2

Management Approach

This chapter is a comprehensive overview of the integrated management approach as implemented today.

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Management Approach

Under integrated management, DNR supports revenue production and ecological values by creating and maintaining a biologically diverse working forest, with healthy streams and wetlands, a mix of tree species, and a diversity of forest structures at the stand and landscape level.

Structural diversity at the stand level includes down wood, snags, canopy layers, and other elements. Structural diversity at the landscape level includes open areas and stands of varying densities and developmental stages from newly planted to mature, including old growth. DNR achieves structural diversity in three primary ways:

- DNR harvests timber to produce revenue for trust beneficiaries in a way that creates and maintains a diversity of forest structures within and across forest stands. For example, DNR thins forest stands to a variety of densities and uses variable retention harvest techniques in which green trees, snags, down wood, and other structural features are retained between one forest rotation and the next to enrich the structural diversity of the new stand.

- Under its HCP conservation strategies, DNR places buffers on streams, limits harvest in wetlands and their management zones and on potentially unstable slopes and landforms, restores and maintains a percentage of each landscape as northern spotted owl habitat, and protects types of marbled murrelet habitat. These practices result in retention of forest stands ranging from young to mature in a highly variable spatial arrangement across the land base.

- DNR intersperses areas deferred per current DNR policies, such as old-growth forests, with areas that are more actively managed.

These practices are aimed at producing a biologically diverse forest that provides quality timber for harvest and habitat for native species. As this

approach is implemented, DNR intentionally learns from it through research and monitoring and consider new information through the adaptive management process.

In the following chapter, these and other concepts will be explained in more detail. The discussion is organized around the following seven major components of integrated management:

- Silviculture
- HCP conservation strategies
- Planning from a landscape perspective
- Research and monitoring
- Adaptive management
- Information management
- Effective communication

A graphic is provided at the start of each section to help readers navigate this chapter.

At the end of this chapter, DNR also discusses response to natural disturbances and adaptation to climate change.

Forest in the OESF

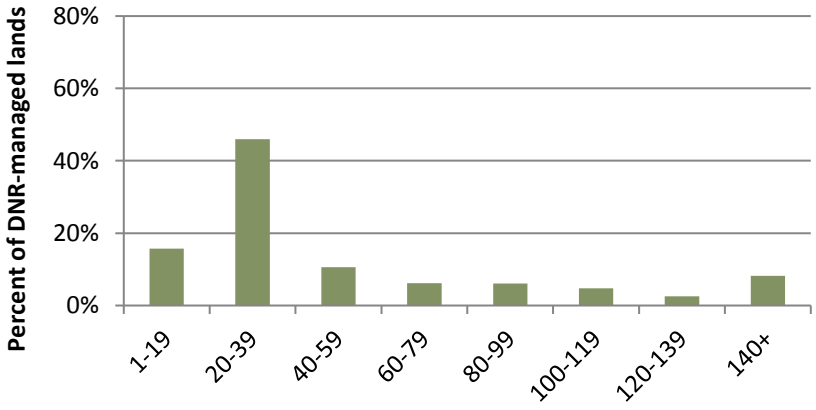
Silviculture

The OESF currently has many structurally simple stands that are a legacy of past clearcuts (carried out under DNR policies that are no longer in place) and widespread natural disturbances such as major windstorms. Chart 2-1 shows that forests across approximately half of state trust lands in the OESF are between 20 and 39 years of age. Over half of the forests on state trust lands in the OESF are in the "Competitive Exclusion" stand development stage, a single-canopy stage in which trees are closely spaced and stands typically lack the down wood, snags, and other structural characteristics of later stages.

Silviculture is the principle tool by which DNR introduces and maintains structural diversity within and across forest stands across the OESF. Following, DNR describes the silvicultural system and harvest methods it uses to accomplish this. The information in this section is meant as a starting point. This is an experimental forest, and techniques are expected to evolve over time.

Chart 2-1. State Trust Lands Forest Stand Age Class Distribution

Based on 2011 Data



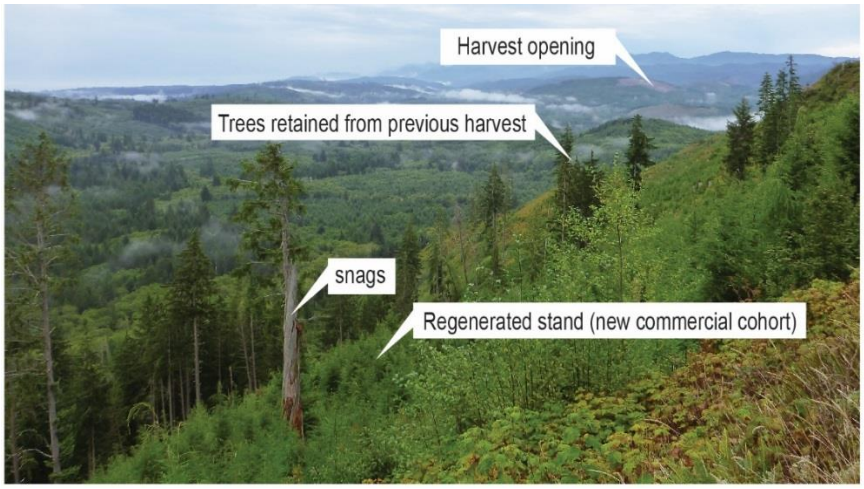
DNR's Silvicultural System: Cohort Management

In the OESF, DNR uses a silvicultural system that focuses on the management of **cohorts**. Cohorts are the portions or attributes of a forest stand that can be defined and managed for, such as large legacy trees, snags, down wood, or a group of trees of similar age and species.

DNR's silvicultural system is called **cohort management,** which is the simultaneous management of multiple cohorts within an area to meet objectives (refer to Figure 2-1). For example, DNR may remove the commercial cohort to generate revenue, while retaining snags, down wood, structurally unique trees, and other "biological legacy" cohorts to support ecological values. By managing cohorts, DNR can intentionally diversify a stand's structure, and by applying cohort management across the landscape, DNR can generate revenue and achieve a variety of stand densities and structures to support ecological values across the OESF.

Figure 2-1. Cohort Management

By leaving some cohorts and removing others, DNR creates and maintains combinations of forest structures within and across forest stands.



The primary harvest techniques used under cohort management incorporate key principles of biodiversity pathways such as retention of biological legacies at harvest (variable retention harvest) and non-uniform thinning (variable density thinning). A third principle of biodiversity pathways, natural regeneration, occurs in smaller forest openings with complex edges, as will be discussed in the following section.

Both variable density thinning and variable retention harvest represent a single entry into the stand. Although some ambiguity exists between them, for DNR the primary difference is whether regeneration is planned

and managed for following a harvest (as with variable retention harvest) or not (as with variable density thinning). Following is a description of these harvest methods. Other harvest methods are discussed at the end of this section.

► Variable Retention Harvest

Variable retention harvest is a type of regeneration, or stand-replacement harvest. In variable retention harvest, key structural elements of the existing stand are maintained while the commercial forest stand cohort is re-initiated (Franklin and others 1997). Retained cohorts may include snags, structurally unique and other leave trees, down wood, and other elements.

One aim of variable retention harvest is to create a favorable environment for the regenerating tree seedlings that represent the new commercial cohort. A favorable environment is one in which low levels of competition for light, water, and nutrients allows for rapid seedling establishment and growth. Site preparation, planting, and vegetation control activities may be conducted to ensure establishment and performance of the regenerated cohort.

Variable Retention Harvest in the OESF

Variable Retention Harvest in the OESF

The within-stand growing environment for trees regenerating after a variable retention harvest resembles an even-aged plantation, but with important differences. Because of DNR's conservation strategies and other policies (refer to Chapter 3), within the harvest boundary DNR also retains large, live trees; streamside forests; northern spotted owl habitat; marbled murrelet habitat; forests on potentially unstable slopes, if the risk of conducting activities on them is high; forested wetlands and bogs; old growth; and unique habitats per the multispecies conservation strategy. The result should be a harvest that is often irregular in shape (refer to photo, above). For that reason, there may be more within-stand competition with a variable retention harvest than

with a clearcut. Depending on the level of retention and the edge density (proportion of the amount of area to the length of the edge), competition from adjacent overstory trees in the immediate growing environment around the seedling may range from virtually none (similar to a clearcut) to high levels (similar to a multi-aged stand). Regenerating trees may grow at different rates depending on their location in the stand.

In stands with small opening sizes and high edge density, DNR is likely to use natural regeneration instead of replanting because of the abundance of natural seed sources of desirable tree species, the high level of competition due to retained trees, or the difficulty of applying a site preparation treatment. However, depending on objectives, replanting may be prescribed by the forester.

► Variable Density Thinning

Thinning involves selective removal of trees from a forest stand to reduce stand density and achieve stated objectives. Thinning redistributes growth from trees that do not contribute to objectives, to those that do. Thinning improves the growth of the retained trees, enhances stand health, and reduces tree mortality. After all types of thinning, one or more future commercial cohorts remain in the previous, dominant canopy (DNR 2009).

Variable Density Thinning in the OESF
Standing in thinned area looking toward a forest opening

A *variable density thinning* is a commercial activity used to accelerate stand development towards a stated objective. The objective is often a more complex stand structure: variable density thinning is often used to emulate characteristics of stand-level heterogeneity that research indicates would develop as trees grow and differentiate under natural or unmanaged conditions. When applied to stands in the Competitive Exclusion stage, a variable density thinning can introduce a substantial level of horizontal and vertical diversity that otherwise might take decades to develop. A variable density thinning also may be applied to more complex stand developmental stages to enhance their duration or promote specified cohorts. Variations in stand density cause trees to grow differently across the stand, with the outcome being greater within-stand diversity of structure, density, and tree sizes, species, and forms

(shapes). Knowing how trees respond to growing space allows the forester to target certain densities for specific objectives.

In variable density thinning:

- Foresters often create a mixture of small openings (gaps), un-thinned patches (skips), and varying stand densities to emulate the micro-scale disturbances that would occur naturally from snow, wind, disease, or other causes, given sufficient time.
- In areas where forest cover is retained, foresters may prescribe a thinning treatment including trees of all or most diameter classes that results in a mixture of healthy dominant, co-dominant, and understory trees. Thinning may be uniform across much of the treated area.
- Openings typically range from ¼ to 2 acres. Openings in the canopy can encourage natural regeneration of trees, growth and development of seedlings and saplings that have developed in the understory (in other words, advanced regeneration), and growth of understory shrubs and herbs. An assumed benefit is that these small openings, along with the general decrease in stand density that occurs through thinning, will increase growing space for retained trees along opening edges. Openings also serve as potential disturbance nuclei for wind and snow damage, thus contributing to the amount of down woody debris and snags and maintaining structurally distinct characteristics for longer periods than would otherwise occur.
- Variable density thinning introduces light into the stand, encouraging the stand to differentiate. For example, in heavily thinned areas, the stand may develop an understory. Differentiation increases structural diversity and often accelerates mortality through the expression of dominance, since larger trees typically out-compete smaller trees for necessary resources.
- Some areas may be skipped to allow for natural mortality, protect existing important structural features, and/or provide for other attributes of within-stand structural diversity or habitat.
- Variable density thinning may also include treatments to create large down wood and snags, or to target their development.
- Regeneration is not a primary objective. Natural regeneration may occur in openings and areas with lower residual density, potentially forming a lower canopy layer and bringing the stand into the Understory Development stand developmental stage.

Similar to a conventional thinning, a variable density thinning must have revenue objectives and financial thresholds to be operationally feasible.

The volume removed makes the thinning financially feasible, and the larger trees that may result from thinning may provide higher-quality timber in the future.

These Methods are not new

Neither variable retention harvest nor variable density thinning as practiced by DNR are new harvest methods. These methods have been developed and refined over the many years that DNR has been implementing integrated management in the OESF. Though they may seem routine today, they were revolutionary at the time they were developed.

As mentioned previously, when the OESF was established DNR was practicing clearcutting. Over the years, DNR began experimenting with new harvest techniques such as retaining biological legacies and reducing the size of forest openings. DNR also learned how to orient openings and arrange leave trees to minimize windthrow (windthrow is the blowing over or breaking of trees in the wind). Much of what has been learned and implemented in the OESF has since been adopted in other DNR planning units. Questions for future research may involve how to implement these complex harvest techniques more efficiently to ensure economically viable timber sales.

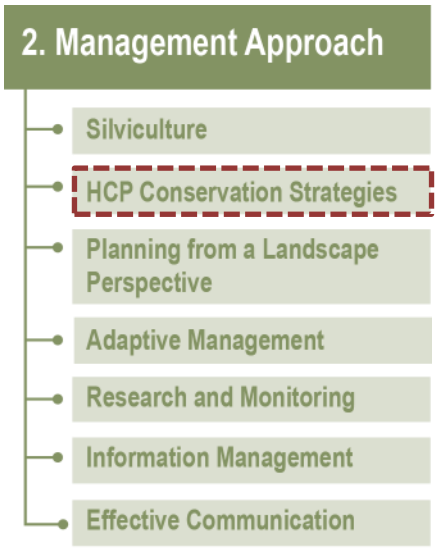
► Other Harvest Methods

The combination of unique site conditions and objectives means that no one harvest method works in all circumstances. To achieve revenue and ecological objectives, foresters planning a timber sale may use a variety of other harvest methods, such as selective product logging, in which only certain, highly valuable trees are removed from a stand, or uniform thinning, in which trees spacing after the thinning is fairly even. The final decision on which harvest method to use is based on numerous, interrelated factors and ultimately is made by the forester planning the sale.

Shovel Logging in the OESF

HCP Conservation Strategies

The HCP includes four major habitat conservation strategies for the OESF: northern spotted owl, riparian, marbled murrelet, and multispecies. Implementing these strategies across the OESF is another means by which DNR achieves a structurally and biologically diverse forest. Following, DNR describes each strategy and how it fits within the integrated management concept. More information on these strategies can be found in Chapter 3.



Northern Spotted Owl Conservation Strategy

Under the northern spotted owl conservation strategy, DNR restores and maintains a level of habitat capable of supporting northern spotted owls on DNR-managed lands in the OESF (DNR 1997, p. IV.86).

The HCP coined the term "unzoned" to describe its approach to northern spotted owl conservation, meaning "no special zones are set aside for either species conservation or commodity production" (DNR 1997 p. IV.81). Instead of designating specific areas on the land base as northern spotted owl habitat, DNR manages the OESF for a "shifting mosaic" of habitat.

DNR based this strategy on the landscapes identified under the 1991 Plan. In each of these 11 landscapes, DNR restores and maintains the following threshold proportions of northern spotted owl habitat: at least 40 percent of DNR-managed lands[1] as Young Forest Habitat and better, and at least 20 percent as Old Forest Habitat (habitat types will be described in Chapter 3). Habitat can be located anywhere within the landscape, and its location can shift over time: as one area matured into habitat, other existing areas of habitat can be harvested so long as threshold proportions of habitat are maintained.

Key features of this strategy include the following:

- Older forest is distributed throughout the forest mix (DNR 1997 p. IV.81) rather than concentrated permanently in one area.
- At any given point in time, any DNR-managed lands in the OESF can contribute toward habitat thresholds. By contrast, in other planning units DNR designates spotted owl management units (SOMU), usually near high-quality habitat on adjacent ownerships. SOMUs occupy only a portion of the overall planning unit; areas outside of the SOMUs have no role in northern spotted owl conservation.

The thresholds selected for the OESF are lower than the 50 percent threshold used in other HCP planning units. When the HCP was developed, DNR's literature search indicated that 30 to 50 percent habitat at spatial scales ranging from northern spotted owl ranges to landscapes was sufficient to support reproductive owl pairs (DNR 1997, p. IV.88). The 40 percent threshold was proposed for the OESF to allow managers and researchers greater flexibility in arriving at effective and efficient solutions to integrating revenue production and ecological values (DNR 1997, p. IV.88).

Riparian Conservation Strategy

Under the riparian conservation strategy, DNR protects, maintains, and restores habitat capable of supporting viable populations of listed, non-listed, and candidate species of salmonids and other species dependent on in-stream and riparian environments. DNR does this by placing interior-core buffers on streams, and by placing exterior wind buffers where needed to prevent windthrow in the interior-core buffer. This strategy also includes protection of wetlands and careful management of roads to prevent fine sediment delivery to streams.

The HCP acknowledged that riparian areas act "almost like zones" because they are linked to relatively fixed physical features on the landscape (DNR 1997, p. IV.81). However, to enable greater integration of revenue production and ecosystem values, management in riparian areas is tailored to the ecological condition of each watershed. For example, depending on watershed conditions DNR allows a small amount of regeneration harvest within interior-core buffers (refer to Chapter 3 for more information).

Because of the abundance of streams in the OESF, DNR anticipates that the riparian conservation strategy will result in complex, productive aquatic habitat in streams and wetlands, as well as late successional conifer forests along streams and on unstable slopes that could benefit aquatic, wetland, riparian obligate, and uplands species (DNR 1997, p.

IV.138). In fact, DNR's projections in the HCP showed that more than half of northern spotted owl habitat would be located in riparian areas (DNR 1997, p. IV.106). For that reason, the riparian and northern spotted owl conservation strategies are inter-dependent, and the patterns of habitat created through the intersection of these two strategies has have a bearing on the overall use of the landscape by northern spotted owls and other wildlife species.

Marbled Murrelet Conservation Strategy

At the time the HCP was written, DNR did not have enough information about marbled murrelet biology to write a long-term conservation strategy for marbled murrelets. Therefore the HCP included an interim strategy.

Under the interim strategy, DNR sets aside specific areas to protect the marbled murrelets and avoid foreclosing future options for management under a long-term strategy. DNR noted in the HCP that preservation of some marbled murrelet nesting habitat would increase the amount of late successional forest available to other species (DNR 1997, p. IV.138). Development of the long-term marbled murrelet conservation strategy currently is underway, and once completed will be integrated into this forest land plan.

Multispecies Conservation Strategy

The multi-species conservation strategy echoes the 1991 Plan's intent of non-species specific management (refer to Chapter 1). Although specific habitat types such as caves and balds are protected, habitat for most native species is envisioned as an outcome of landscape-level management in the OESF (DNR 1997, p. IV.137). For example, conservation measures for riparian areas and northern spotted owl and marbled murrelet habitat are expected to create interconnected patches of late-successional, mid-aged, and young forests (DNR 1997, p. IV.137) that support a range of species.

Planning from a Landscape Perspective

Planning from a landscape perspective is a multi-scale, multi-disciplined approach to planning that was recommended in the HCP as a means of implementing integrated management. This type of planning involves looking at the entire land base at different spatial scales to balance multiple objectives for revenue and ecological values, including the objectives of the four major habitat conservation strategies.

As well as knowledge and expertise in numerous disciplines such as wildlife biology, silviculture, forestry, forestry engineering, ecology, and hydrology, this type of planning requires powerful computer-based analytical tools. At this time, the tool most central to the planning process is a forest estate model called the "tactical model."

How the Tactical Model Works

The tactical model looks across the land base and decades to develop an "optimal solution" of where, when, and; by what method to harvest or not harvest to meet multiple objectives over time.

In the tactical model, all DNR-managed lands in the OESF are classified as either "operable" or "deferred." Operable areas are fully or partially available to the model for harvest (for example, thinning and variable retention harvest, or thinning only). By contrast, deferred areas are unavailable to the model for harvest.

Areas deferred from harvest in the tactical model include the following:

- Permanent deferrals, for example natural area preserves.
- Areas deferred from harvest per current DNR policies, such as old-growth forests. Areas deferred per DNR policies will remain deferred for as long as the policy that deferred them remains in place.
- Areas deferred in the model to represent current management practices and guidance, for example potentially unstable slopes or

landforms. DNR has guidance from both the forest practices rules and the HCP on preventing an increase in the frequency and severity of landslides. For those areas, DNR's conservative approach is to categorize them as deferred in the tactical model with the understanding that management decisions for those areas will be made on a case-by-case basis.

The number of acres deferred in the tactical model is fluid. For example, some areas may be incorrectly mapped as unstable and vice versa. Deferred areas are updated in the model each time the model is rerun.

The model also has access to "yield tables," which are projections of forest growth under "no management" and a variety of silvicultural regimes.[2] Yield tables are built with the forest vegetation simulator, a growth model developed by USFS.

The model's task is to find the optimal solution to maximize "net present value," meet ecological objectives, and stay within the bounds of current DNR policies. (Net present value is the cash inflow [revenue from timber sales] minus cash outflow [costs of forest management]). To develop its solution, the model sorts through the information in the yield tables to find the silvicultural regime for each area that best enables the model to meet its objectives.

As an example, consider the northern spotted owl conservation strategy. DNR's objective is to restore and maintain at least 40 percent of each landscape as Young Forest Habitat or better, and at least 20 percent as Old Forest Habitat. The model keeps track of the amount of habitat in each landscape currently, and the amount of habitat projected to develop over time. With this information, the model then develops a solution of which stands to harvest or not harvest over time to meet thresholds in each landscape while also maximizing net present value.

The model also performs a watershed assessment to determine how much harvest it can recommend in riparian areas while also riparian function, and how much harvest it can recommend in each Type 3 watershed without causing a detectable increase in peak flow (periods of high stream flow or maximum discharge, usually associated with storm events). The watershed assessment is described in Chapter 3.

The model provides two major types of outputs:

- A **harvest schedule**. The harvest schedule is the model's solution in list and map form. It recommends the types, locations, and timings of harvests.

- A **state-of-the-forest file**. The state of the forest file is a forecast of forest conditions (such as stand development) that are projected to occur as a result of implementing the harvest schedule.

How the Tactical Model is Used

The model is used as a planning tool to help DNR balance multiple objectives across the land base. **However, the model is only a tool and a guide; it is not meant to replace on-the-ground observation and decision making. Harvest and other management decisions *always* are based on actual, field-verified conditions.** Foresters use the harvest schedule provided by the model as a *starting point* for selecting an area to harvest. They begin each timber sale by doing an office review and field reconnaissance of the areas currently recommended by the model for harvest. Foresters consider costs, forest conditions, difficulty in harvesting and extracting the logs ("operability"), long-term objectives, and other factors. If the timber sale is feasible, it is implemented. During the implementation process, sale boundaries suggested by the model may be adjusted to accommodate unmapped streams, potentially unstable slopes, or other features. If the timber sale is not feasible, foresters may alter the sale or return to office review to select another area.

The Tactical Model Through Time

Deviations from the harvest schedule will occur as foresters plan and implement timber sales. As time passes, the effect of these deviations on the model's optimal solution may be compounded. To address this issue, DNR updates and re-run the model periodically. Factors that may trigger additional model runs include but are not limited to the following:

- **Operational needs**. Region managers may request a re-run of the model when needed to support operations.
- **Changes in the land base**, such as significant land acquisitions or transfers that would affect DNR's objectives, for example the balance of northern spotted owl habitat in a landscape.
- **Changes to the way DNR maps or models the stream network**.
- **Changes to DNR's northern spotted owl habitat definitions**, or changes in the way northern spotted owl habitat is represented in the model.
- **Changes to procedures** recommended through the adaptive management program, if those changes are likely to affect the harvest schedule.
- **Changes to underlying scientific assumptions** that affect how the model projects growth over time.
- **Changes to policies,** such as development of the long-term marbled murrelet conservation strategy.
- **Significant natural disturbances**, such as fire or windstorms.

Updating and rerunning the model will help keep DNR on track to meet its objectives and ensure that foresters have the most current information to help them with timber sale planning.

In addition, over time DNR expects to take advantage of technological and other advances to improve its modeling. These improvements may range from modification of the modeling framework to development of an entirely new tactical model using different software, to adoption of a different type of model that enables DNR to analyze management questions in new ways. Models used to develop the tactical model, such as the forest vegetation simulator, also may change.

Subsequent models will be built to represent current DNR policies as well as the integrated management approach and the strategies outlined in this forest land plan.

Adaptive Management

Adaptive management is a formal process for continually improving management practices by learning from the outcomes of operational and experimental approaches (Bunnel and Dunsworth 2009). The ultimate goal of this process is to improve the integration of revenue production and ecological values in the OESF.

The adaptive management process is focused on the forest management strategies DNR uses and the working hypotheses on which those strategies are based. The primary working hypothesis for the OESF is that it is possible to manage a working forest for both revenue production and ecological values. DNR breaks this broad, overarching hypothesis into primary hypotheses, which are then further distilled into specific hypotheses. For example, one of the primary working hypotheses for the riparian conservation strategy is that riparian conservation objectives can be met by placing buffers on streams. That hypothesis is broken into more specific hypotheses about the effectiveness of interior-core and exterior wind buffers.

Most management strategies are based on working hypotheses because of uncertainties (incomplete knowledge) about how forest conditions are

affected by management. DNR prioritizes uncertainties, reduces (learns about) them through research and monitoring, and determines whether the new information affirms or warrants a change in management.

Chapter 3 includes goals, objectives, and strategies for adaptive management. Refer to Chapter 4 for a detailed description of the adaptive management process and to the forestry handbook for the adaptive management procedure (PR 14-004-530, *Adaptive Management in the OESF HCP Planning Unit*).

Research and Monitoring

Research and monitoring is the primary means by which DNR gathers new information and reduce key uncertainties about the integrated management approach. Refer to Chapter 3 for goals, objectives, and management strategies, and Chapter 4 for a detailed description of this program.

Information Management

Information management includes collecting, managing, and sharing information and data between foresters, managers, planners, scientists, and others involved in implementing the integrated management approach.

Information management is critical to the success of integrated management for three primary reasons. First, implementing DNR's management strategies requires sophisticated models informed by up-to-date data. Second, assessing the success of these strategies, notably the strategies for riparian areas and northern spotted owl habitat, involves tracking both forest management activities and ecological conditions over time. And finally, the adaptive management process is critically dependent on effective information management. In order to "learn from doing," it is necessary to know what has been done and why.

Information management in the OESF is best described as a system with three major nodes. These three nodes include the following:

- **Land Resource Manager** (LRM). Formerly known as the planning and tracking database, LRM is a depository for all information pertaining to the day-to-day management of the OESF. In LRM, foresters record planned and completed silvicultural activities, including site preparation, planting, thinning, and regeneration harvest; sold products and timber volumes; and other information.

- **GIS layers**. GIS layers are DNR's data in spatial form, and include planned and completed timber sales, forest roads, stream location and type, potentially unstable slopes or landforms, habitat delineation, stands selected for thinning under the northern spotted owl conservation strategy, land ownership, and many other types of information.

- **Research and Monitoring Database**. The research and monitoring database is a depository of all current research projects being carried out in the OESF. The database includes detailed information such as principal investigators and cooperators, location, and a brief summary of the project, plus links to study plans and other documents.

Information flows between these three nodes constantly. For example:

- Foresters completing a timber sale enter all pertinent information for that sale into LRM.
- Information from LRM is used to update GIS layers, and both LRM and GIS layers are used to update the tactical model. The tactical model is used to produce an updated harvest schedule, which is then output into a GIS layer.
- Foresters use the updated GIS layers to plan their next timber sales.
- A research project is entered into the research tracking database and a polygon for that project is created on a GIS layer so foresters know where the project is. Foresters check this layer when planning timber sales.
- Information in LRM on completed timber sales also may be used to monitor compliance with HCP conservation strategies.

Because these systems are closely related, and because both GIS and LRM inform tactical model updates, keeping this information current is important. The success of information management also depends on standardized processes for data collecting and formatting and the flexibility to adapt and change these systems over time. Refer to the OESF Living Library for more information.

Effective Communication

Through effective communication, DNR builds public confidence in the sustainability of DNR's forest management practices and the effectiveness of its conservation strategies, and also engages in a dynamic exchange of ideas both internally and external to DNR. Effective communication is particularly vital to the success of DNR's adaptive management process.

Multiple formal and informal pathways are used to communicate with trust beneficiaries and other stakeholders, tribes, research partners, and the general public. Formal avenues include meetings of the Board of

Natural Resources, public meetings, and the State Environmental Policy Act (SEPA) checklists for timber sales. Less formal opportunities may exist for involvement in research and monitoring projects and for comments on research and monitoring reports and proposed management changes. Communication efforts may include workshops, an annual conference, a newsletter, articles in scholarly journals, magazines, and other publications. In addition, DNR provides information about the OESF in general and on research and monitoring projects on its website (www.dnr.wa.gov).

Effective communication also involves providing educational opportunities in the OESF. These opportunities include internships for undergraduate and graduate students, field trips for K-12 and college students, and lectures and presentations at colleges and universities. The topics covered in these activities range from specific ecological questions to descriptions of environmental monitoring and adaptive management. As funding allows, DNR will continue to support ongoing educational activities and envisions providing additional opportunities such as summer education programs and job shadowing for students in natural resource management field.

Response to Natural Disturbances

In the OESF, DNR protects trust assets from natural disturbances such as fire, wind, insects, and tree disease epidemics by creating and maintaining a forested landscape that is biologically diverse and resilient, as healthier forests are less likely to experience catastrophic losses (DNR 2006). DNR also considers windthrow risk when planning and implementing timber sales.

However, DNR cannot protect state trust lands from all natural disturbances. Small losses due to wind, disease, and other disturbances are natural and expected and accounted for in a general way in DNR's model projections. Such losses can support DNR's ecological objectives, for example by increasing structural diversity and providing large woody debris to stream.

DNR also cannot predict nor account for losses due to catastrophic storms that affect large areas. The historical record shows 14 storms of hurricane-strength winds on the coast in the last 200 years; two storms had winds in excess of 150 miles per hour (Henderson and others 1989,

Mass 2008). Examples of major windstorms that have affected the OESF include the following:

- The Great Olympic Blowdown on January 21, 1921, which felled an estimated 20 percent of the timber along the entire Olympic Peninsula coastline (Mass 2005);
- The Columbus Day Storm on October 12, 1962, in which hurricane-force winds along the coast blew down an estimated 15 million board feet of timber in Washington and Oregon (Mass 2005); and
- The Inauguration Day Storm of January 20, 1993 with winds over 80 miles per hour to the Washington coast and over 100 miles per hour to exposed sites in the coastal mountains and Cascades (Mass 2005).

When in the best interest of the trusts, DNR salvages forest stands that have been materially damaged by fire, wind, insects, or disease (DNR 2006). Currently, for natural disturbance events in northern spotted owl habitat DNR follows salvage guidelines in the 2006 Settlement Agreement[3], which will remain in place until the sustainable harvest calculation for the 2015 through 2024 sustainable harvest planning decade has been approved by the Board of Natural Resources. For salvage in other areas, DNR follows the catastrophic loss policy in the *Policy for Sustainable Forests*, RCW 79.15.210, RCW 79.15.220, and WAC 296-54, which addresses worker safety.

Once the 2006 Settlement Agreement has expired, DNR will follow a new procedure (currently in development) for salvage harvest after natural disturbance events. DNR also is developing new guidelines for salvage in marbled murrelet habitat as part of the marbled murrelet long-term conservation strategy, currently in development. Once the long-term strategy has been completed and approved, DNR will follow the guidance in the long-term strategy for salvage in marbled murrelet habitat.

Adaptation to Climate Change

Climate change is a change in average temperature and weather patterns that occurs on a regional or global scale over decades to centuries. Climate change is closely linked to a global rise in temperature, often referred to as global warming (Ecology 2011).

In Washington, the anticipated impacts of climate change may include warmer temperatures, reduced snowpack, increased frequency of extreme weather events, and a rise in sea level (Ecology 2011, USFWS 2011). These changes could shift the upper elevation range limits of tree species (Halofsky and others 2011); cause larger, more intense fires (Running 2006); and increase tree mortality (vanMantgem and others 2009). For a summary of how climate change could affect the forests of the OESF and the wildlife they support, refer to Chapter 3 of the final environmental impact statement for this forest land plan, which is listed under "documents" in the living library.

Although numerous studies have been completed to date, the exact timing, severity, and local effects of climate change are still uncertain. Given these uncertainties, it is also difficult to predict exactly how and when the forest will respond to changing conditions. What *is* certain, is that change will occur.

DNR will meet these challenges by creating and maintaining a biologically diverse forested land base. DNR also will continue following current policies on forest health and resilience, catastrophic loss prevention, and genetic resources. Information gathered through research and monitoring, particularly information that explores links between management and ecological conditions, may help inform future adaptation strategies. DNR has an adaptive management process in place to consider, select, and implement changes in management.

DNR also participates in climate change research, either through direct involvement or contribution of funding, supplies, and test sites. For example, DNR has been involved in studies examining how climate change may affect Douglas fir.

As a prudent trust lands manager, DNR manages its forests to "conserve and enhance the natural systems and resources of forested state trust lands….to produce long-term, sustainable trust income, and environmental and other benefits for the people of Washington" (DNR 2006, p. 3). DNR is fully committed to this goal, and will continue to examine its policies, procedures, and strategies as needed in the future to make sure the OESF continues to thrive as conditions change.

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[1] DNR uses the term "DNR-managed lands" instead of state trust lands because northern spotted owl habitat in natural resources conservation areas and natural area preserves contributes toward habitat thresholds. DNR is given credit for the habitat contributions provided by these lands in terms of meeting the conservation objectives of the HCP (DNR 1997, p. I.5).

[2] In the tactical model, silvicultural regimes are based on a limited number of silvicultural activities such as thinning and stand replacement harvest; other necessary activities such as planting and vegetation management are assumed to occur. Actual silvicultural regimes are more comprehensive and detailed.

[3] Washington Environmental Council et al. v. Sutherland et al. Settlement Agreement (King County Superior Court No. 04-2-26461-8SEA, dismissed April 7, 2006). This agreement expires, in total, with adoption of a sustainable harvest level for the next decade (fiscal years 2015-2024).