditions must be described in terms specific enough to allow progress toward their achievement to be determined, but do not include completion dates.
Objectives (Landscape-level)	A concise, measurable and time-specific statement of a desired rate of progress toward a desired condition or conditions. Objectives should be based on reasonably foreseeable budgets.
Standards (Project-level)	A mandatory constraint on project and activity decision-making established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects or to meet applicable legal requirements.
Guidelines (Project-level)	A constraint on project and activity decision-making that allows for departure from its terms as long as the purpose of the guideline is met. Guidelines are established to help achieve or maintain a desired condition or conditions, to avoid or mitigate undesirable effects or to meet applicable legal requirements.
Suitability of Lands (Project-level)	Specific lands within a plan area are identified as suitable for various multiple uses or activities based on the desired conditions applicable to those lands. The plan also identifies lands within the plan area as not suitable for uses that are not compatible with desired conditions for those lands.

that must be followed in preparing projects. It is very important to note that project plan components—especially standards—are most useful when greater certainty is important, such as in meeting diversity requirements necessary to protect at-risk species. Under the planning rule, every action proposed on Forest Service lands must comply with standards and guidelines and may not occur on lands unsuitable for that action.

DIVERSITY

NFMA requires that the Forest Service's planning regulations "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives" (16 U.S.C. § 1604(g)(3)(B)). This diversity requirement has been interpreted by the agency in the NFMA planning regulations and by the courts.

The Forest Service has interpreted the diversity requirement in NFMA through the development of the 2012 Planning Rule, which offers an approach to meeting the diversity requirement described in more detail in the following section on the ecosystem-species approach. A pivotal piece of the diversity interpretation is the persistence of individual species on national forest lands. Maintaining viable populations of native species is the scientifically accepted method of achieving the conceptual goal of maintaining species diversity. According to a 1999 Committee of Scientists report commissioned for the purposes of forest planning, "[d]iversity is sustained only when individual species persist; the goals of ensuring species viability and providing for diversity are inseparable" (Committee of Scientists 1999: 38).

The federal judiciary's interpretation of the diversity requirement in the rule include a ruling that the NFMA diversity mandate not only imposes a substantive standard on the Forest Service, it "confirms the Forest Service's duty to protect [all] wildlife" (*Seattle Audubon Society v. Moseley*, 1489). Courts have also recognized that the Forest Service's "statutory duty clearly requires protection of the entire biological community" (*Sierra Club v. Espy*, 364).

THE ECOSYSTEM-SPECIES APPROACH

Three overarching substantive requirements (Table 2) in the planning rule pertain to NFMA's diversity requirement:

1. Maintain or restore the ecological integrity of terrestrial and aquatic ecosystems (219.9(a)).
2. Maintain or restore the diversity of ecosystems and habitat types (219.9(a)).
3. Provide the ecological conditions necessary for at-risk species (219.9(b)).

The fundamental premise of the planning rule for meeting the NFMA diversity requirement is that plan components for ecosystem integrity and diversity will provide the ecological conditions to both maintain the diversity of plant and animal communities and support the persistence of most (but not all) native species in a

Table 2. Ecological concepts and requirements of the 2012 Planning Rule[1]

Ecological Concept	Definition and Requirement from the Planning Rule (219.9, if applicable)
Ecosystem	*Definition:* A spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and elements of the abiotic environment within its boundaries. An ecosystem is commonly described in terms of its composition, structure, function and **connectivity**. *Requirement:* The plan must include plan components, including standards or guidelines, to maintain or restore the diversity of ecosystems and habitat types throughout the plan area. In doing so, the plan must include plan components to maintain or restore key characteristics associated with terrestrial and aquatic ecosystem types, rare aquatic and terrestrial plant and animal communities, and the diversity of native tree species similar to that existing in the plan area.
Ecological Integrity	*Definition:* The quality or condition of an ecosystem when its dominant ecological characteristics (e.g., composition, structure, function, **connectivity**, species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence. *Requirement:* The plan must include plan components, including standards or guidelines, to maintain or restore the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area, including plan components to maintain or restore their structure, function, composition and **connectivity**.
At-risk Species ▪ Threatened and Endangered ▪ Candidate and Proposed ▪ Species of Conservation Concern	*Definition:* Threatened and endangered species are federally listed under the ESA; proposed and candidate species have been either formally proposed or are being formally considered for listing under the ESA. Species of conservation concern are species for which the regional forester has determined that the best available science indicates substantial concern over the species' capability to persist over the long-term in the plan area. *Requirement:* The responsible official shall determine whether or not the (ecosystem) plan components provide the ecological conditions necessary to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area. If the responsible official determines that the (ecosystem) plan components are insufficient to provide such ecological conditions, then additional, species-specific plan components, including standards or guidelines, must be included in the plan to provide such ecological conditions in the plan area.
Ecological Conditions	*Definition:* The biological and physical environment that can affect the diversity of plant and animal communities, the persistence of native species and the productive capacity of ecological systems. Ecological conditions include habitat and other influences on species and the environment, e.g., the abundance and distribution of aquatic and terrestrial habitats, **connectivity**, roads and other structural developments, human uses and invasive species.
Viable Population	*Definition:* A population of a species that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments.
Focal Species	*Definition:* A small subset of species whose status permits inference to the integrity of the larger ecological system to which it belongs and provides meaningful information regarding the effectiveness of the plan in maintaining or restoring the ecological conditions to maintain the diversity of plant and animal communities in the plan area. Focal species would be commonly selected on the basis of their functional role in ecosystems.

plan area (219.9). To meet the rule's requirements for at-risk species (which include federally listed threatened and endangered species, proposed and candidate species, and species of concern (SCC)), additional "species-specific" plan components may be necessary. The rule's two-tiered conservation approach (alternatively called the "ecosystem-species" or "coarse-fine filter" planning method) relies on the use of surrogate measures, or key characteristics,

1. Ecological "conditions" are defined broadly to include human structures and uses, while "ecological integrity" stresses dominant "characteristics" that suggest natural conditions and should not include human structures and uses. The term "key ecosystem characteristics" is commonly used in discussions of ecological integrity, but should not be understood to apply to human structures and uses in that context. Human structures and uses are nevertheless relevant to species viability and persistence, and therefore to diversity.

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Connectivity is an ecological condition that pronghorn and other species need to persist within and beyond the boundaries of national forests and grasslands.

to represent the condition of ecosystems, as well as the identification of at-risk species and evaluation of whether those species will be sustained through ecosystem-level plan components, or whether they require specific management attention in the form of species-level plan components.

At the ecosystem scale, the rule requires forest plans to have plan components to maintain or restore the integrity of terrestrial and aquatic ecosystems in the plan area (219.9(a)(1)) and the diversity of ecosystems and habitat types (219.9(a)(2)). Essentially this requires forest plans to maintain or restore the variety of ecosystems and habitat types found on the forests (e.g., conifer forests, wetlands, grasslands), as well as the condition of the ecosystems themselves. If the ecosystem-scale plan components are not sufficient to provide ecological conditions (i.e., meet the conservation needs) for at-risk species, additional plan components to do so are required (219.9(b)(1)). In some cases, the Forest Service may determine that it is beyond its authority or "not within the inherent capability of the plan area" to provide those conservation conditions and thus other requirements apply (219.9(b)(2)).

Connectivity plays a key role in the rule's conservation approach (see Table 2). As a key characteristic of ecosystems, connectivity should be addressed through ecosystem-scale plan components in order to maintain or restore "ecological integrity." Connectivity may also be an "ecological condition" needed by individual species, and so forest plans may need to address connectivity at the species level. For example, a recent amendment to forest plans in Wyoming protects migration corridors between seasonal habitats for pronghorn (Ament et al. 2014).

The rule's approach to conservation planning relies on the use of key characteristics in assessments, planning and monitoring to represent the condition of ecosystems, as well as the identification of at-risk species, some of which may require connectivity conditions to persist. It will be necessary for forest plans to identify key characteristics of ecosystem connectivity, as well as structure, function and composition (Table 3).

The concept of ecological integrity is used to represent the status of an ecosystem. An ecosystem is considered to have integrity when its key ecosystem characteristics occur within the natural range of variation (NRV) (219.19). NRV can be thought of as a reference condition reflecting "natural" conditions. Those conditions can be estimated using information from historical reference ecosystems or by other science-based methods. For example, many current forest ecosystems exhibit landscape connectivity patterns that differ from historical or reference conditions. For the purpose of sustaining ecosystems and wildlife, the 2012 Planning Rule directs the Forest Service to manage key characteristics of ecosystems, including their connectivity characteristics, in light of these reference conditions.

It is therefore important that forest plans have plan components, including desired conditions, to move landscapes toward a more natural range of connectedness.

ISSUES OF SCALE

The definition of connectivity in the planning rule intends for it to be provided at appropriate ecological scales. Strategies for managing connectivity in forest plans will vary based on the relevant species and their particular requirements for connectivity. The planning process must consider the habitat needs of target species and the nature of their movements. Forest plans should provide for habitat connectivity to address localized movements, as well as landscape-scale linkages between larger blocks of habitat.

Land managers must look at the broader landscape context when addressing connectivity in forest plans (219.8(a)(1)). They should consider what they are connecting and be alert to connecting specific watersheds or other geographic areas identified as being relatively more important for a particular species. Aquatic species provide a good example of large-scale connectivity needs because the existence of a connected network of aquatic ecosystems is known to be critically important to migratory aquatic species, especially when disturbances occur.

Steelhead trout and other migratory fishes need a connected network of aquatic ecosystems to survive. Forest plans must consider the large-scale connectivity needs of these species.

For many species, persistence within a national forest depends on connectivity that extends beyond forest boundaries. While the Forest Service has no authority to regulate land uses outside national forests, it can influence conservation on adjacent lands by how it chooses to manage its own lands. A forest plan should consider

Table 3. The use of key characteristics in forest planning

Ecosystem Character	Definition (219.19)	Examples of Key Characteristics
Connectivity	Ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the exchange of flow, sediments and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long-distance range shifts of species, such as in response to climate change.	Structural: size, number and spatial relationship between habitat patches, mapped landscape linkages and corridors. Functional: measure of ability of native species to move throughout the planning area and cross into adjacent areas.
Composition	The biological elements within the different levels of biological organization, from genes and species to communities and ecosystems.	A description of major vegetation types, patches, habitat types, soil types, landforms and wildlife populations.
Structure	The organization and physical arrangement of biological elements such as snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern and connectivity.	Arrangement of patches within a landscape, habitat types within a forest, trees within a forest stand, wildlife within a planning area.
Function	Ecological processes that sustain composition and structure such as energy flow, nutrient cycling and retention; soil development and retention; predation and herbivory; and natural disturbances such as wind, fire and floods.	Types, frequencies, severities, patch sizes, extent and spatial pattern of disturbances such as fires, landslides, floods and insect and disease outbreaks.

connectivity when prioritizing lands for acquisition or conservation easements on adjacent ownerships. At a finer scale, a forest plan's requirements for size and arrangement of patch characteristics may be sufficient to produce an appropriately structured landscape for connectivity.

CONNECTIVITY INFORMATION

The scientific literature includes many connectivity and corridor studies and analyses. Peer-reviewed connectivity information pertaining to all regions of the country is readily available to inform national forest planning. In recent years, the Forest Service Research and Development Branch itself has produced numerous materials on various aspects of connectivity that can be used to support analyses of conditions, trends and sustainability. The available literature includes general publications about the science of connectivity and research on specific locations and/or species.[2] Examples include Cushman and others' analysis of corridors (2012) and McKelvey and others' (2011) identification of wolverine corridors.

Independent analyses of connectivity are also now available for many areas. The nationwide system of Landscape Conservation Cooperatives (LCC) has prioritized managing for connectivity across the country. For example, the South Atlantic LCC is completing a project titled "Identifying and Prioritizing Key Habitat Connectivity Areas for the South Atlantic Region." The Western Governors Association spearheaded the development of databases and mapping systems in the western states to identify important habitat and corridors region-wide.

The planning rule also cites other governmental management plans as sources of information to consider in assessing and planning for connectivity (219.6(a)(1)). It is critical that forest plans take into account land uses on adjacent lands and the importance of such lands to connectivity. The Forest Service should engage with highway departments, state wildlife agencies, tribal governments and county planning organizations that might affect connectivity on adjacent or intervening landscapes. These entities may have identified potential corridors that should be recognized in the forest planning process.

CONNECTIVITY COORDINATION

There is an additional requirement in NFMA that is particularly important to developing plan components for connectivity. It is a procedural requirement that the planning process be "coordinated with the land and resource management planning processes of State and local governments and other Federal agencies" (16 USC § 1604(a)). One of the purposes of the planning rule was to "[e]nsure planning takes place in the context of the larger landscape by taking an 'all-lands approach'" (77 Fed. Reg. 21164).[3] To accomplish this, forest plans should consider how habitat is connected across ownership boundaries.

The planning rule accounts for this type of "all lands" connectivity by:

- Requiring assessments to evaluate conditions, trends and sustainability "in the context of the broader landscape" (219.5(a)(1)).
- Recognizing that sustainability depends in part on how the plan area influences, and is influenced by, "the broader landscape" (219.8(a)(1)(ii), (iii)).
- Requiring coordination with other land managers with authority over lands relevant to populations of species of conservation concern (219.9(b)(2)(ii)).
- Requiring coordination with plans and land-use policies of other jurisdictions (219.4(b)).
- Requiring consideration of opportunities to coordinate with neighboring landowners to link open spaces and take joint management objectives into account (219.10(a)(4)).

Achieving the broader scale "all-lands" goals of the planning rule requires partnerships and compatible management across landscapes among multiple landowners and jurisdictions. In particular, there is a need for a landscape-scale strategic approach to conserving connectivity. NFMA has established that the way to communicate a long-term and reliable management commitment for National Forest System lands is through forest plan decisions for specific areas.

There is a significant commitment to connectivity conservation within Forest Service policy and from many agency partners. Examples of coordinated multi-agency planning efforts that specifically address connectivity and can guide the Forest Service as it seeks to implement the new rule are summarized in Appendix A.

2. Forest Service research publications on the topic may be found by entering the search term "connectivity" at www.treesearch.fs.fed.us/.

3. The planning rule defines landscape as "[a] defined area irrespective of ownership or other artificial boundaries, such as a spatial mosaic of terrestrial and aquatic ecosystems, landforms, and plant communities, repeated in similar form throughout such a defined area" (219.19).

BEST PRACTICES FOR CONNECTIVITY PLANNING

The following sections present guidance and best practices for connectivity planning, including examples from case studies in forest planning. Resources associated with the case studies are listed in the references at the end of the guide. Additional forest planning case studies are available online at www.defenders.org/forestplanning.

ASSESSING CONNECTIVITY

The planning rule requires that assessments be conducted prior to plan revisions to determine what needs to be changed in the existing forest plan, to serve as the basis for developing plan components and to inform a monitoring program. The Forest Service must review all relevant existing information and then determine the best available scientific information about conditions, trends and sustainability for connectivity in relationship to the forest plan within the context of the broader landscape (219.5(a)(1)). The Forest Service must document in the assessment report "how the best available scientific information was used to inform the assessment" (219.6(b)).

For connectivity, the assessment should address both ecosystem and species-level connectivity issues. At the ecosystem-scale, the assessment needs to identify the ecosystems and habitat types within the planning area, and then evaluate the diversity and integrity of those based on information related to their structure, function, composition and connectivity.

We recommend including the following in an assessment of connectivity at the ecosystem level:

- The selection of key characteristics for connectivity (see Table 3, page 10).
- A discussion of the NRV or "reference conditions" for the characteristics (e.g., historical pattern and connectivity).
- An evaluation of system drivers (e.g., climate change) and stressors (e.g., barriers to connectivity) on the characteristics.
- A discussion of the future status of the characteristic under current management and the current plan.

The end result should be a connectivity assessment that can be used to determine:

- How the current plan needs to change to maintain or restore connectivity.
- What plan components may be necessary to achieve the ecosystem-based connectivity requirements in the rule.

Connectivity must also be assessed as a potential condition necessary to sustain individual species. In the assessment, the Forest Service will present information on the ecological needs of species so that plan components can be developed to meet the rule's requirements for species. Particular attention should be paid to the connectivity needs of all at-risk species. To demonstrate that plan components will be effective in maintaining a "viable population" in the plan area, the assessment must provide a means of determining a "sufficient distribution" (see Table 2, page 8). The assessment should describe the relationship between connectivity and the distribution of species necessary for persistence, especially with regard to stressors like climate change. It is important that the assessment evaluate how species move, what barriers to those movements may exist and how the Forest Service can reduce the impact of those barriers within the context of recovery, conservation and viability.

The Flathead National Forest plan revision (assessment, 2014), which is being conducted under the 2012 Planning Rule, offers an example of assessing connectivity needs. The Flathead assessment includes a significant discussion of connectivity for terrestrial habitat, views connectivity from both an ecosystem and species perspective and considers both shorter term vegetation barriers on the forest and longer term human barriers between national forest lands. The example below shows how the Flathead National Forest presented a key ecosystem characteristic, description and data source for connectivity (adapted from Flathead 2014: 103, Table 26):

Key Ecosystem Characteristic: Horizontal Patterns and Landscape Connectivity

Description: The horizontal pattern of forest size/structure classes across the landscape and the spatial linkages between them, which is influenced both by human

activities, such as harvesting and development, and natural processes, such as wildland fire.

Data Source for Current Condition: Montana Natural Heritage Program databases; Flathead National Forest VMap; Flathead National Forest NRV analysis.

The assessment provides a description of current and reference (NRV) conditions and expected trends for this key characteristic, as well as an evaluation of the impact of stressors (e.g., from timber harvest and developments) on habitat. The following is a key finding from the assessment:

> *Significant departures from historical conditions in patch sizes and density was noted in the NRV analysis for nearly all forest structural classes forest-wide. This trend mirrored that occurring at the larger Northern Rocky Mountain ecoregion, where drastically increased forest fragmentation was noted. The analysis found a decrease in patch size and corresponding increase in patch density, resulting in a trend of increasing forest fragmentation. The changes were most dramatic for the early successional forest patches and found to be outside the range of historical variability, which is of particular concern to ecological integrity* (Flathead 2014: 137, internal citations omitted).

JOHN JACOBSON/WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

The Flathead National Forest connectivity assessment for the fisher specifies that this at-risk species requires mature forests arranged in connected, complex shapes with few isolated patches.

The Flathead assessment also presented connectivity information for an at-risk species, the fisher. This information can be used to determine the effectiveness of the current plan in providing for habitat connectivity for the species or to develop new plan components:

> *At the scale of 50–100 km2 (12,355–24,710 acre) landscapes, fishers in northern Idaho and west-central Montana selected for home ranges with greater than 50 percent mature forest arranged in connected, complex shapes with few isolated patches, and open areas comprising <5 percent of the landscape. Jones and Garton (1994) stated that preferred habitat patches should be linked by travel corridors of closed canopy forest and that riparian areas make excellent corridors provided they are large enough to enable fishers to avoid predation* (Flathead 2014: 197).

CONNECTIVITY MANAGEMENT AREAS

For connectivity, it is especially important to determine where plan components will apply. While it may be relatively easy to state desired forest-wide conditions related to connectivity, this approach by itself fails to focus efforts on areas with known connectivity values (e.g., roadless areas) and may not effectively promote integration with other uses that can lead to recognition of conflicts.

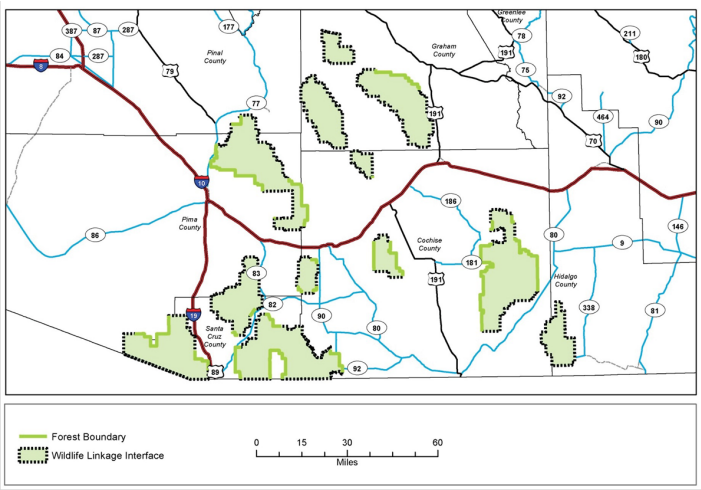
The planning rule states that the plan must indicate to which part of the plan area each plan component applies (219.7(e)). It defines "management areas" as parts of the plan area that have "the same set of applicable plan components" (219.19). Desired conditions and other plan components should be specified for particular linkage areas or corridors where they can be identified and the assessment finds them to be important to the persistence of target species in the plan area. Where connectivity is constrained, it may be necessary to identify specific areas to be managed as patches and their connecting corridors. Identifying specific management area(s) for connectivity provides clear forest plan direction on the importance of these areas and clarity for future projects.

The following case studies are examples of spatially recognizing connectivity in forest planning. An additional example is provided in the section on "Barriers to Connectivity" on page 18.

CASE STUDY: Wildlife Linkages in the Sky Islands

The mountainous "sky islands" of the Coronado National Forest in Arizona are made up of forested ranges separated by valleys of desert and grassland plains. They are among the most diverse ecosystems in the world because of their topographic complexity and location at the convergence

Figure 1. Wildlife linkages on the Coronado National Forest



Source: Coronado 2013: 64, Figure 3

U.S. FISH AND WILDLIFE SERVICE

A remote camera captured this image of an ocelot in the Huachuca Mountains of Arizona, an area where the proliferation of highways has affected connectivity among ocelot populations. To address the problem, the Coronado National Forest plan designated linkage areas on the boundary of the forest to coordinate connectivity management with other jurisdictions.

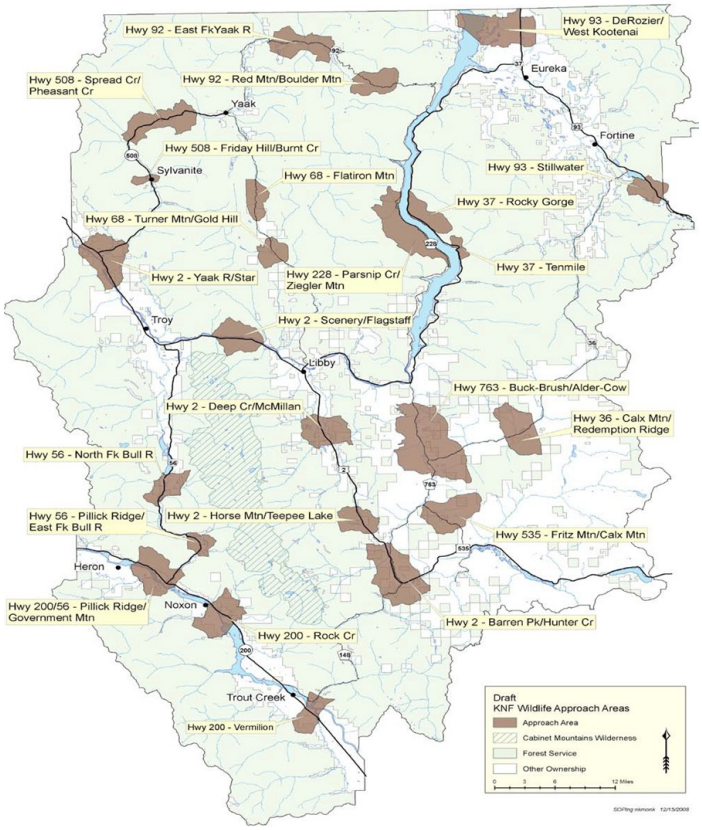
of several major desert and forest biological provinces. The valleys act as barriers to the movement of certain woodland and forest species. Species such as mountain lions and black bears depend on movement corridors between mountain islands to maintain genetic diversity and population size. Ocelots and jaguars at the northern end of their range here depend on connectivity to source populations in Mexico. The proliferation of highways and resulting increase in the number of road deaths among dispersing ocelots has affected connectivity among ocelot populations and colonization of new habitats. Movement corridors for jaguars in the American Southwest and northern Mexico are not well known but probably include a variety of upland habitats that connect some of the isolated, rugged mountains, foothills and ridges in this region.

The revised plan for the Coronado (draft, 2013) designates "wildlife linkages interface" areas, based on a statewide interagency effort that produced *Arizona's Wildlife Linkages Assessment* (Arizona Wildlife Linkages Workgroup 2006). The forest plan recognized that land management outside of the national forest boundaries affects biological resources on the national forest. Using data from the interagency group, the plan designates linkage areas on the boundary of the national forest (see Figure 1). These designated areas have management direction to maintain and reduce connectivity barriers and to coordinate connectivity management with other jurisdictions.

CASE STUDY: Grizzly Bear Approach Areas

The Kootenai National Forest in Idaho and Montana provided an excellent example of how to plan strategically for connectivity that has been confined to identifiable corridors and linkage areas. In 2008, the Kootenai identified and mapped locations of 24 approach areas important for grizzly bear connectivity using the best available scientific information from existing government and nongovernmental organizations, criteria for barriers (land ownership, topography, forest cover, land development) and wildlife use (Figure 2). Approach areas were defined as places where corridors or linkage zones cross what are termed "fracture zones" (e.g., valley bottoms

Figure 2. Grizzly bear approach areas on the Kootenai National Forest[4]



Source: Brundin and Johnson 2008: 3, Figure 1

4. The approach areas were not carried forward into the final, revised forest plan.


NATIONAL PARK SERVICE

The Kootenai National Forest plan identified "approach areas"—places where roads and other barriers to connectivity may hinder grizzly bear movement.

with highways and railways) where animal movements may be hindered and mortality risk elevated. The Kootenai also identified conservation measures that could be included in the forest plan as plan components for the approach areas and identified private lands where land exchanges, conservation easements or direct acquisition may be appropriate to improve management for one or more wildlife species (IGBC Public Lands Wildlife Linkage Taskforce 2004).

CASE STUDY: Blue Mountains Wildlife Corridor Management Area

The draft Blue Mountains National Forests plan (proposed plan, 2014), which covers the Malheur, Umatilla and Wallowa-Whitman national forests (the three forests span the states of Oregon, Washington and Idaho), establishes a management area identified as a "wildlife corridor" to connect wilderness areas and provide for landscape connectivity and defined as follows:

> *Wildlife corridors are areas designed to maintain habitat linkages between wilderness areas. Although disagreement exists regarding the utility of corridors, this management area emphasizes management for landscape connectivity, which is "the degree to which the landscape facilitates or impedes movement among resource patches," [sic] (Taylor et al. 1993) or "the functional relationship among habitat patches, owing to the spatial contagion of habitat and the movement responses of organisms to landscape structure," [sic] (With et al. 1997). A wide variety of vegetation structure and composition is present, with some showing evidence of past human disturbance and others showing affects primarily from natural disturbances, such as wildfires. Both summer and winter motor vehicle travel is restricted to designated routes. Recreation users can expect to find evidence of human activity in the form of vegetation management, mining, and road building. However, many of the roads that are closed to motor vehicle travel occur in these areas* (Blue Mountains 2014: 90).

The plan also provides a "strategy" for each management area. While the draft forest plan has drawn some criticism over unrelated issues, establishing a management area for corridors based on landscape function and structure allows for the design of habitat linkages in a variety of forms other than just simple linear connection between habitat patches.

LANDSCAPE PLAN COMPONENTS FOR CONNECTIVITY

Forest plan connectivity assessments should indicate if plan components are necessary to maintain or restore connectivity, either as an important contribution to ecological integrity or to provide conditions necessary for an at-risk species. An early consideration in forest plan connectivity planning should be the desired structure and pattern of the planning area landscape and the development of landscape plan components—desired conditions and objectives, where the desired condition describes how the connected landscape should look, and the objectives describe the timeframe and steps for achieving the desired condition.

Forest plans should include desired conditions and objectives for the sizes and distribution of habitat patches and other key characteristics of connectivity. It is also important to show the general areas where connectivity will be emphasized on a map and that the identification and management of these areas take into account the role and contribution of national forest lands to connectivity across other land ownerships.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The Canada lynx, a species listed as threatened under the Endangered Species Act, requires connected habitat across wide areas. Forest plan standards are in place to ensure that the connectivity and other habitat needs of lynx are met on national forests.

Table 4. Examples of landscape connectivity plan components in forest plans

Landscape Plan Components	Case Study and Comments
▪ Forest boundaries are permeable to animals of all sizes and offer consistent, safe access for ingress and egress of wildlife. In particular, segments of the national forest boundary identified in [the wildlife linkages interface] remain critical interfaces that link wildlife habitat on both sides of the boundary. Fences, roads, recreational sites and other man-made features do not impede animal movement or contribute to habitat fragmentation.	The Coronado National Forest consists of isolated mountain ranges, leading the draft plan to explicitly recognize the importance of connectivity and the value of coordinated planning with adjacent jurisdictions. This is especially important to ocelots and jaguars, which occur here at the northern end of their range and depend on connectivity to source populations in Mexico (Coronado 2013). This is direction for a specific management area.
▪ Retain natural areas as a core for a regional network while limiting the built environment to the minimum land area needed to support growing public needs. ▪ Reduce habitat loss and fragmentation by conserving and managing habitat linkages within and, where possible, between the national forests and other public and privately conserved lands. ▪ Preserve wildlife and threatened, endangered, proposed, candidate and sensitive species habitat and connecting links between the San Diego River Watershed and San Dieguito/Black Mountain.	The forest plan for the Cleveland National Forest was revised in conjunction with three other California national forests. The forests face a common management challenge of collaborating in nontraditional formats with local communities and governments to maintain and restore habitat linkages between the national forests and other open space reserves. This is forest-wide direction, but also refers to specific locations.
Landscape patterns are spatially and temporally diverse and have a positive influence on overall ecological function and scenic integrity. Landscape patterns provide connectivity, allowing animals to move across landscapes. Landscape patterns are resilient and sustainable, considering the range of possible climate change scenarios. The plans include a forest-wide desired condition that mentions "the ability of species and individuals to interact, disperse, and find security within habitats in the planning area" (Blue Mountains 2014: 30).	The Blue Mountains National Forests provide an important wildlife corridor connecting habitats and wildlife migration routes between the Rocky Mountains and central Oregon (Blue Mountains 2014). This is forest-wide direction about landscape patterns, in addition to the specific management area direction described above.
Federal ownership is consolidated when opportunities arise to improve habitat connectivity and facilitate wildlife movement.	This is forest-wide direction in the proposed action for the Nez Perce-Clearwater plan revision for use in subsequent land adjustment planning. Identifying priority locations in the plan would be more helpful (Nez Perce-Clearwater 2014).

Table 4 presents examples of landscape connectivity plan components in forest planning. (The language of the plan components is either verbatim or summarized. See the "References" section for source materials.) It should be noted that these examples (drawn from older forest plans) would need to be worded more explicitly under the 2012 Planning Rule, which requires desired conditions to be "specific enough to allow progress toward their achievement to be determined" (219.7(e)(1)(i)).

PROJECT PLAN COMPONENTS FOR CONNECTIVITY

Project components pertain to how projects are designed and implemented under the forest plan. Standards and guidelines, and suitability determinations for connectivity should be designed to promote achievement of the desired conditions and objectives for connectivity. Connectivity standards should be developed when greater certainty is important, such as in meeting diversity requirements necessary to protect at-risk species.

Table 5 provides examples of standards and guidelines for connectivity in forest planning. (The language of the plan components may be verbatim or summarized. See the "References" section for source materials.)

AQUATIC ECOSYSTEM CONNECTIVITY

Forest Service lands are most often found in the higher elevations of watersheds where streams provide clear, high-quality water. Management of aquatic ecosystems often centers on providing habitat that will support important fisheries.

Plan components for ecosystem integrity (including connectivity) must take into account the interdependence of terrestrial and aquatic ecosystems (219.8(a)(1)). There

Table 5. Examples of connectivity standards and guidelines in forest plans

Project Connectivity Plan Component	Case Study and Comments
▪ Retain connections of at least 400 feet in width to at least two other [late-successional/old growth] stands. ▪ Connections should occur where medium diameter or larger trees are common, and canopy closures are within the top one-third of site potential. ▪ The length of connecting corridors should be as short as possible. ▪ Understory should be left in patches or scattered to assist in supporting stand density and cover.	The Eastside Screens are rules for logging adopted as amendments to forest plans east of the Cascade crest in Washington and Oregon in 1996. They are intended to protect remaining late-successional and old-growth forests and to retain "connectivity corridors" between them (USFS 1995).
▪ When highway or forest highway construction or reconstruction is proposed in linkage areas, identify potential highway crossings. ▪ [National forest] lands in lynx linkage areas shall be retained in public ownership. ▪ New permanent roads should not be built on ridge-tops or saddles, or in lynx linkage areas.	The Canada lynx was listed as a threatened species in March 2000, largely due to a lack of adequate regulatory mechanisms in existing land management plans for federal lands. Lynx are known to disperse over wide areas, therefore it was important to add conservation measures to forest plans for lynx connectivity, which the Forest Service did in 2007 (USFS 2007) .

is an additional requirement in the planning rule to maintain or restore the ecological integrity of riparian areas, "including plan components to maintain or restore structure, function, composition, and connectivity …" (219.8(a)). This must be done by establishing "riparian management zones" and applying plan components to them that address riparian management issues. In particular, plan components for riparian management areas must specifically address ecological connectivity, blockages of watercourses, and aquatic and terrestrial habitats (219.8(a)(3)).

Many connectivity issues become intertwined in riparian areas, and plans can address them in conjunction with either terrestrial or aquatic connectivity or both. At a broad scale, management of riparian zones contributes to overall ecological integrity by providing connectivity between watersheds for both terrestrial and aquatic species. Riparian zones also provide connectivity that contributes to the terrestrial and aquatic integrity of individual watersheds. At a fine scale, the integrity of riparian areas themselves depends on the quality of aquatic and terrestrial habitat and often requires connectivity within and from riparian areas to other systems, including the hydrologic connectivity of a water body to floodplains or groundwater (floodplain connectivity can be a limiting factor for fish).

Sophisticated conservation strategies for salmonid species have been included in forest plans in the inland Pacific Northwest for two decades. The "PACFISH" and "INFISH" conservation strategies (1995) developed by the Forest Service and the Bureau of Land Management address connectivity in two primary ways. At the broader scale, they designate watersheds where management will emphasize water quality and fish habitat. This includes existing stronghold populations of fish and, importantly, additional watersheds that can be connected to those strongholds and restored. This will create a network of connected high-quality habitat that allows recolonization after a disturbance event such as a wildfire, flood or drought has rendered an area temporarily unsuitable.

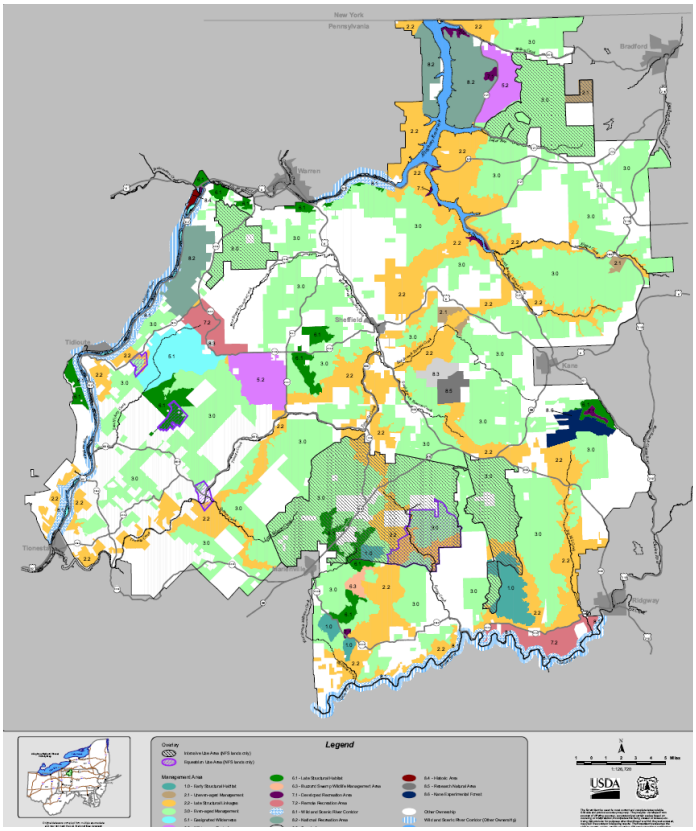
The Eastern Brook Trout Joint Venture, a partnership of state and federal agencies, nongovernmental organizations, and academic institutions, used a similar approach with the eastern brook trout in its native habitat (Maine to Georgia).According to its publication, *Conserving the Eastern Brook Trout: Action Strategies*, restoration should focus on habitat supporting populations that are doing relatively well, and then extend to adjacent habitats. An important part of this strategy is to "[i]dentify barriers to fish passage and re-establish habitat connectivity where possible" (Eastern Brook Trout Joint Venture 2008: 26).

The combination of designating watersheds and identifying connectivity barriers should lead to objectives that prioritize locations for restoration, such as the following connectivity objectives:

- Increase aquatic habitat connectivity through replacement of 90 culverts.
- Restore stronghold watersheds connectivity for aquatic species in four to six subwatersheds or on 80 to 120 stream miles.
- Establish self-sustaining brook trout populations in 10 percent of known extirpated key watersheds by 2025.

Existing forest plans also define riparian management areas, where standards and guidelines to protect aquatic resources apply to various management activities. While

Figure 3. Old forest connectivity management



Source: Allegheny National Forest Management Area Map (2007)

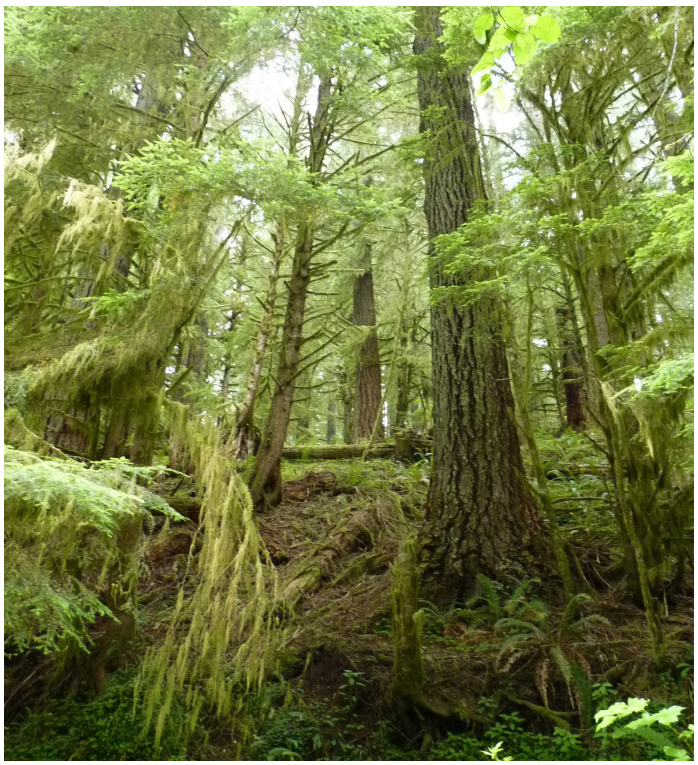
these plan components are primarily for the purpose of protecting resident fish, they also facilitate migration. The following type of standard would specifically address this connectivity issue: Construction or reconstruction of roads shall provide for passage of fish at all stream crossings.

BARRIERS TO CONNECTIVITY

National forest lands encompass a variety of permanent developments such as roads, railways, energy and mineral development infrastructure, recreation infrastructure and fencing. Evaluation and management of connectivity require determining the nature and effect of barriers on permeability and providing direction to reduce the effects of existing barriers and to avoid the creation of new ones. The more confined and unique the corridors or linkage zones are, the more attention should be paid to how barriers are managed**.** Forest plans must address barriers to connectivity that are relevant to ecological diversity and the persistence of species in a plan area.[5]

One key aspect of barriers that must be considered in relation to national forest management is their cause and degree of permanence. If barriers to wildlife movement and connectivity are due to natural disturbance (e.g., a forest opening caused by a fire or landslide), they can be viewed as transitory barriers that can be expected to "move" from place to place as new openings are created and then closed by natural succession. However, if the movement barrier for a particular species of wildlife is a lack of habitat that is difficult to restore, such as old-growth forest, the connectivity problem may be longer term and the need to protect existing patches using project plan components may be greater.

The Allegheny National Forest in Pennsylvania provides an example of old forest connectivity management, where habitat diversity was one of the key issues identified at the beginning of the plan revision process. The forest plan paid specific attention to "providing late structural and old growth forests and habitat connectivity across the landscape" (ROD, 2007: B-3). The revised plan established a management area for "late structural linkages" based on



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Forest plans should recognize the value of rare habitats, such as old-growth forest like this in the Siuslaw National Forest, in providing for connectivity.

5. While the effectiveness of habitat corridors providing connectivity is no longer disputed (Gilbert-Norton et al. 2010), potential negative consequences may result from movement of invasive, exotic, and otherwise harmful species or diseases, especially in aquatic habitats. This has been noted especially for inland trout species, where enhancing connectivity could do more harm than good by promoting competition or hybridization with non-native species, or introducing diseases. These kinds of risks should be identified and mitigated to the extent possible when designing landscape connections. Moreover, efforts to connect landscapes that have not historically been connected should be avoided.

existing core blocks of wilderness areas, research natural areas, national recreation areas and other protected areas. It was also designed to specifically include areas of known goshawk nest sites and rattlesnake dens, thus affording additional protection for these species (see Figure 3).

ROADS AND CONNECTIVITY

Roads and their associated human uses are one of the most common, persistent and obstructive barriers to terrestrial and aquatic wildlife connectivity. The National Forest System has approximately 375,000 miles of roads.[6] Decisions to build, decommission, open or close roads can affect connectivity in significant ways. Recognition of the role of unroaded (i.e., roadless) areas for the purposes of connectivity planning is equally important. Forest plans provide the overall guidance for how many roads there will be on a forest and how they are to be used.

Use of roads by the public is also governed by the Forest Service "Travel Management Rule," regulations published in 2005 to establish a nationally consistent approach to local determinations of where excluding motorized use is necessary to protect other resources or, conversely, where such use is desirable and ecologically acceptable. The regulations require each national forest to identify and designate roads, trails, and areas that are open to motor vehicle use. Motorized use is prohibited anywhere that is not so designated. These decisions are part of travel management plans, and these plans must be consistent with forest plans.

Clearly, decisions to have a road or to allow motorized use should take into account the effect of that particular road on connectivity. To fully understand the effects, it is necessary to know what role an area or corridor is expected to play in providing connectivity and what else is likely to happen there that will affect its connectivity value. The forest plan is the place to provide answers to those questions.

Where motorized use is inconsistent with the desired condition for an area, including desired connectivity conditions, a forest plan can identify the area as one that is not suitable for motorized use. This precludes the establishment of motorized routes in the area. It should also lead to eliminating any existing motorized use through road or area closures.

Site-specific desired conditions for connectivity are helpful in deciding where to manage for motorized use. The Gallatin National Forest Travel Plan Final

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Roads and their associated human uses are one of the most common, persistent and obstructive barriers to connectivity on national forest lands. The National Forest System has about 375,000 miles of roads.

6. See www.fs.fed.us/eng/transp/.

Environmental Impact Statement (2006) includes a site-specific goal for identified "wildlife corridors," which provides a good example of a desired condition that should be included in a forest plan:

> *Provide for wildlife movement and genetic interaction (particularly grizzly bear and lynx) between mountain ranges at Bozeman Pass (linking the Gallatin Range to the Bridger/Bangtails); across highway 191 from Big Sky to its junction with highway 287 (linking the Gallatin and Madison Mountain Ranges); the Lionhead area (linking the Henry's Lake Mountains to the Gravelly Mountains and areas west); Yankee Jim Canyon (linking the Absoroka Mountains to the Gallatin Range); and at Cooke Pass (linking the Absoroka/Beartooth Range to areas south)* (Gallatin 2006: 3-88 – 3-89).

A connectivity characteristic commonly used in forest plans to protect wildlife and fish habitat is road density. Road density limits are especially useful for protecting big game hunting opportunities. The presence and use of roads have also been found to create risks to movement of large carnivores such as grizzly bears, a federally listed threatened species. To comply with the ESA, forest plans in grizzly bear range include restrictions on road density.

The Flathead National Forest provides some of the most important grizzly bear habitat in the National Forest System. As a result of ESA consultation on the forest plan, the Forest Service adopted Amendment #19 in 1995 that applied objectives and standards for each of 70 grizzly bear management subunits across the Flathead (where national forest ownership is greater than 75 percent) (Flathead 1995). For example, an objective was developed stating that within five years total road density of greater than two miles per square mile would occur on less than 24 percent of the grizzly bear management unit and in 10 years that would be further reduced to less than 19 percent. Similarly, standards were used to ensure there would be no net increases in road densities above a certain threshold and to maintain the security of core grizzly bear habitat areas. These types of connectivity and security plan components have been successful in reducing the number of roads forest-wide by approximately 700 miles and increasing secure core area from 63 percent to 70 percent (Flathead 2012: unpaginated, Tables 16b-9 and 16b-10).

For terrestrial species, it is often the use of the road that is more of a barrier to connectivity than the physical presence of the road. Many current plans address the need to limit motorized access during big game hunting season or to protect sensitive big game habitat such as winter range.

CONCLUSION

The connectivity planning direction found in the 2012 Planning Rule provides a significant opportunity to develop and implement landscape- and project-scale connectivity strategies on Forest Service lands and to coordinate connectivity planning across land ownerships. To be successful, forest planning stakeholders—including Forest Service planners, conservation advocates, scientists and other agencies and governments—must collaborate to devise innovative approaches.

Connectivity planning also requires forward thinking to execute the vision of a connected landscape. There is no one way to develop and implement connectivity strategies within forest plans. We hope this guide stimulates innovative ideas and is a starting point for developing effective approaches to connectivity planning within forest plans.

Share Your Experiences

Please share your forest planning experiences with us and let us know if this guide was useful. Your input will help us build our list of case studies and improve the effectiveness of this planning tool. Send your feedback to Pete Nelson (pnelson@defenders.org).

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APPENDIX:
EXAMPLES OF COORDINATED CONNECTIVITY PLANNING

Multi-Organization Initiatives, including the Forest Service

America's Great Outdoors Initiative
www.doi.gov/americasgreatoutdoors/index.cfm

One of the goals of the President's America's Great Outdoors Initiative is "the conservation of land, water, wildlife, historic, and cultural resources, creating corridors and connectivity across these outdoor spaces, and for enhancing neighborhood parks." The "Large Landscapes Initiative" seeks to "improve collaboration across federal agencies and with state and local partners, especially given the inherent cross-jurisdictional nature of restoring large landscapes." It currently includes a study of specific wildlife linkage locations across major highways in the "Crown of the Continent" ecosystem in Montana.

Department of the Interior, Landscape Conservation Cooperatives
www.fws.gov/landscape-conservation/lcc.html

LCCs provide a forum for federal agencies (including the Forest Service), states, Tribes, non-governmental organizations, universities and others to work together to coordinate management response to climate change at the landscape level. "New wildlife corridors" was one of the specific needs identified nationally. The Great Northern LCC partners, for example, agreed to conservation goals that prominently feature connectivity as an important element of ecosystem integrity, and they also identified "target species" that depend on connectivity. Land management plans would be the vehicle for the Forest Service to incorporate broader landscape conservation goals.

Western Governors' Association Wildlife Corridors and Crucial Habitat Initiative
www.westgov.org/wildlife-corridors-and-crucial-habitat

The Western Governors' Association's initial policy stated that federal land management agencies should identify key wildlife migration corridors in their land management plans. The Forest Service is participating in implementing this connectivity guidance. In November 2012, the Forest Service encouraged forest supervisors conducting forest planning to consider information compiled by states for this initiative as part of implementing the 2012 Planning Rule.

Grizzly Bear Recovery Planning
www.igbconline.org/index.php/population-recovery/grizzly-bear-linkage-zones

The Recovery Plan for Grizzly Bear identifies the need to evaluate potential linkage areas within and between recovery areas. The Interagency Grizzly Bear Committee (IGBC, which includes the Forest Service) determined that "… linkage zone identification and the maintenance of existing linkage opportunities for wildlife between large blocks of public lands in the range of the grizzly bear are fundamental to healthy wildlife." Maps of linkage areas have been developed by the U.S. Fish and Wildlife Service and sanctioned by the IGBC.

Forest Service Initiatives

Properly addressing connectivity in land management plans will also promote coordination and integration within the Forest Service and advance other agency prerogatives.

The Forest Service Strategic Framework for Responding to Climate Change includes "development of wildlife corridors to facilitate migration" as a strategy to address climate change effects (www.fs.fed.us/climatechange/pdf/Roadmapfinal.pdf). One of the "immediate initiatives" in the roadmap is connecting habitats to improve adaptive capacity by:

- Collaborating with partners to develop strategies that identify priority locations for maintaining and restoring habitat connectivity. Seeking partnerships with private landowners to provide migration corridors across private lands.
- Removing or modifying physical impediments to species movement most likely to be affected by climate change.
- Managing forest and grassland ecosystems to reduce habitat fragmentation.
- Continuing to develop and restore important habitat corridors for fish and wildlife.

The Forest Service Open Space Conservation Strategy states that "[o]ur vision for the 21st century is an interconnected network of open space across the landscape that supports healthy ecosystems and a high quality of life for Americans" (www.fs.fed.us/openspace/national_strategy.html).