ELLIOTT STATE RESEARCH FOREST

Aquatic and Riparian Area Research Strategy

We cannot implement and study forestry on a landscape scale without addressing the concerns of terrestrial, riparian, and aquatic ecosystems as an integrated system. Riparian forests provide several critical functions, including large wood recruitment, controls on stream temperature, litter input, flow regimes and reducing stream sediment loads that are important for maintaining native aquatic biota in headwater streams. We will use observational and experimental research across the Elliott State Research Forest (ESRF) landscape to explore how different management strategies affect these processes and will inform future forest policy and management practices.

Fundamental aquatic and riparian conservation studies will be set in the context of a research forest that includes studies on terrestrial and aquatic ecosystems. The studies will recognize both as interconnected components of a larger system. Riparian ecosystems potentially encompass a wide range of habitats and conditions across the landscape, including fish bearing and non-fish bearing streams, perennial and intermittent streams, adjacent forests, saturated streamside soils, headwalls, side slopes, ridges, and the biota contained within. Because previous research has primarily sectioned the landscape into seemingly discrete areas such as designated riparian areas along fish-bearing versus non-fish bearing streams, there is a knowledge gap around an integrated whole-ecosystem response to alterations in streamside and key upland forests. How do we sustainably integrate across the forest landscape, including headwalls and intermittent streams, when managing for aquatic biota? By studying a suite of forest management approaches and seeking practices compatible with forest values, we can envision a future where forest management doesn't lead to the degradation of our aquatic and terrestrial ecosystems.

The ESRF will contribute to the recovery of imperiled species by: (1) conducting research that expands our knowledge and understanding of aquatic ecosystems and the ecological processes that influence them in coastal Oregon; (2) conveying findings to land-managers and other interested parties to improve management and conservation of aquatic ecosystems in coastal Oregon and elsewhere; and (3) by restoring key ecological attributes and processes that affect onsite and downstream habitat for Oregon Coast Coho Salmon ESU (OCCS) in streams of the ESRF. The ESRF has a limited potential to directly contribute to the increased production of the ESU because it is dominated by steep streams and narrow valleys, which have a limited potential to provide productive habitat for coho salmon. However, the areas in the lower portions of watersheds that originate on the ESRF, but that are on private lands downstream of the ESRF, have some of the greatest capacity to provide freshwater habitat and production for coho salmon within the range of the OCCS ESU. The ESRF can definitely contribute to the recovery of OCCS by providing wood, sediment, high quality water, nutrients, and food to the lower portions of watersheds that are outside of the ESRF, where the potential for productive habitats is greatest. Thus, the ESRF is the foundation for developing comprehensive recovery and conservation efforts for the three independent coho populations that it supports [C6] (Lower Umpqua, Tenmile, and Coos).

Core Strategies

The Elliott State Research Forest will advance knowledge of riparian areas and aquatic systems through passive management and active restoration experiments. The core framework for studying riparian areas is part of the land-use allocation of watersheds across the forest into Conservation Research Watersheds (CRWs) and Managed Research Watersheds (MRWs). In the approximately 35,000-acre CRW, all actions will aim to research long-term, landscape-level conservation outcomes. In the Management Research Watersheds (MRW), a range of research treatments are applied at a watershed scale, with multiple replicates, to support the investigation of a wide variety of response variables.

Typically, in actively managed forests, designated riparian conservation areas (RCAs) of a given width are delineated and explicitly managed for conservation of aquatic and riparian functions. The ESRF and proposed research design scale creates a unique opportunity to measure the long-term effects of varying levels of integration of RCAs with upland forests on species recovery. Within the reserve treatment areas that are not actively managed, the relevance of designated RCAs is less evident. Currently, approximately 61% of the ESRF is proposed to be placed in reserves, where restoration thinning of approximately 14,000 acres of existing Douglas-fir plantations may occur over the next 10-20 years and where no harvests will occur on roughly 37,000 acres of naturally regenerated older forests. Therefore, in the near term, the aquatic, riparian and upslope ecosystems within the unlogged reserves will be the same fully integrated system that has been in place since the last significant disturbance over 100 years ago, without need for RCAs. Designated RCAs are most applicable in the approximately 18.5% of the landscape under Intensive management, with even-age clearcuts on a 60 year or greater rotation. The older, more diverse designated RCAs will be less integrated with these young upslope homogenous plantations. With their retention of legacies, longer rotations, and canopy complexity, the extensive treatments on 20% of the landscape will be managed to facilitate better integration with the RCAs.

The research design for the forest intends to move beyond forest management alternatives alone and also explore

restoration actions designed to improve the ecological function of RCAs (including forests and associate streams). Further, because we are approaching research in the ESRF from a whole system perspective, the riparian and aquatic research program will encompass the assessment of research outside riparian areas (such as research on road restoration and decommissioning, recreation, harvest on steep slopes, earth movement, and natural disturbances). Upslope activities will include components to preserve their integrity and understand resilience and resistance of RCAs associated aquatic ecosystems.

Key Attributes of a Riparian Conservation Strategy

Land Use Allocation: The large area of forest placed in reserve in the CRW anchors the conservation strategy by establishing a contiguous area managed for long term ecological functions in support of full integration of terrestrial and aquatic ecosystems. Here, research-related actions will be limited to those that are likely to benefit the long-term conservation of native biota (e.g. restoration of forest complexity). In the MRW, research will utilize a framework including reserve forests and forests influenced to a varying degree by timber harvesting. The MRW will be capable of testing the ability to integrate and quantify these strategies' capacity to accommodate a broader suite of values and variables.

Riparian Conservation Areas: The aquatic and riparian conservation component of the system-based research strategy will rely on a set of designated RCAs. These RCAs design will maintain and restore vital ecological processes that influence the aquatic ecosystem in the Intensively managed and Extensively managed treatments. In the Reserves, the designated RCA will only be applicable for a limited time when thinning occurs over the next 10-20 years. Activity within RCAs will be limited to forests where prior management actions have resulted in conditions that require limited intervention to test restoration of ecological processes (such as over-stocked plantations, or the absence of large conifers or hardwoods). The activity may occur throughout the entire width of the RCA with the objective of removing trees that were established following harvesting activities that have occurred since the 1950's. The criteria and characteristics of restoration and experimental treatments in RCAs will always be to maintain and restore the ecological process. The aim of the treatments will not be to produce timber volume. All treatments will occur within an experimental context with monitoring, data collection and analysis, and reporting within an adaptive management framework. Trees that are cut down in the RCA will remain on site and some may be removed depending on the specifics of the particular research study. A detailed study plan will be submitted to the advisory board for the ESRF (the structure and operation of this is not complete at this time) for approval before the study is initiated. There may be some studies, such as those that examine the effects of additional light reaching the stream by reducing canopy density in the riparian area, that may require the felling or girdling of trees over 65 years of age when there are a large number of these trees in the experimental area. In such cases, only trees that predate the 1868 fire may be felled or girdled, and only after the study plan is reviewed and approved by the advisory board.

Non-fish bearing streams: These streams are the most abundant portion of the riverine network of the ERSF, comprising more than 80% of the stream miles on the ESRF. Non-fish bearing streams are critical to maintaining the aquatic ecosystem's productivity by providing cool water, wood, sediment, fish prey, and nutrients to fish-bearing streams. These streams provide habitat for a suite of native amphibians, insects, birds, bats and other organisms, and they function as a corridor for energy and nutrient flux within the watershed. Research on these streams will focus on: (1) Their ecological role and influence on fish-bearing streams; (2) How they may serve as movement corridors within and among watersheds for terrestrial organisms, energy and carbon; (3) How to treat previously managed forest areas adjacent to these streams to change the vegetative composition and structure. By doing so, it will create opportunities to study the influences on riparian soils and use by terrestrial and riparian organisms, the behavior of landslides and the effects on fish-bearing streams, and the production of invertebrates and nutrients that transport to fish-bearing streams.

In recognition of the importance of non-fish bearing streams we are expanding the stream channel network in our analysis to facilitate the identification of headwater areas. Our complete modeled stream network is 2,099 miles, which is approximately 3 times the length of the stream network defined by ODF (702 miles) and by the National Hydrography Dataset (747 miles).

Fish bearing streams: We used the regulatory definition of fish-bearing streams , which encompasses the upper limit of coastal cutthroat trout in stream networks. Cutthroat trout presence generally extends further into the headwaters of stream networks than any other fish species, even higher than non-game fish such as sculpin. We have defined fish bearing streams as those with a gradient of 20% or less, which is based on eDNA data for resident cutthroat trout, and provides a fish-bearing stream network approximately 30% longer than that employed by ODF on the Elliott State Forest.

Steep Slopes: Steep slopes are a key attribute of the ESRF landscape. If you add up the area proposed for the CRW reserve, the reserves in the MRW and the riparian conservation areas (RCA) approximately 61% of the Elliott will be placed in reserves or highly protected status. Many of these reserve areas will provide additional protection to steep slopes since, aside from some initial restoration thinning in the plantations being converted to reserves, there will be no harvesting or sustained soil disturbance. The riparian strategy is focused on increasing protections to sites with steep slopes which contain streams

most likely to deliver wood to fish bearing streams. In the approximately 17% of the land base in extensive harvests, there will be longer intervals between regeneration harvests and high levels of retention from 20-80% during harvest entries thereby reducing logging-based disturbance on steep slopes. In the remaining 18% of the land in intensive regeneration harvests we will follow the OFPA rules related to steep slopes that include reports on risk level. The Tyee formation has special limits for harvest operations on steep slopes. Side slopes greater than 75% and head walls greater than 65% require special consideration related to ground disturbance during timber harvests. The combination of large-scale reserves, RCAs and extensive harvests will provide significant resource protection on approximately 81% of the Elliott.

As integrators of local and watershed-scale processes, streams in the ESRF are ideal locations to research how steep slopes, directly and indirectly, affect ecological processes in aquatic ecosystems. There are opportunities to better understand the integration of steep slopes and the streams confined by them and how this relationship changes with time and space. Do key processes leading to the production and delivery of large trees and sediment/nutrient pulses to the aquatic systems occur more quickly in steep landscapes? And if so, what implications does this have for the retention of carbon, nutrients and biota in headwater ecosystems? We are particularly interested in quantifying the role of large wood in sorting sediments and creating functional habitat in steep landscapes. This process is generally understood but lacks long-term empirical data. Studies will seek to provide knowledge of short and long-term impacts of headwater stream retention and headwater stream failure (landslides). While conducting this research, we will monitor the landscape using the High Landslide Hazard Location database produced by the State of Oregon, followed by more site-specific examinations to address the hazards brought by specific operations.

Our riparian protection strategy is integrated with shallow translational landslide probabilities in non-channel areas and is conceptually based on identifying and prioritizing for protection those slopes and stream channels most likely to initiate and sustain a debris torrent that delivers large wood to fish-bearing streams. Potential debris torrent initiation sites and debris torrent channels are a component of the evaluation of large wood recruitment potential that we are employing in our riparian strategy. As a key part of our debris torrent and wood recruitment modeling methodology, delineated stream channels are extended far upslope and into headwall areas that are not identified as stream channels in existing stream inventories, which is approximately three times the length of the channel network identified by the Oregon Department of Forestry and in the National Hydrographic Dataset (NHD). This network includes areas that may be susceptible to debris flow initiation and, to the extent possible with the available data and research methodologies, identifies these areas as potential sources of large wood to fish-bearing streams. Additionally, our modeling identifies areas on slopes not identified as stream channels that have a high probability of initiating shallow translational landslides that evolve into a debris flows that deliver large wood to fish-bearing streams. Riparian buffers will extend to these high-probability areas.

Roads: We commit to reducing the current road network density and their related adverse impacts on the ESRF, and in particular in the Conservation Research Watersheds, while maintaining and balancing for necessary access for research, harvesting, management, education, fire protection, and recreation. Roads are imposed on the landscape to maintain access to remote sites for several uses, including recreation, firefighting and removing wood products. Roads also represent a significant human impact on the larger forest system in terms of chronic long-term disturbance, fragmentation, sediment yield, and access for invasive species. Regardless of the use, gaining access via roads disrupt ecosystem processes essential for the proper functioning of aquatic and riparian ecosystems. This disruption is especially evident where there are hydrologic connections between the road and aquatic networks such as sediment-laden runoff and rapid peak flows. Given the density of roads and streams on the ESRF and the presence of listed species, ways to mitigate impacts of strong hydrologic connections are areas of potential significance and wide application in the Northwest.

While still early in development, the OSU proposal for an ESRF envisions studies on the degree of hydrologic connections of current and legacy roads and their primary locations on the ESRF. Monitoring will identify candidate roads for modification with the goal of testing methods for reducing hydrologic connections through road restoration, and long-term monitoring of subsequent impacts on habitat. In support of this, the ESRF will maintain an inventory of the road network to identify current and legacy roads that present a risk to the aquatic and riparian system and seek to implement modifications to the road system prioritizing segments that pose the highest risk to aquatic resources.

We will examine the possibility and effectiveness of partial road decommissioning in the context of providing access for firefighting and recreation consistent with reserve goals and State Land Board guidance. The road network in the CRW and MRW reserve watersheds will likely decline over time, and new, permanent roads may be constructed as part of a strategy to decommission road segments that are a problem. Still, we must implement such a strategy in the context of the forest research plan.

OSU is committed to working with the local watershed councils to restore and improve the ecological condition of streams on the ESRF. OSU will ensure that the work of these groups continues by: (1) supporting their efforts to secure funds from OWEB and other sources; (2) attempting to integrate restoration efforts into the research design; and (3) providing data for and input into the restoration work of the various watershed groups. The councils should be able to use the establishment of the ESRF as the foundation for developing a comprehensive watershed recovery program for each of the independent populations that occur on the ESRF. The councils will be briefed on research activities and findings on regular basis once the ESRF is established.

ATTACHMENT C

Attachment C describes the steps we are taking to conduct a landscape analysis to allocate and integrate the riparian areas with adjacent research treatments and for determining RCA width requirements in intensive and extensive research treatments.

Integrating riparian areas with adjacent research treatments

The process for determining where wood delivery will occur and prioritization for RCA width requirements in Extensive and Intensive research treatments.

We propose to use modeled potential large wood recruitment to fish-bearing streams as a criterion for the development and evaluation of stream buffer strategies incorporated into the research designs of MRWs. The aquatic and riparian research strategy envisioned for the ESRF relies on wood recruitment for its specific value as habitat for imperiled species and as a proxy for the attainment of other ecological functions. Typically, most large wood recruited to fish-bearing streams comes from channel-adjacent sources through processes such as chronic and episodic tree mortality, bank erosion, and landslides. These same processes recruit large wood to non-fish-bearing channels. In steep and constrained non-fish-bearing (NFB) channels, episodic debris flows can deliver substantial quantities of accumulated large wood to fish-bearing streams. However, not every NFB tributary has the same potential to deliver wood. Therefore, we want to integrate our treatment of the riparian system with the upslope forests' treatments to ensure water quality and fish habitat as follows.

1. Establish the wood recruitment goal for the MRWs in the ESRF. The CRWs will have a goal of 100% of potential wood recruitment to fish bearing streams since the system is being managed as a reserve.

2. Delineate and classify NFB streams on the ESRF as to their potential for wood recruitment to fish bearing streams. Identify tributaries and headwalls with high potential for wood recruitment and other conservation components.

3. Calculate site potential tree height and riparian buffer needed to ensure wood delivery to the stream.

4. Overlay potential Reserves, Intensive and Extensive treatments, and adjust to better integrate Reserves and Extensive with NFB streams with high potential for wood recruitment. Reserves, Extensive treatments, and RCA's will have the largest trees on the landscape, so they will best emulate historical conditions.

5. Calculate wood recruitment potential and compare against goal. Repeat as needed.

6. Create riparian systems in which different combinations of stream buffers on fish-bearing and non-fish-bearing systems achieve a stated goal for wood recruitment into FB streams.

7. Use riparian systems to test the effectiveness of buffer combinations relative to tradeoffs with other social and ecological attributes, such as habitat, accessibility, and fiber yield. Design several different wood recruitment strategies that meet the goal and develop an experiment to test effectiveness and tradeoffs with other values (see example Figure 12).

Figure 10. Example of the first step in integrating treatments along the West Fork of the Millicoma River

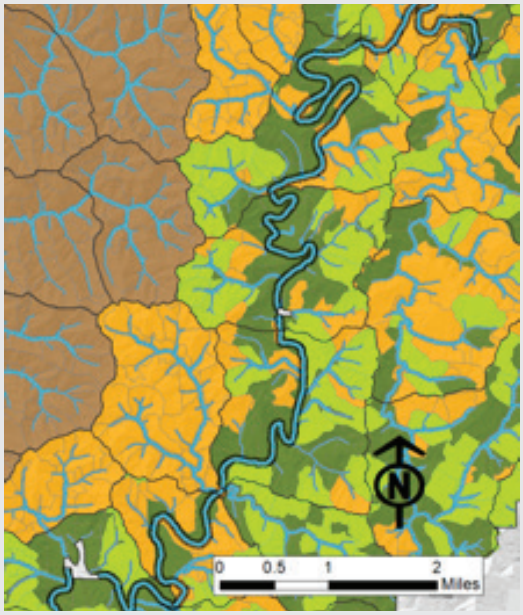

Figure 10. *Example of the first step in integrating riparian and upslope treatments along the West Fork of the Millicoma River on the ESRF. The goal is to ensure the presence of large trees where wood recruitment is most likely to occur from riverside to headwall. The current percentage of each riverside riparian treatment is listed in table 2.*

Table 2. Percent of river miles along the West Fork of the Millicoma River

Treatment	Percent bordering river	Proposed riparian conservation area width (ft)
Extensive	26%	200
Intensive	6%	200
Reserve	68%	NA

Table 2. *Percent of river miles along the West Fork of the Millicoma River that are bordered by the proposed experimental treatments in Figure 10.*

Figure 11. Proposed Stand level allocation of extensive, instensive and reserve treatments

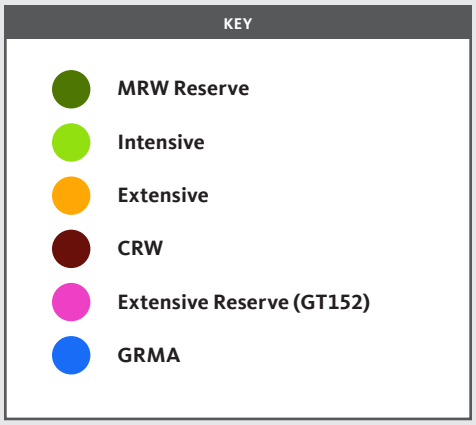

Figure 11. Map showing proposed stand level allocation of intensive, extensive, extensive reserve and GRMA (Generic Riparian Management Areas). GRMA's were estimated by fixed buffers of 100ft and 50ft on fish bearing and high debris torrent non fish bearing streams respectively that flow through areas where timber harvests will occur.

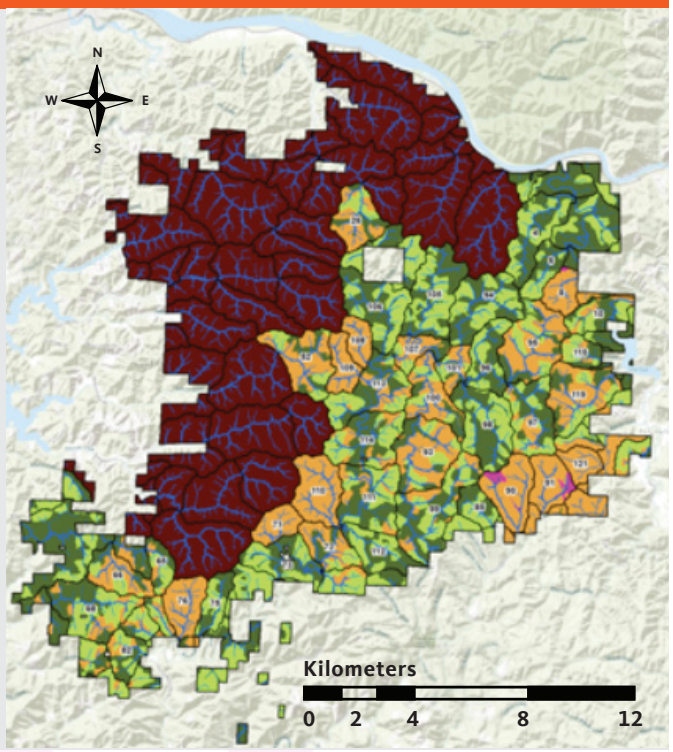

Figure 12. Three example buffer configurations with ~70% wood yield on the Elliott State Forest

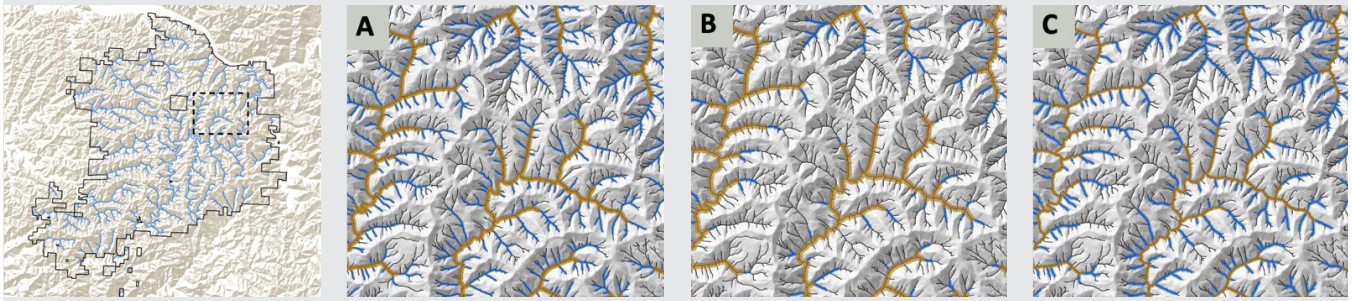

Table 3. Three example riparian buffer width scenarios attaining ~70% wood recruitment

Alternative	Fish-bearing			Non-fish-bearing			Total Modeled Stream Miles	Total ODF Stream Miles	Total NHD Stream Miles	Protected Potential Recruitment	Total NHD Stream Miles
	Buffer Width (feet)	Buffered Miles	Total FB Stream Miles	Buffer Width (feet)	Buffered Miles	Total NFB Stream Miles					
A	100	237	237	50	721	1,862	2,099	702	747	70%	16.5%
B	120	237	237	60	151	1,862	2,099	702	747	70%	10.8%
C	80	237	237	70	706	1,862	2,099	702	747	70%	14.8%

ATTACHMENT D

Attachment D is intended to provide initial riparian area treatments and details on stream buffers in the CRW, MRW, and the West Fork of the Millicoma River.

Aquatic and riparian treatments are structured to test the effectiveness and tradeoffs of providing critical ecological processes, such as wood recruitment, cold water, litter fall, and sediment, all of which are important to Coho salmon. Because past management has reduced the supply of wood in streams in the Elliott and other Coast Range forests, particularly of large wood, ensuring high levels of wood recruitment necessitates riparian buffers wide enough to encompass many other riparian functions.

Monitoring and data analysis will test large wood's ability to be a proxy for other ecological functions while ensuring riparian functions are protected to achieve the desired level of effectiveness needed to meet the ecological, social, and regulatory requirements for the RCAs. The research plan objective is to attain nearly 100% of potential wood recruitment in the CRW and reserve watersheds located in the MRW, and a minimum of 70% in the portions of the MRW that are not in reserves.

Research protocols call for RCAs to vary in size and configuration according to stream type and upslope research treatment. Stream types reflect the presence of fish, timing of flow (perennial versus seasonal), and susceptibility to landslide-associated debris flows that deliver wood to fish-bearing streams. Measure RCAs as the slope distance from the outer edge of the channel migration zone and reference to a site potential tree height of 200 feet, per local BLM data. The ESRF research design, in which the RCAs play a critical role, allows for varying, site-specific implementation, with a minimum set of standard prescriptions applied as set forth below.

STREAM TYPES:

1. Fish-bearing: Streams connected and accessible to reaches with a gradient of 20% or less.

2. Perennial non-fish bearing: Streams modeled as providing year-round flow but not having game fish.

3. Key Debris Flow Torrent intermittent streams: Streams with a high potential to deliver wood to fish-bearing streams. These streams are typically steep, with few gradient breaks and with approximately 90-degree angle of entry into fish-bearing streams.

4. Other: Streams primarily intermittent streams with low potential for wood delivery to fish-bearing streams.

RCA BUFFERS IN THE CRW AREA AND AREAS DESIGNATED AS RESERVES IN THE MRW:

The Reserve treatments include existing Douglas-fir plantations, in recognition of the need for a focused effort to recruit future old stands and unlogged naturally regenerated older forests. Therefore, Reserves will have two starting points: a) Exploring treatments to restore and enhance conservation value in established plantations transitioning to older, more complex forests; b) Conserving unmanaged mature forests as they move through natural successional processes. Since there is no harvesting in "b", there is no need for designated RCAs. Designated RCAs are only applicable when thinning adjacent to reserve stands to restore dense Douglas-fir plantations. Once these thinning treatments are complete, there will be no more harvesting in the Reserves, thus the designated RA will integrate with the surrounding forest over time. However, during thinning, RCAs at these locations will be 200 feet slope distance on fish-bearing and non-fish-bearing perennial streams, and key debris flow torrents. Thinning to reduce the density of existing plantation stands within RCAs buffers that are less than 65 years of age may be undertaken if determined necessary to support and enhance long-term ecological functions of the RCAs. Thinning would primarily be conducted to promote the more rapid development of large trees that can potentially be recruited to the stream or the establishment of hardwoods to provide higher quality litter resources to the stream, increase habitat diversity and stream productivity. No removal of residual trees (>65-year-old trees as of 2020) will occur from the RCA or upslope areas during thinning operations.

RCA BUFFERS IN THE MRW:

The following are standard prescriptions that apply to RCAs adjacent to Intensive and Extensive treatments. No intensive stand replacement management will be conducted within RCAs. Thinning to reduce the density of less than 65-year existing plantation stands within RCA buffers may occur, but only in the context of a study aimed to understand how management can enhance long-term ecological functions of the RCA.

- Fish-bearing: 120 - 200 feet
- Perennial Non-Fish: 50 - 200 feet
- Key Debris Flow Torrent: 50 – 200 feet for high potential

The specific size and configuration of the different RCA components will depend on the level of desired wood delivery potential.

WEST FORK MILLICOMA RIVER PROPOSED RCAS:

The designated RCAs for the West Fork Millicoma River from its entry into the ESRF in the southwest portion of the forest through the confluence with Elk Creek will be established and maintained as follows:

- The RCA will be a distance equal to the site potential tree height, (200 feet measured as the horizontal distance from each side of the channel migration zone) on either side of the river and 200 feet measured as horizontal distance along any non-fish bearing stream that has a high potential to deliver wood to the adjacent fish-bearing stream.

- Note that under the current research plan, the river's main channel will be bordered by 68% Reserves, 26% Extensive and 6% Intensive treatments. Since 68% of the river is bordered by Reserves that will not experience timber harvests, the area protected greatly exceeds the 200' designated RA (Table 2.).

- To further minimize the potential for adverse impacts to this ecologically and recreationally valuable region, the approximately 30% of the West Fork Millicoma watershed in Reserves and 30% of the area in Extensive can be integrated with the non-fish bearing streams identified as high potential for debris flow torrents that deliver wood to fish-bearing streams. Doing so would ensure the wood delivered during a debris flow will be large diameter.

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