2023-2025 BIENNIUM CMER WORK PLAN

Prepared by:
COOPERATIVE MONITORING, EVALUATION AND RESEARCH COMMITTEE
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EXECUTIVE SUMMARY

The 2023-2025 Biennium Cooperative Monitoring, Evaluation and Research Committee (CMER) Work Plan and associated budget have been approved by the Forest Practices Board (Board) based on recommendations from the Timber, Fish and Wildlife Policy Committee (Policy) and CMER. The CMER Work Plan presents an integrated strategy for conducting research and monitoring to provide scientific information to support the Forest Practices Adaptive Management Program (AMP). The overarching purpose of the Work Plan is to inform CMER participants, Policy constituents, the Board and interested members of the public about CMER research and monitoring activities. Revisions are completed biennially to update the research findings of CMER and the changes in policy priorities and funding.

One hundred and seventeen (117) projects are included in the Work Plan. Since the AMP began in 2001, 56 projects have been completed, 16 projects are ongoing, and 41 projects under consideration. The projects cover a range of topics related to the forest practices rules and are at various stages of development or completion. Projects originated as priority research topics in Schedule L-1 of the Forests and Fish Report (April 1999), which was later revised and adopted by the Board in February 2001 and incorporated into the Washington Forest Practices Habitat Conservation Plan (FP HCP).

The Work Plan is organized hierarchically into rule groups, programs, and projects. Section 2.0 describes the CMER research and monitoring strategy, and the approaches used to address critical questions relevant to the AMP. Section 3.0 describes CMER and Policy procedures for prioritization at the program and project level, and Section 4.0 presents the Board approved 2023-2025 biennium projects and budget allocations. Proposed budget allocations for 2023-2025 projects and activities can be found in Table 4. Section 5.0 describes the CMER research and monitoring program, with program and project descriptions organized by rule group. Appendix A contains a table titled “CMER Projects, Objectives, and Targets,” which links specific resource objectives and key riparian functions (e.g., in-stream temperature, large woody debris, litter, sediment) to CMER projects, organized by programs within rule groups.

For the 2023-2025 biennium, there are 2 projects in the Stream Typing Rule Group, 6 projects in the Type N Riparian Prescriptions Rule Group, 3 in the Type F Prescriptions Rule Group, 2 in the Unstable Slopes Rule Group, 1 in the Roads Rule Group, and 2 in the Wetlands Protection Rule Group. Of the 16 active projects, 13 are ongoing and 3 are being scoped. Specific project descriptions can be found on the pages listed below; however, reading the entire subsection describing a rule group is recommended to both better understand the programs and projects in that rule group and comprehend how they are integrated to answer critical research and monitoring questions.

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ACRONYMS AND ABBREVIATIONS

AMP	Adaptive Management Program
AMPA	Adaptive Management Program Administrator
BACI	Before After / Control Impact study
bapa	basal area per acre
BCIF	Westside Type N Buffer Characteristics, Integrity, and Function Project
BMP	Best Management Practice
Board	Forest Practices Board
BTO	Bull Trout Habitat Overlay
BTSAG	Bull Trout Scientific Advisory Group
CMER	Cooperative Monitoring, Evaluation and Research Committee
CMZ	Channel Migration Zone
CWA	Clean Water Act
DEM	Digital Elevation Model
DFC	Desired Future Condition (riparian)
DNR	Department of Natural Resources
Ecology	Washington State Department of Ecology (also WDOE)
eDNA	environmental DNA
EIS	Environmental Impact Statement
ELZ	Equipment Limitation Zone
EMEP	Eastside Modeling Evaluation Project
ENREP	Eastside Type N Riparian Evaluation Project
EPA	Environmental Protection Agency
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
ESA	Endangered Species Act – Federal law
ESICCS	Eastside Type F Channel Wood Characterization Study
ETHEP	Eastside Timber Habitat Evaluation Project
EWRAP	Eastern Washington Riparian Assessment Project
FEMAT	Forest Ecosystem Management Assessment Team
FFR	Forests & Fish Report
FHS	Eastside Type N Forest Hydrology Project
FPA	Forest Practices Application
FPARS	Forest Practices Application Review System (FPARS)
FP HCP	Forest Practices Habitat Conservation Plan
GIS	Geographic Information System
HCP	Habitat Conservation Plan
hgm	hydrogeomorphic
HPA	Hydraulics Permit Approval – WDFW Permits
ISAG	In-Stream Scientific Advisory Group
ISPR	Independent Scientific Peer Review
IWT	Initial Writing Team
LCBAPA	Mean live conifer basal area per acre
LHZ	Landslide Hazard Zone
LWAG	Landscape and Wildlife Scientific Advisory Group
LWD	Large Woody Debris – logs in streams-sometimes called LOD (Large Organic Debris)
MDT	Monitoring Design Team

NCASI	National Council for Air and Stream Improvement (timber industry research group)
NWIFC	Northwest Indian Fisheries Commission
OSU	Oregon State University
PIP	Perennial Initiation Point (Survey)
Policy	Timber, Fish and Wildlife Policy Committee
QA/QC	Quality Assurance / Quality Control
RCW	Revised Code of Washington – Statute, Laws
RFQQ	Request for Qualifications and Quotations
RIL	Rule-Identified Landforms
RLIP	Regional Unstable Landforms Identification Project
RMAP(s)	Road Maintenance and Abandonment Plans
RMZ	Riparian Management Zone
RSAG	Riparian Scientific Advisory Group
SAA	Stream-Associated Amphibians
SAG	Scientific Advisory Group, a sub-group of CMER
SAGE	Scientific Advisory Group- Eastside
SEPA	State Environmental Policy Act
TFW PC	Timber/Fish/Wildlife Policy Committee
TFW	Timber, Fish and Wildlife
THT	Timber Habitat Types
tpa	trees per acre
TWIG	Technical Writing Implementation Group
UMA	Upland Management Area
UPSAG	Upslope Scientific Advisory Group
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code – Rule
WARSEM	Washington State Road Surface Erosion Model
WAU	Watershed Administrative Unit
WDFW	Washington Department of Fish and Wildlife
WetSAG	Wetlands Scientific Advisory Group
WMZ	Wetland Management Zone

1.0 INTRODUCTION

The Washington State Forest Practices Board (Board) adopted an adaptive management program (Washington State Forest Practices Rules, WAC 222-12-045) in concurrence with the 1999 Forests and Fish Report (FFR) legislation (RCW 76.09.370). This legislation, guided primarily by the Washington Forests and Fish Report, formed the basis for the federally approved Washington Forest Practices Habitat Conservation Plan (FP HCP) in 2006. The purpose of the Forest Practices Adaptive Management Program (AMP) is to:

> "provide science-based recommendations and technical information to assist the Board in determining if and when it is necessary or advisable to adjust rules and guidance for aquatic resources to achieve resource goals and objectives."

To provide the science needed to support adaptive management, the Board established the Cooperative Monitoring, Evaluation and Research Committee (CMER). The Board appoints core CMER members and empowers CMER to implement research per guidelines established by the FFR and implemented under the FP HCP.

Currently, CMER is supported by six active scientific advisory groups (SAGs). One former SAG (the Bull Trout Scientific Advisory Group, or BTSAG) has been merged with another SAG (the Riparian Scientific Advisory Group [RSAG]). The SAGs consist of both core voting CMER members and additional scientific participants representing the various stakeholders of the forest practices rules. The purpose of the SAGs is to design and implement the research and monitoring prioritized by CMER. Each SAG focuses on specific aspects of the forest practices rules, according to their areas of scientific expertise. Table 1 provides a brief description of the SAGs.

Table 1. CMER Scientific Advisory Group Structure

Active Scientific Advisory Group	**Acronym**	**Develops and Oversees Projects Related To:**
In-Stream Scientific Advisory Group	ISAG	In-stream issues, including stream typing and fish passage.
Landscape-Wildlife Advisory Group	LWAG	Wildlife, including stream-associated amphibians
Riparian Scientific Advisory Group	RSAG	FP HCP riparian strategy
Scientific Advisory Group – Eastside	SAGE	Issues specific to eastside of the Cascade Mountains
Upland Processes Scientific Advisory Group	UPSAG	Roads, mass wasting, and channel processes
Wetlands Scientific Advisory Group	WetSAG	Wetland issues, including identification and protection
Inactive Scientific Advisory Group	**Acronym**	**Develops and Oversees Projects Related To:**
Bull Trout Scientific Advisory Group	BTSAG	Bull trout biology and the forest practices rules designed to maintain bull trout habitat. In 2008, this SAG was merged with RSAG.

In 2012, the Forest Practices Board directed CMER to conduct a pilot process to test if the application of a Lean approach would result in increasing the efficiency and reducing the time of

developing the scoping and study design phases of CMER projects. The pilot process replaced the role of the SAGs in study design with smaller Initial Writing Teams (IWTs) and Technical Writing and Implementation Groups (TWIGs). The premise was that smaller groups of scientists and technical experts along with fewer review steps would be more efficient in developing research study designs. The pilot program included five projects. By late 2018, four of the five projects had approved study designs); the Eastside Type N Riparian Effectiveness Project, the Roads Prescription-Scale Effectiveness Monitoring Project, Westside Type F Riparian Prescription Monitoring Project, and the Forested Wetlands Effectiveness Project. The study design of the remaining project (Unstable Slopes Criteria) is currently in process. Following completion of scoping and study design, project implementation will transition back into CMER's process outlined in the PSM. The revised PSM incorporates many parts of the Lean process.

The goal of the CMER Work Plan is to present an integrated strategy for conducting research and monitoring that will provide credible scientific information to support the Forest Practices Adaptive Management Program. The purpose of the Work Plan is to inform CMER participants, TFW Policy Committee (Policy) constituents, the Board, and interested public about CMER activities. The plan is now revised each biennium in response to research findings of CMER or the scientific community, changing technology, changes in policy objectives, and funding. This version supersedes the Biennial 2021-2023 CMER Work Plan.

The remainder of the document describes the CMER research and monitoring program as well as CMER recommendations for the Work Plan. Section 2.0 describes the organization of the CMER research and monitoring strategy, and the approaches used to address research and monitoring questions relevant to Forest Practices Adaptive Management. Section 3.0 describes CMER procedures for prioritizing programs (topic areas) and projects. Section 4.0 presents the Board-approved CMER Work Plan, including project prioritization, scheduling, and budget allocations. Section 5.0 describes the CMER research and monitoring program, with program and project descriptions organized by rule group. Appendix A contains the table titled "CMER Projects, Objectives, and Targets," which links specific resource objectives and key riparian functions (e.g., in-stream temperature, large woody debris, litter, sediment) to CMER projects, organized by programs within rule groups.

2.0 CMER RESEARCH AND MONITORING STRATEGY

The CMER Work Plan consists of 117 projects (including multiple phases of a given project) covering a range of topics related to the forest practices rules. These projects are at various stages of development or completion. Since the AMP began in 2001, 56 projects have been completed, 16 projects are ongoing, and 41 under consideration. The Work Plan is organized hierarchically into rule groups, programs, and projects, as described below.

2.1 FOREST PRACTICES RULE GROUPS

At the highest level, the CMER Work Plan is organized by forest practices "rule groups." A rule group is a set of forest practices rules relating either to a particular resource, such as wetlands or fish-bearing streams, or to a particular type of forest practice, such as road construction and maintenance. The ten rule groups are shown in Table 2. Although the rule group divisions are somewhat arbitrary, they provide a useful framework for developing a research and monitoring strategy.

Table 2. Description of the Rule Groups Used as a Framework for the CMER Work Plan

Rule Group	Description	Rule Context
Stream Typing	Prescriptions for identifying fish-bearing and non-fish-bearing streams	WAC 222-16
Type N Riparian Prescriptions	Prescriptions for identifying non-fish-bearing streams and management of adjacent riparian areas	WAC 222-30
Type F Riparian Prescriptions	Prescriptions for managing fish-bearing streams and adjacent riparian areas	WAC 222-30
Channel Migration Zone	Prescriptions for delineating channel migration zones	WAC 222-30
Unstable Slopes	Prescriptions for identifying and managing areas potentially susceptible to mass wasting/erosion processes	WAC 222-24, -30
Roads	Prescriptions for identifying and managing erosion and runoff from forest roads	WAC 222-24
Fish Passage	Prescriptions for identifying and preventing fish passage barriers	WAC 222-24
Pesticides	Prescriptions for application of forest chemicals	WAC 222-38
Wetlands Protection	Prescriptions for identifying and managing wetlands	WAC 222-30
Wildlife	Prescriptions for protecting wildlife	WAC 222-10, -30

2.2 RESEARCH AND MONITORING PROGRAMS

Critical research and monitoring questions are identified at the rule group level to address information gaps related to scientific uncertainty and resource risk associated with the rules. Once these research and monitoring questions are identified, programs are developed to address them. Programs consist of one or more related projects designed to strategically address a set of

related scientific questions. The CMER Work Plan lists 34 programs containing multiple projects at various stages of development.

CMER research and monitoring programs utilize a variety of approaches to address critical questions at different spatial and temporal scales. The Work Plan incorporates an integrated research and monitoring approach as recommended by the Monitoring Design Team (MDT) Report (MDT 2002). This includes **effectiveness monitoring** to evaluate prescription effectiveness at the site or landscape scale; **extensive status and trends monitoring** to evaluate status and trends of resource condition indicators across FP HCP lands; and **intensive/validation monitoring** to identify causal relationships and document cumulative effects at the watershed scale. CMER also conducts **rule implementation tool projects** to develop, refine, or validate science-based management tools necessary for implementing the rule(s) (e.g., predictive models, protocols, etc.) or for establishing performance standards. These four approaches are summarized below:

Effectiveness Monitoring:
Effectiveness monitoring programs are designed to evaluate the performance of the prescriptions in achieving resource goals and objectives. Effectiveness monitoring differs from the other approaches in that it is directed at prescription effectiveness, primarily at the site scale.

Extensive Status and Trends Monitoring:
Extensive monitoring programs evaluate the current status of key watershed resources and habitat condition indicators across FP HCP lands, and document trends in these indicators over time as the forest practices prescriptions are applied across the landscape. Extensive monitoring provides a statewide, landscape-scale assessment of the effectiveness of forest practices rules to attain specific performance targets on FP HCP lands. Extensive monitoring is designed to provide report-card-type measures of rule effectiveness (i.e., to what extent are FP HCP performance targets and resource condition objectives being achieved on a landscape scale over time). These measures can then be used to determine the degree to which progress is meeting expectations.

Intensive Monitoring (Cumulative Effects) and Validation Monitoring:
Intensive monitoring is designed to evaluate cumulative effects of multiple forest practices at the watershed scale. Analysis of these effects improves our understanding of the causal relationships and effects of forest practices rules on aquatic resources. Intensive monitoring integrates the effects of multiple management actions over space and through time within the watershed. Evaluation of monitoring data requires an understanding of the effects of individual actions on a site, and the interaction of those responses through the system. Evaluating biological responses is similarly complicated, requiring an understanding of (1) how various management actions and site conditions interact to affect habitat conditions, and (2) how aquatic resources respond to these habitat changes. Taken together, these evaluations will address the adaptive management program's objectives for validation monitoring. This sophisticated level of understanding of physical and biological systems can be achieved with an intensive, integrated monitoring effort.

Rule Implementation Tool Development:
Rule implementation tool projects are designed to develop, refine or validate tools used to implement the forest practices rules.

1. Methodology Tool Development Projects develop, test, or refine protocols, models, and guidance that are designed to identify and locate management features specified in the forest practices rules, such as the Last Fish/Habitat Model, landslide screens, Np/Ns breaks and sensitive sites, or the achievement of specified stand conditions (e.g., the desired future condition [DFC] basal area target).
2. Target Verification Projects consist of studies designed to verify assumptions and targets developed during FFR negotiations that authors identified as having a weak scientific foundation (such as the DFC basal area targets for Type F streams), or that have been established in the Methodology Tool Development Projects.

Rule implementation tools differ from tools needed to implement a specific monitoring program or project. For example, the Road Surface Erosion Model is a tool necessary to implement several projects in the Roads Rule Group Effectiveness Monitoring Program. Monitoring implementation tools are typically included with the effectiveness monitoring programs.

3.0 PRIORITIZATION OF CMER PROJECTS

3.1 CMER PRIORITIZATION PROCESS

CMER's long-term goal is to address the full range of critical questions identified in the CMER Work Plan, while recognizing that availability of funding, time, and human resources will limit the number of projects that can be developed and implemented each year. In order to focus effort and resources on the most critical issues for Forest Practices Adaptive Management, CMER prioritizes proposals for research and monitoring at both the program and project levels. Establishing priorities allows CMER to pursue the most pressing issues in an orderly manner.

The first step in CMER's prioritization process was to rank the relative importance of proposed programs in meeting FP HCP goals and objectives. CMER projects have since gone through several rankings in response to budget priorities and changes in workload allocation. The program prioritization strategy was to:

1. Rank effectiveness/validation monitoring and extensive status and trend monitoring programs on the basis of scientific uncertainty and risk to aquatic resources.
2. Evaluate the importance of rule implementation tool programs by consulting with DNR and then establish priorities on a project basis.
3. Defer integration of the intensive monitoring program into the CMER Work Plan until further scoping and coordination with other efforts occurs.

CMER members attending the December 19, 2002 CMER meeting provided an initial ranking of programs for effectiveness monitoring and extensive status and trend monitoring. The group evaluated each program by asking two questions:

1. How certain are we of the science and/or assumptions underlying the rule?
2. How much risk is there to aquatic resources if the science or assumptions underlying the rule are incorrect?

These questions were selected as the criteria to rank programs, because the need for scientific information to inform adaptive management is most critical when there is a high level of scientific uncertainty concerning the interaction between forest practices, watershed processes, and aquatic resources; and where the sensitivity of the processes and aquatic resources to potential disturbance creates the greatest risk of resource impacts.

Uncertainty is a measure of confidence in the science underlying a rule, including the causal relationships providing the conceptual foundation for the prescriptions and assumptions about prescription effectiveness and resource response when the prescription is applied on the ground. High uncertainty indicates that little is known about the underlying science and the rule is likely based on assumptions that have not been validated. It may also indicate that the prescription is untested and performance under field conditions is unknown. Low uncertainty indicates that the science underlying the rule is well known and accepted or that the prescription (or similar treatment) has been evaluated under similar conditions. Risk is a

measure of the potential for detrimental impacts to aquatic resources, including fish, stream-associated amphibians, and water quality. High risk indicates the activity covered by the prescription has a greater potential to affect aquatic resources due to its magnitude, frequency, or direct linkage to the resource. Low risk indicates the rule has less potential to affect resources.

CMER averaged individual scores to obtain mean risk and uncertainty scores for each program. These were multiplied to get a combined score that was used to rank the programs (Table 3). Policy accepted the rankings and instructed CMER to use them to prioritize projects on effectiveness/validation and extensive status and trend monitoring.

Table 3. Rankings for Effectiveness Monitoring and Extensive Status and Trends Monitoring Programs (completed December 19, 2002).

Program Title	Overall Ranking	Uncertainty		Risk	
		Mean	Rank	Mean	Rank
Effectiveness/Validation Programs					
Type N Buffer Characteristics, Integrity Function	1	4.4	1	3.9	1
Eastside Type F Desired Future Range and Target	2	4.2	2	3.8	2
Type N Amphibian Response	3	4.2	2	3.7	3
Road Sub-Basin-Scale Effectiveness Monitoring	4	3.4	5	3.4	4
Type F Statewide Prescription Monitoring	5	3.2	7	3.1	6
Mass Wasting Effectiveness Monitoring	6	3.2	6	2.9	8
Eastside (BTO) Temperature	7	3.0	9	3.2	5
Wetlands Revegetation Effectiveness	8	3.5	4	2.7	11
Road Prescription-Scale Effectiveness Monitoring	9	2.6	14	3.1	6
Hardwood Conversion	10	3.0	8	2.6	12
Wetlands Mitigation	11	2.8	11	2.7	10
Fish Passage Effectiveness Monitoring	12	2.6	14	2.9	9
Wildlife Program	13	2.9	10	2.4	14
Wetland Management Zone Effectiveness Monitoring	14	2.8	12	2.5	13
CMZ Effectiveness Monitoring	15	2.7	13	2.1	15
Forest Chemicals	16	2.0	16	2.1	16
Extensive Status and Trends Monitoring Programs					
Extensive Riparian Monitoring	1	3.5	2	3.5	1
Extensive Mass Wasting Monitoring	2	3.7	1	2.9	3
Extensive Fish Passage Monitoring	3	3.1	3	3.1	2

CMER used program rankings shown in Table 3, as well as information from DNR consultations on the relative importance of rule implementation tool programs, to provide guidance to the SAGs on where to focus time and energy in scoping and developing programs and projects. Since 2002, when Table 3 was developed, some program titles within the Work Plan have been changed to clarify research strategies within the rule group and program structure. However, the basic prioritization has not changed.

The second stage of prioritization occurs at the project level in order for CMER to make recommendations to Policy concerning scheduling and allocation of funding among the projects developed by the SAGs. Projects are prioritized based on (1) the extent to which they are deemed essential to inform the Forest Practices Adaptive Management Program, (2) input from DNR on their importance in improving implementation of forest practices rules, (3) status of projects relative to Policy decisions on adaptive management, and (4) the need to follow through and complete work already underway. CMER and the Adaptive Management Program Administrator (AMPA) develop each fiscal year's proposed projects based on those criteria.

3.2 POLICY PRIORITIZATION

Policy is responsible for reviewing and approving each CMER Work Plan before submitting it to the Board for approval. Policy is also responsible for providing guidance to CMER on project prioritization, consistent with directions outlined in WAC 222-12-045 and in Section 22, "Guidelines for Adaptive Management Program," in the Forest Practices Board Manual.

Policy's process for prioritizing projects may not always be consistent with CMER's process regarding scientific uncertainty and potential risk to aquatic resources. While Policy has in past years approved CMER's Work Plan priorities, Policy must also consider annual/biennial state budget fluctuations and other factors associated with meeting milestones in accordance with the FP HCP and/or Clean Water Act (CWA) assurances.

In 2009, due to delays in meeting deadlines for determining if forest practices rules met CWA assurances, Policy decided to prioritize CMER projects according to whether they were answering critical questions associated with the CWA assurances. Due to substantial budget shortfalls expected in 2010 and beyond, Policy directed CMER to implement only ongoing projects in FY 2010, and delay new projects until adequate funding was available. Active projects in the current CMER Work Plan reflect these priorities, based on Policy's input concerning CMER's annual budget and the CWA.

The Washington State Department of Ecology (Ecology) is charged with overseeing the CWA assurances milestones. Ecology has developed a document outlining specific CMER projects targeted at answering critical questions associated with the CWA. Ecology's document also lists timelines and anticipated completion dates for those CMER projects.

In 2012, in response to a threat of a lawsuit, a settlement was reached that further affected CMER's project priorities. This settlement agreement included a project work schedule (CMER Master Project Schedule) that can be changed with consensus by the full Policy committee and is approved annually by the Board. In general, the settlement work schedule maintained CMER's prior priorities, with emphasis on CWA projects.

4.0 2023-2025 BIENNIUM CMER WORK PLAN PROJECTS AND BUDGETS

Table 4 presents information on ongoing and new CMER projects for the 2023-2025 biennium, organized by rule group. Project budgets are categorized as either Tier 1 or Tier 2 projects. Tier 1 projects are those projects CMER is certain to implement in 2023-2025. Tier 2 projects are those projects that CMER may initiate in 2023-2025, but that have not yet been approved by CMER and/or Policy and may still require additional work on study design, review, and/or accurate costs.

Table 4. 2023-2025 Biennium CMER Projects and Budget

	Tier 1	Tier 2
Stream Typing Rule Group		
Evaluation of physical features that define fish habitat in forested landscapes (PHBs)	635,600	
Default Physical Criteria (DPCs) Assessment Project	0	
LiDAR Based Water Typing Model	0	
Fish/Habitat Detection Using eDNA	0	
Type N Rule Group		
Type Np Hard Rock Phase III – Amphibian Demographics	398,600	
Temperature and Amphibians in discontinuously flowing Np reaches		
Type N Experimental Buffer Treatment in Soft Rock Lithologies	80,000	
Eastside Type N Riparian Effectiveness Project (ENREP)	1,238,073	
Extensive Monitoring: Type F/N Stream Temperature	100,000	
Extensive Riparian Status and Trends Monitoring- Vegetation, Type F/N-Westside and Eastside	0	
Riparian Characteristics and Shade Response Study	320,231	
Type F Rule Group		
Eastside Timber Habitat Evaluation (ETHEP)	322,521	
Westside Type F Riparian Effectiveness Prescription Monitoring Project	197,272	
Unstable Slopes Rule Group		
Unstable Slope Criteria Project	90,000	
Deep-Seated Landslide Research Strategy Project	500,000	
Roads Rule Group		
Road Prescription-Scale Effectiveness Monitoring Project	1,212,194	
Wetlands Rule Group		
Forested Wetlands Effectiveness Project	338,328	

	Tier 1	Tier 2
Wetland Management Zone Effectiveness Monitoring	0	
Subtotal Projects (by Tier 1 and Tier 2)	**$5,432,819**	**0**
Total Project (both Tier 1 and Tier 2)	**$5,432,819**	
Project Staffing		
CMER Principal Investigator Staff at NWIFC (4, including Eastside)	1,496,463	
Project Support		
Contingency Fund for Active Projects	100,000	
CMER Project Managers (4)	1,257,048	
Dispute Resolution Mediation Contingency Funds (Policy mediation/facilitation and CMER Technical Arbitration Panel on-call contracts)	200,000	
SAO Recommendations		
Onboarding and training for new members (CMER, Policy and Board)	70,000	
Technical Editor and CMER Statistical support (on-call contract)	20,000	
Science review of the program every five years	0	
Review decision making model and principal participation - facilitated caucus principals' meetings	75,000	
Integrated online workspace for AMP and public facing dashboard (SAO Recommendation)	20,000	
SAO Recommendations		
Program Administration		
AMP Administrator and Contract Specialist / CMER Coordinator	889,950	
Independent Science Review Panel	143,222	
CMER Conference	5,000	
Information Management System Updates	4,000	
Subtotal Staffing, Support, and Administration	**$4,279,703**	
Total 2023-2025 Biennium Expenditures for Projects, Staffing, Support, and Administration (by Tier 1 and Tier 2)	**$9,712,522**	**0**

5.0 RULE GROUP DESCRIPTIONS AND MONITORING STRATEGIES

This portion of the Work Plan includes research and monitoring strategies for each forest practices rule group. Information on each rule group is presented separately, in a similar format. The "Rule Overview and Intent" briefly describes the rule; the "Rule Group Resource Objectives and Performance Targets" lists the objectives and targets from Schedule L-1, adopted by the Board in 2001; and the "Rule Group Strategy" describes the programs within a given rule group and how they work together to answer the rule group critical questions.

The programs for each rule group are organized by approach (i.e., rule implementation tools, effectiveness monitoring, extensive monitoring, and intensive monitoring). The "Program Strategy" section describes how the specific research and monitoring projects work together to answer the rule group's specific critical questions. Some programs include additional sub-questions to the rule group critical questions. These questions are identified in tables under each program strategy. The description, goals and status of each project are also described under each program.

Because of the complexity of the riparian strategy, it is divided into four rule groups: Stream Typing Rule Group (Type F/N delineation), Type N Rule Group (non-fish-bearing streams), Type F Rule Group (fish-bearing streams and associated wetlands), and Channel Migration Zone Rule Group. The remaining rule groups are Unstable Slopes, Roads, Fish Passage, Pesticides, Wetlands Protection, and Wildlife. The last section in this chapter describes the intensive monitoring/cumulative effects program, which addresses cumulative effects and validation of performance targets/resource objectives.

5.1 STREAM TYPING RULE GROUP

5.1.1 Rule Overview and Intent

The Forest Practices Board adopted rules delineating waters of the state into three categories, Type S waters (shorelines of the state), Type F waters (fish-bearing), and Type N waters (non-fish-bearing). Distinguishing the upstream limits of Type F (or S) waters is particularly important, because fish use and lack thereof in streams creates differences in the aquatic resources of concern, the forest management strategies, and the prescriptions applied.

Prior to the rules associated with the Forests and Fish Report (1999), stream typing was based on a set of physical and beneficial-use criteria. Due to questions about the accuracy of this system, the forest practices rules require development of a statewide stream map using a multiparameter, field-verified, GIS logistic regression model to identify the upper extent of Type F streams.

The intent of the Stream Typing Rule Group is to develop a statewide stream typing map, described as follows in the forest practices rules:

> "The department will prepare water type maps showing the location of Type S, F, and N (Np and Ns) Waters within the forested areas of the state. The maps will be based on a multiparameter, field-verified geographic information system (GIS) logistic regression model. The multiparameter model will be designed to identify fish habitat by using geomorphic parameters such as basin size, gradient, elevation and other indicators. The modeling process shall be designed to achieve a level of statistical accuracy of 95% in separating fish habitat streams and nonfish habitat streams. Furthermore, the demarcation of fish and nonfish habitat waters shall be equally likely to over and under estimate the presence of fish habitat. These maps shall be referred to as 'fish habitat water typing maps' and shall, when completed, be available for public inspection at region offices of the department. Fish habitat water type maps will be updated every five years where necessary to better reflect observed, in-field conditions."

Until the fish habitat water type maps described above are adopted by the Board, WAC 222-16-031—the Interim Water Typing System—will continue to be used.

5.1.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:

- Streams and their associated wetlands should be typed to include fish habitat. Fish habitat is defined in the forest practices rules to mean "habitat, which is used by fish at any life stage at any time of the year, including potential habitat likely to be used by fish, which could be recovered by restoration or management, and including off-channel habitat."
- The rules also direct that DNR will prepare water typing maps, which will be based on a multiparameter, field-verified, peer-reviewed, geographic information system (GIS) logistic regression model. The multiparameter model will be designed to identify fish

habitat by using geomorphic parameters such as basin size, gradient, elevation, and other indicators.

Performance Target:

- The predictive fish habitat model should have a statistical accuracy of +/- 5% with the line of demarcation between fish and non-fish-habitat waters equally likely to be over- and under inclusive.

5.1.3 Rule Group Strategy

The Forests and Fish Report (FFR) provided rationale and guidance for a strategy related to the stream typing system. The FFR indicated that the current approach to stream typing was not adequately precise, defined a modeling approach for developing a new map, and set specifications for the accuracy of the model. It also called for development of a field protocol for inclusion in the Forest Practices Board Manual.

The In-Stream Scientific Advisory Group (ISAG) was tasked in 2003 with developing and validating a GIS-based model to predict the upstream extent of fish habitat (Table 5). This task fell under the Stream Typing Program, which is categorized as a rule tool.

Table 5. Stream Typing Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Name	Task Type	SAG
How can the line demarcating fish- and non-fish-habitat waters be accurately identified?	Stream Typing Program	Rule Tool	ISAG
To what extent do current default physical criteria for Type-F waters, considering potential geographic differences, accurately identify the upstream extent of (detected) fish use (all species) and/or fish habitat?	Stream Typing Program	Rule Tool	ISAG
Can alternative (to current) default physical criteria for Type-F waters, considering potential geographic differences, be identified that would more accurately and consistently identify the upstream extent of (detected) fish use (all species) and/or fish habitat?	Stream Typing Program	Rule Tool	ISAG
Are there sustained gradient or stream size thresholds alone that serve as default physical criteria?	Stream Typing Program	Rule Tool	ISAG
How well and under what conditions does eDNA sampling accurately and consistently identify the upstream extent of fish use, abundance, and/or fish habitat?	Stream Typing Program	Rule Tool	ISAG

Rule Group Critical Questions	Program Name	Task Type	SAG
To what extent can LiDAR be used with the current fish habitat model to develop a new model for predicting the upstream extent of fish habitat sufficient to meet the requirements of the Forest and Fish Agreement?	Stream Typing Program	Rule Tool	ISAG
What constitutes a 'permanent natural barrier' (PNB) to different species of fish at different life stages?	Stream Typing Program	Rule Tool	ISAG
To what extent does the current water typing survey window account for seasonal and annual variability in fish distribution considering potential geographic differences?	Stream Typing Program	Rule Tool	ISAG
How do different fish species use seasonal habitats (timing, frequency, duration)?	Stream Typing Program	Rule Tool	ISAG
How does the upstream extent of fish use at individual sites vary seasonally and annually?	Stream Typing Program	Rule Tool	ISAG
How does the delineation of the upstream extent of fish habitat change seasonally?	Stream Typing Program	Rule Tool	ISAG
What are the most appropriate/effective methods (include electrofishing) for documenting fish presence/absence in lotic habitats?	Stream Typing Program	Rule Tool	ISAG
How do species interactions influence the upper extent of fish habitat?	Stream Typing Program	Rule Tool	ISAG
What, if any, biological indicators can be effectively used to help identify fish presence and/or fish habitat?	Stream Typing Program	Rule Tool	ISAG
Has the upstream extent of fish distribution been affected in managed forests?	Stream Typing Program	Extensive Status and Trends Monitoring	ISAG
To what extent do anthropogenic blockages downstream affect fish occupancy in habitats at/near the upstream extent of fish distribution?	Stream Typing Program	Extensive Status and Trends Monitoring	ISAG
To what extent do depressed fish stocks influence electrofishing detections, fish distribution, and habitat identification?	Stream Typing Program	Extensive Status and Trends Monitoring	ISAG
What are the rates of fish recolonization and habitat recovery in systems impacted by natural disturbance (debris flow, mass wasting, fire, etc.), and what are the variables that influence those rates?	Stream Typing Program	Extensive Status and Trends Monitoring	ISAG
To what extent could altered flow regimes, caused by climate change, effect fish distributions, fish populations and/or fish habitat?	Stream Typing Program	Extensive Status and Trends Monitoring	ISAG

5.1.4 Stream Typing Program (Rule Tool)

5.1.4.1 Program Strategy

The purpose of the Stream Typing (Rule Tool) Program is to identify projects that will refine and/or validate the water typing process, specifically as the process relates to identifying the regulatory Type-F/N break.

Table 6. Stream Typing Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
How can the line demarcating fish- and non-fish-habitat waters be accurately identified?	Last Fish/Habitat Prediction Model Development Project
	Annual/Seasonal Variability Project
	Last Fish/Habitat Prediction Model Field Performance Project
	Potential Habitat Breaks
To what extent do current default physical criteria for Type-F waters, considering potential geographic differences, accurately identify the upstream extent of (detected) fish presence (all species) and/or fish habitat?	Default Physical Criteria Assessment Project
Can alternative (to current) default physical criteria for Type-F waters, considering potential geographic differences, be identified that would more accurately and consistently identify the upstream extent of (detected) fish presence (all species) and/or fish habitat?	
Are there sustained gradient or stream size thresholds alone that serve as default physical criteria?	
How well and under what conditions does eDNA sampling accurately and consistently identify the upstream extent of fish presence, abundance, and/or fish habitat?	Fish/Habitat Detection Using eDNA Project
To what extent can LiDAR be used with the current fish habitat model to develop a new model for predicting the upstream extent of fish habitat sufficient to meet the requirements of the Forest and Fish Agreement?	No projects developed at this time.
What constitutes a 'permanent natural barrier' (PNB) to different species of fish at different life stages?	No projects developed at this time.
To what extent does the current water typing survey window capture seasonal and annual variability in fish distribution considering potential geographic differences?	Potential Habitat Breaks

Rule Group Critical Questions	Project Names
How do different fish species use seasonal habitats (timing, frequency, duration)?	Potential Habitat Breaks
How does the upstream extent of fish use at individual sites vary seasonally and annually?	Potential Habitat Breaks
How does the delineation of the upstream extent of fish habitat change seasonally?	Potential Habitat Breaks
What are the most appropriate/effective methods (include electrofishing) for documenting fish presence/absence in lotic habitats?	No projects developed at this time.
How do species interactions influence the upper extent of fish habitat?	No projects developed at this time.
What, if any, biological indicators can be effectively used to help identify fish presence and/or fish habitat?	No projects developed at this time.

5.1.4.2 Last Fish/Habitat Prediction Model Development Project

Description:
A GIS-based logistic regression model was developed, associating geomorphic parameters (i.e., basin size, gradient, elevation, and other indicators) with last fish points to determine and map the upstream boundary of Type F (fish-habitat) streams. The forest practices rules specified that once the model was developed, with an accuracy of 95%, the resulting map would be used as rule.

Status:
The model was completed in 2006. The model results did not achieve the target accuracy of 95%. In response, DNR developed new water type maps based on the model in March 2006, but the maps are only to be used as a starting point for delineating fish habitat, not as rule. The DNR maps are currently used as part of the forest practices application process in combination with the Interim Water Typing System (WAC 222-16-031). This water typing rule specifies physical criteria for identifying fish-bearing streams (channel width, channel gradient, and contributing basin area), unless overridden by a protocol survey for determining fish use.

Based on the results of this project, and the CMER recommendation that further efforts to improve the model would likely not increase its level of accuracy, Policy decided that additional CMER work on the model was not necessary at this time. Policy has identified stream typing as a task to be resolved on their Policy work list.

5.1.4.3 Annual/Seasonal Variability Project

Description:
The Annual/Seasonal Variability Project was conducted to help validate the Last Fish/Habitat Model. The project goal was to assess whether the upstream extent of fish distribution in eastern Washington varies annually and/or by season. The study sampled for changes in the location of the uppermost detected fish

at both "terminal" (midstream) and "lateral" (tributary junctions) fish distribution points. Key questions related to this project include the following:

- Does the upstream extent of fish distribution vary with seasons?
- What is the magnitude of the variation in the upstream extent of fish distribution between seasons?
- Are there trends in fish movement upstream or downstream related to season or year?
- What is the magnitude of observed variability?
- Is there a drought impact on fish distribution?

Annual variability estimates were obtained from two years of summer data, collected during the low-flow period (2001–2002). Project results indicated a range of observed annual variability from 943 meters (m) downstream to 400 m upstream of terminal last fish points (n=172). Last fish points did not change from 2001 to 2002 at 51 of 172 locations; and, when movement occurred (in either direction), the last fish point shifted by 25 m or less at 61 of the 172 terminal points. Last fish points shifted by more than 100 m in either direction at 17 of 172 locations, and moved more than 200 m at only 8 locations. Last fish points shifted by more than 500 m at only 3 locations; all of these were downstream movements. For all last fish points in 2002 (terminal and lateral combined), 94% of last fish points shifted by 50 m or less. Of 309 terminal and lateral sites resurveyed in 2002, last fish points did not change at 150 sites.

Seasonal/annual variability estimates were obtained in the summer and fall of 2005; these estimates were compared, to the extent possible, with the annual variability estimates from 2001–2002. Project results showed similar differences in the seasonal variability of fish movement between years, with the majority occurring within 100 m of the original survey. Seasonal variability results included the average upstream/downstream movements, as well as trends in upstream/downstream movement.

The project also assessed the sampling error to help determine the degree to which the field survey protocol (using a single-pass electroshocking survey) was likely to detect the "last fish" at the maximum upstream extent of fish distribution.

Status:
Work began in 2000–2001 to identify annual and seasonal variability of last fish points and also to assess sampling error. Additional field survey data were collected in 2002 and 2003. In 2005, a seasonal variability study was completed and a final report was provided in the spring of 2006. This study was conducted as a subproject to inform the Last Fish/Habitat Prediction Model Field Performance Project. However, since the model did not meet the required target accuracy (95%), Policy decided that additional CMER work on annual and seasonal variability was not necessary at this time.

5.1.4.4 Last Fish/Habitat Prediction Model Field Performance Project

Description:
The objective of the Last Fish/Habitat Prediction Model Field Performance Project was to assess the performance of the model predictions in western Washington. ISAG developed a study design, which was approved by CMER, and a pilot field test of the study design was performed. This test primarily included resurveying a randomized sample of last fish points and comparing those points to the predicted model point. If the field-identified last fish point occurred upstream of the model-predicted point, the prediction was considered to be an underestimation of fish habitat; if the field-identified last fish point occurred downstream of the model-predicted point, the prediction was considered to be an overestimation of fish habitat. ISAG compiled existing information related to water typing and presented this, along with the model performance assessment's study design and pilot field effort results, to the Policy Subgroup on Water Typing.

Status:
Because the model did not achieve the level of accuracy specified in the forest practices rules (95%), and because further work was unlikely to improve upon that level of accuracy, Policy decided that no additional CMER work was necessary at this time.

5.1.4.5 Default Physical Criteria Assessment Project

Description:
The accuracy of the current default physical criteria has not been validated, and research describing the physical characteristic at the upstream extent of fish distribution is limited. Also, protocol survey practitioners have frequently observed differences between the upstream extent of (detected) fish presence and the default physical criteria. The magnitude of difference between the last fish and the default physicals has not been assessed. Therefore, research is needed to (1) compare and quantify how the current default physical criteria correspond to the uppermost point of fish presence and potential fish habitat; (2) determine the physical characteristics of habitat likely to be used by fish, and (3) determine if sustained gradient or stream size thresholds alone serve as default physical criteria.

Status:
In 2016, a Board-designated science panel initiated work on the study design, with the consideration of combining it with the Potential Habitat Breaks study. ISAG reviewed and provided comments on the draft, however, no final/approved study design was produced. The Board then created a special Water Typing Subcommittee to provide recommendations on next steps. Per recommendation of the Water Typing Subcommittee, in November 2019 the Board recommended that CMER develop a "Default Physicals Criteria" study design. CMER then voted that ISAG should have the lead in responding to this Board motion. ISAG presented the Board with a strategy outline to develop water typing study designs in May 2020, and initiated work on revising the Potential Habitat Breaks study design. Following CMER approval of the Potential Habitat Breaks study design in September 2022, ISAG initiated work on the Default Physical Criteria study design. ISAG anticipates that the PHB and DPC studies will use data from the same field sites but use different analyses to answer the questions specific to each.

5.1.4.6 Fish/Habitat Detection Using Environmental DNA (eDNA)

Description:
Genetic material shed by all living organisms and found in the environment is referred to as environmental DNA or eDNA. In the last two decades, noninvasive genetic sampling has been recognized as an effective conservation and management tool for monitoring the presence and distribution of specific species and to assist in quantifying biodiversity within a specific environmental system. Environmental DNA sampling methods are being developed that may contribute to more accurate demarcation between fish- and non-fish-habitat waters.

Guidelines for the application of eDNA sampling methods and assays would need to be established to assure consistent application of this tool for the detection and monitoring of aquatic species across FP HCP lands. Some of the more critical methodology considerations include sampling protocols and study design that prevent contamination in the field and laboratory, choosing the most appropriate sample analysis method (e.g., qPRC probe for specific species or metabarcoding with an array designed for multiple species), minimum reporting guidelines, natural inhibitors for DNA extraction and amplification, and the validation of assays. Also paramount is the consideration of the limitations on inference including temporal and spatial processes, correlation of eDNA with abundance, probability of uncertainty of results, and potential for allochthonous DNA.

Recent and ongoing projects are establishing the empirical and experimental data needed to address these concerns. There is a rapidly growing body of research and methodology reports concerning the application of eDNA analysis that should be consulted as CMER moves forward in the development of projects aimed to test eDNA as a Water Typing tool. Some key questions that can be answered by literature review and collaborative projects include the following:

- How does eDNA sampling compare with electrofishing for overall effectiveness, costs, and accuracy for identifying fish presence?
- What sampling conditions are conducive to accurately and consistently identify fish presence?
- Could eDNA sampling be used to better characterize fish presence as it relates to fish habitat?

Status:
A collaborative pilot field project labeled “Fish/Habitat Detection Using eDNA Project” was approved by CMER in the spring of 2018. In this pilot study, streams were surveyed for fish detection using both electrofishing and eDNA techniques. The fieldwork was completed in 2018, followed by laboratory/data analyses and reporting in 2019. The pilot report was finalized and the report is available online (CMER#2021.05.25).

5.1.4.7 Evaluation of physical features that define upstream extent of fish habitat in forested landscapes across Washington State (PHB)

Description:
The purpose of the proposed study is to determine which combinations of gradient, channel width, barriers to migration, and other physical habitat and geomorphic conditions can be used to most accurately define potential habitat breaks (PHBs). Specific study elements are being finalized within ISAG. The study will be conducted across multiple years and seasons at sites in Washington State. Upstream fish distribution limits (i.e., EOF locations) will be determined during each season at each site using electrofishing. Data from this study will be analyzed to determine the combinations of gradient, channel width, and other geomorphic features that best define PHBs, fish habitat, and whether these vary spatially and temporally. The results of this study will be used to evaluate the accuracy of PHB criteria selected by the Board in determining the regulatory break between fish (Type F) and non-fish bearing (Type N) waters.

Status:
The study design was developed by a Board-designated science panel and subsequently approved by ISPR in 2018. It was also reviewed by members of CMER and ISAG in 2019. An updated version of the study design was presented to the Board. The Board then created a Water Typing Subcommittee to provide recommendations on next steps. Per recommendation of the Water Typing Subcommittee, in November 2019 the Board recommended that CMER develop a "Potential Habitat Breaks" study design. CMER then voted that ISAG should have the lead in responding to this Board motion. ISAG presented the Board with a strategy to develop water typing study designs in May 2020, and initiated the work thereafter. CMER approved the Study Design in September 2022 and began an interactive ISPR process.

5.1.5 Stream Typing Program (Extensive Status and Trends Monitoring)

5.1.5.1 Program Strategy

The purpose of the Stream Typing (Extensive Status and Trends Monitoring) Program is to identify projects for evaluating the current status of key watershed processes and/or habitat conditions that relate to the water typing at the landscape scale.

Table 7. Stream Typing Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Has the upstream extent of fish distribution been affected in managed forests?	Recoverable/Restorable Fish Habitat Project
What type, and how much, fish habitat has been restored and recovered through forest management practices and to what degree has it affected fish distribution and abundance?	Recoverable/Restorable Fish Habitat Project
To what extent do anthropogenic blockages downstream affect fish occupancy in habitats at/near the upstream extent of fish distribution?	No projects developed at this time.

To what extent do depressed fish stocks influence electrofishing detections, fish distribution, and habitat identification?	No projects developed at this time.
What are the rates of fish recolonization and habitat recovery in systems impacted by natural disturbance (debris flow, mass wasting, fire, etc.), and what are the variables that influence those rates?	No projects developed at this time.
To what extent could altered flow regimes, caused by climate change, affect fish distributions, fish populations, and/or fish habitat?	No projects developed at this time.

5.1.5.2 Recoverable/Restorable Fish Habitat Project

Description:
"Fish habitat" means habitat which is used by fish at any life stage at any time of the year including potential habitat likely to be used by fish which could be recovered by restoration or management and includes off-channel habitat (WAC 222-16-010). The primary intent of this project will be to assess potential landscape-scale differences in fish distribution patterns within managed and unmanaged forestlands. In addition, the project will identify and quantify different types of fish habitat that have been recovered and/or restored through forest management practices (e.g., riparian buffer prescriptions, RMAPs) since the FP HCP was implemented. Where possible, the project will also investigate the degree to which fish distribution and abundance has changed from pre- to post-restoration and recovery.

Status:
This project was proposed for inclusion by ISAG (2016) in the CMER Master Project Schedule for the 2017–2019 biennium. Due to a shift in the FP Board priorities this project has been put on hold and will be re-evaluated and new priorities will be determined by ISAG.

5.2 TYPE N RIPARIAN PRESCRIPTIONS RULE GROUP

5.2.1 Rule Overview and Intent

Type N streams are protected under forest practices rules for several reasons. First, they provide habitat for stream-associated amphibians (SAA) covered by the agreement. Second, water quality standards pertaining to these streams need to be met. Finally, Type N streams contribute water, nutrients, woody debris, and sediment that affect downstream fish habitat and water quality.

Two buffering strategies are prescribed for Type Np streams: the clear-cut and the partial-cut strategies. The clear-cut strategy is prescribed for the westside, whereas landowners on the eastside have the flexibility to use either clear-cut or partial-cut strategies. The clear-cut strategy on the westside involves a patch buffering system where portions of the riparian stand can be clear-cut to the stream, but remaining areas are protected with a 50-foot (ft.) wide no-cut patch buffer. The patch buffer includes fixed and flexible components. Fixed components include 50-56 ft. buffers around most sensitive sites (e.g., connected springs and seeps, Np initiation points, and stream junctions) and on both sides of the stream 300-500 ft. upstream from the Type F/Type Np junction. The flexible component allows the landowner to choose where to place the remaining buffer to bring the total buffer length to a minimum of 50% of the Type Np length. Eastside landowners have the second option of using the partial-cut strategy, a continuous 50-ft. buffer along the length of the Type Np stream. The partial-cut buffer can be thinned, provided that the appropriate basal area and leave tree requirements are met. A 30-ft.-wide equipment limitation zone (ELZ) is established on all Type N streams (Np and Ns) statewide to minimize sediment input from bank and soil disturbance. Operations within the ELZ are designed to avoid soil disturbance, and sediment delivery must be mitigated.

The Type N rules are based on the assumption that riparian buffering strategies will result in aquatic conditions that meet resource objectives and consequently achieve the three Forests and Fish Report performance goals. However, a high level of uncertainty exists in the science underlying these assumptions because the functional relationships between riparian management practices, riparian functions, and aquatic resource response are not well studied or understood. Several major areas of uncertainty include the following:

1. How to identify the upper boundary of perennial flow in Type N streams.
2. How riparian stands and the inputs and functions they provide respond to management practices and the level of protection provided by the prescriptions.
3. The habitat utilization patterns of SAAs and their response to riparian management practices.
4. The effects of Type N riparian management practices on sediment, large woody debris (LWD), temperature, and nutrient regimes in downstream fish-bearing streams.

5.2.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:
The Type N riparian prescriptions are designed to accomplish the following FP HCP resource objectives:

- Provide cool water by maintaining shade, groundwater temperature, flow, and other watershed processes controlling stream temperature.
- Provide complex in- and near-stream habitat by recruiting LWD and litter.
- Prevent delivery of excessive sediment to streams by protecting stream-bank integrity, providing vegetative filtering, protecting unstable slopes, and preventing routing of sediment to streams.
- Provide conditions that sustain SAA population viability within occupied sub-basins.

Performance Targets:

- Stream Temperature: To be developed
- Water quality standards: To be developed
- Sediment: Target related to harvest and activities in the ELZ has yet to be developed.
- Groundwater Temperature: To be developed.

5.2.3 Rule Group Strategy

As mentioned above, the forest practices Type N riparian prescriptions were based on assumptions that contain scientific uncertainties. The Type N riparian strategy is designed to address those areas of scientific uncertainties by focusing on critical questions related to delineation of Np/Ns streams, characterization of Np streams, identification and characterization of sensitive sites, and the effectiveness of the rules in achieving FP HCP goals and resource objectives. The critical questions, programs, task types, and responsible scientific advisory groups (SAGs) are listed in Table 8. The first step in the strategy involves rule tool programs that address how to delineate and characterize Type N streams and sensitive sites. The Type N Delineation Program addresses how to characterize and delineate the uppermost boundaries of Type N streams, including perennial and seasonal streams. The purpose of the Sensitive Site Program is to refine the descriptions of SAA sensitive sites in the forest practices rules and to estimate their importance to SAAs.

After rule tools have been developed to characterize and/or delineate Type N streams, the next step in the strategy is to assess the effectiveness of the riparian prescriptions in meeting resource goals and performance targets. The Type N Riparian Effectiveness Program assesses how the forest practices riparian prescriptions, as well as alternative buffer prescriptions, address the FP HCP resource objectives (i.e., riparian processes and functions) within Type N streams, as well as their contribution to downstream Type F streams. The Type N Amphibian Response Program addresses how SAA population viability is maintained by the Type N prescriptions on the westside. The Extensive Riparian Status and Trends Monitoring Program is then designed to

provide a snapshot of temperature and riparian vegetation conditions in Type N streams across the FP HCP landscape and to document how those conditions change over time.

Table 8. Type N Riparian Prescriptions Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Names	Task Type	SAG
How should the initiation point of Type Np streams be identified for management purposes?	Type N Delineation Program	Rule Tool	UPSAG
Can the methods used to identify and characterize sensitive sites be improved?	Sensitive Site Program	Rule Tool	LWAG
Are rule-identified sites valuable for amphibians?	Sensitive Site Program	Rule Tool	LWAG
Are sites important to amphibians correctly identified by rule?	Sensitive Site Program	Rule Tool	LWAG
How do survival and growth rates of riparian leave trees change following Type Np buffer treatments? Are riparian processes and functions provided by Type Np buffers maintained at levels that meet FP HCP resource objectives and performance targets for shade, stream temperature, LWD recruitment, litterfall, and amphibians? How do other buffers compare with the forest practices Type N prescriptions in meeting resource objectives? How do the Type N riparian prescriptions affect water quality delivered to downstream Type F/S waters? Are the Type N performance targets valid and meaningful measures of success in meeting resource objectives? What is the frequency and distribution of windthrow in forest practices buffers on Type N and F streams? What site and habitat conditions are associated with sites with significant blowdown? What is the effect of buffering or not buffering spatially intermittent stream reaches in Type Np streams?	Type N Riparian Effectiveness Program	Effectiveness	RSAG SAGE
Is stream-associated amphibian (SAA) population viability maintained by the Type N prescriptions?	Type N Amphibian Response Program	Effectiveness	LWAG
What is the current status of riparian conditions and functions in Type N streams on a statewide scale, and how are conditions changing over time?	Extensive Riparian Status and Trends Monitoring Program	Extensive	RSAG
Are forest practices riparian prescriptions effective at protecting groundwater flow and temperature?	Groundwater Conceptual Model Project Type N Riparian Effectiveness Program	Effectiveness	UPSAG RSAG SAGE WetSAG

5.2.4 Type N Delineation Program (Rule Tool)

5.2.4.1 Program Strategy

Because the Type N protections differ between perennial and seasonal stream reaches, it is important that perennial and seasonal reaches can be identified before management activities occur. This is difficult because determining a flow regime requires walking extensive stream lengths during the summer dry season. The need for a simpler year-round determination method led to the basin area default method contained in the FFR. The Type N Delineation Program was designed to determine whether regulatory delineation methods were sufficiently accurate and whether there were preferable alternatives.

The Type N Delineation Program evaluated existing and alternative delineation methods using observational field studies. In 2001, a pilot study (administered by UPSAG) was conducted to validate existing methods for defining perennial and seasonal streams for both western and eastern Washington, as described below. Based on the results of the study, in November 2006 the Forest Practices Board adopted the rule that eliminated the option to use a default basin size. Though the Board Manual was to be relied upon to provide guidance for determining the uppermost point of perennial flow, the proposed Board Manual language for providing this guidance was not approved at that time. Currently, no further action is being taken by CMER on this issue.

Table 9. Type N Delineation Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names	SAG
How should the initiation point of Type Np streams be identified for management purposes?	Perennial Initiation Point Survey: Pilot Study	UPSAG

5.2.4.2 Perennial Initiation Point Survey: Pilot Study

Description:
The Perennial Initiation Point (PIP) pilot study was initiated in 2001 to evaluate field methods and inform sampling needs for a subsequent statewide field study. The field portion of the study was done by Forests and Fish cooperators (tribes, timber companies, and the Washington Department of Fish and Wildlife [WDFW]) on a voluntary basis. CMER staff performed data analysis and reporting under the direction of the Np technical subgroup and UPSAG.

Completion of the pilot study in 2004 was followed by independent scientific peer review (ISPR), and revisions and the preliminary scoping of a coordinated statewide study.

Status:
The pilot study was completed in 2004. A coordinated statewide study has not been scoped or initiated based on direction from Policy.

5.2.5 Sensitive Site Program (Rule Tool)

5.2.5.1 Program Strategy

The Sensitive Site Program, which began in 1999, consists of two rule-tool implementation projects. The purpose of this program is to refine the descriptions of stream-associated amphibian (SAA) sensitive sites in the forest practices rules and to estimate their importance to SAAs. The strategy is to first develop a field methodology to assist forest managers in identifying sensitive sites, and then characterize sensitive sites that are the most important to the SAAs addressed in the FP HCP. See Table 10 for critical questions and associated projects.

Table 10. Sensitive Site Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Are sites important to amphibians correctly identified by rule?	SAA Sensitive Sites Characterization Project Sensitive Sites and Amphibians Project
Are rule-identified sites valuable for amphibians?	
Can the methods used to identify and characterize sensitive sites be improved?	SAA Sensitive Sites Identification Methods Project Sensitive Sites and Amphibians Project

5.2.5.2 SAA Sensitive Sites Identification Methods Project

Description:
The purpose of this project is to develop a practical methodology for identifying SAA sensitive sites, such as headwall seeps, side-slope seeps, and headwater springs. This project is intended to inform the Type N riparian rule by providing a standard methodology (field guide) for field managers to identify SAA sensitive sites when designing harvest units.

Status:
This project was completed in 2007. One manuscript has been published in a peer-reviewed journal. This project is administered by the Landscape and Wildlife Advisory Group (LWAG).

5.2.5.3 SAA Sensitive Sites Characterization Project

Description:
The purpose of this project is to document the distribution and characteristics of sensitive sites as described by the forest practices rules and to verify their use and habitat value for SAAs. The project will generate information on the characteristics of sensitive sites, validate the extent to which they are used by amphibians, and determine if other sensitive sites exist. Information from this project could result in changes to the sensitive site criteria in the rules to better focus buffer protection on areas important to SAAs.

Status:
This project was completed in 2006. One manuscript has been approved by CMER and published. This project is administered by LWAG.

5.2.5.4 Sensitive Sites and Amphibians Project

Description:
This project proposes to use existing data from a combination of the Hard Rock project, SAA Sensitive Sites Identification Methods Project, and SAA Sensitive Sites Characterization Project to synthesize information on characteristics of FP Sensitive Sites and riparian sites important to amphibians. If desired, a second field phase of this project would focus on remaining uncertainties associated with seeps, including identification, characterization and amphibian use on the Type N landscape.

Project Critical Questions:

- Are rule-identified sites valuable for amphibians?
- Are sites important to amphibians correctly identified by rule?
- Can the methods used to identify and characterize sensitive sites be improved?

Status:
This project has not been initiated or scoped.

5.2.6 Type N Riparian Effectiveness Program

The effectiveness of the prescription package for Type N riparian management is uncertain because there are many gaps in the scientific understanding of headwater streams, their aquatic resources, and the response of riparian stands, amphibians, water quality, and downstream fish populations to different riparian management strategies. Consequently, prescriptions are based on assumptions that have been neither thoroughly studied nor validated. This program is ranked first among the 16 CMER programs. This program has been divided into two sections, one for the westside and one for the eastside, due to differences in the prescriptions and critical questions, which lead to unique program strategies.

5.2.6.1 Program Strategy (Westside)

The purpose of this program is to evaluate the westside Type N riparian management prescriptions, including response of riparian vegetation, growth and mortality of buffer trees, level of riparian functions provided, biotic and water quality responses to prescriptions (both within the Type N system and in downstream fish-bearing waters), and the prescriptions' effectiveness in achieving performance targets and meeting water quality standards. Critical questions for this program, along with the projects designed to answer them, are shown in Table 11.

Three CMER projects evaluated the effectiveness of the westside Type N riparian prescriptions. These projects used different but complementary approaches to inform adaptive management. The Westside Type N Buffer Characteristics, Integrity, and Function (BCIF) Project examined a random sample of westside Type N forest practices applications (FPAs) after harvest to evaluate the performance of Type N prescriptions as they are applied operationally over the range of conditions occurring in the FP HCP landscape. The Type N Experimental Buffer Treatment Project in Hard Rock Lithologies (Hard Rock project) and Type N Experimental Buffer Treatment Project in Soft Rock Lithologies (Soft Rock project) focused on aquatic resource response to Type N prescriptions in streams with competent (i.e., less erodible, or hard rock) and relatively incompetent lithologies in western Washington. Both

studies used a manipulative experimental design that compared the effectiveness of the riparian buffers left in harvested watersheds to unharvested control sites. The Type N Experimental Buffer Treatment Project in Soft Rock Lithologies served as a companion study to the Hard Rock project. The Soft Rock project provided important confirmation of the effect of forest practices prescriptions on the more erodible substrates that were not included in the Hard Rock project.

Table 11. Type N Riparian Effectiveness Program – Westside: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
How do survival and growth rates of riparian leave trees change following Type Np buffer treatments?	Westside Type N Buffer Characteristics, Integrity, and Function (BCIF) Project Type N Experimental Buffer Treatment Projects (Hard Rock and Soft Rock projects)

Rule Group Critical Questions	Project Names
Are riparian processes and functions provided by Type Np buffers maintained at levels that meet FP HCP resource objectives and performance targets for shade, stream temperature, LWD recruitment, litterfall, and amphibians?	Westside Type N Buffer Characteristics, Integrity, and Function (BCIF) Project Type N Experimental Buffer Treatment Projects (Hard Rock and Soft Rock projects); the Soft Rock project did not include amphibians or litterfall
How do other buffers compare with the forest practices Type N prescriptions in meeting resource objectives?	Type N Experimental Buffer Treatment Project in Hard Rock Lithologies (the Soft Rock project testd only the forest practices rule buffer, no alternative buffers)
How do the Type N riparian prescriptions affect water quality delivered to downstream Type F/S waters?	Type N Experimental Buffer Treatment Projects (Hard Rock and Soft Rock projects; the Soft Rock project did not include fish)
What is the frequency and distribution of windthrow in forest practices buffers? What site and habitat conditions are associated with sites with significant blowdown?	Westside Type N Buffer Characteristics, Integrity, and Function (BCIF) Project Type N Experimental Buffer Treatment Projects (Hard Rock and Soft Rock projects) Windthrow Frequency, Distribution, and Effects Project
Are forest practices riparian prescriptions effective at protecting groundwater flow and temperature?	No project identified
Are the Type N performance targets valid and meaningful measures of success in meeting resource objectives	No project identified
What is the effect of buffering or not buffering spatially intermittent stream reaches in Type Np streams?	Discontinuous Np Project
What are the physical characteristics and functions of accumulations of instream slash through time? How does amphibian use of reaches with accumulations of instream slash vary through time?	Slash in Type N Streams Project

5.2.6.2 Westside Type N Buffer Characteristics, Integrity, and Function (BCIF) Project

Description:
The Westside Type N Buffer Characteristics, Integrity, and Function Project was designed to evaluate the effectiveness of the westside Type N riparian prescriptions, including survival of buffer leave trees, stand condition and trajectory over time, and changes in riparian functions, including shade, LWD recruitment, and soil disturbance/stream-bank protection. A random sample of 15 Type Np treatment sites in the western hemlock zone strata of western Washington were selected from forest practices applications (FPAs). Treatment sites were paired with unharvested reference sites to provide an unbiased estimate of the magnitude of change following application of the clear-cut and 50-ft. buffer prescriptions. Data were also collected on the PIP buffer prescription.

Status:
Initial post-harvest sampling at 15 treatment/reference pairs were initiated in the fall of 2003. Low-altitude photography and field measurements of canopy conditions were collected post-harvest in 2004. After a pilot project to evaluate feasibility of aerial photography, the Riparian Scientific Advisory Group (RSAG) determined that field data were needed to accomplish the project objectives. Field data were collected on riparian stand conditions, fallen trees, LWD recruitment, shade, channel wood loading, and soil disturbance from windthrown trees. Field data were collected three and five years after timber harvest in the summer/fall of 2006 and 2008. A draft report was submitted for ISPR in October 2010. The report was revised to address ISPR comments and the final report was approved by RSAG and CMER in December 2011. The ten-year, post-harvest data collection effort was completed in the summer of 2013. The final report was approved by CMER October 2019. TFW Policy and the FP Board approved no further action or recommendations were needed at this time based on the results of this study.

5.2.6.3 Type N Experimental Buffer Treatment Project in Hard Rock Lithologies (Hard Rock Project)

Description:

This study is a field experiment that assessed the effects of clear-cut harvest of Type N basins with three riparian buffer strategies (compared to unharvested reference basins) during Phase 1 (2006–2011), extended monitoring in Phase 2 (2012–2017), and a current monitoring in Phase 3. Study responses included riparian stand structure, tree mortality, wood recruitment and loading, stream temperature and cover, discharge, nutrient export, suspended sediment export, stream channel characteristics, litterfall input and detritus export, biofilm and periphyton, macroinvertebrate export, and stream-associated amphibian density. Data on downstream effects on stream temperature and fish populations were also assessed, where possible. Study sites were limited to basins with basalt or other hard rock lithologies, where the target amphibian species are more likely to be found. The BACI (Before- After /Control-Impact) study design includes randomized blocks, with sites assigned to one of four treatments, including the reference.

Status:

This study consisted of three years of pre-harvest data collection 2006-2008 and multiple years of post-harvest data collection spanning from 2009–2017. The Phase 1 report is complete, and five findings reports (one covering findings of the entire study, with separate reports for stand structure and tree mortality, wood recruitment and loading, stream temperature and cover, and stream-associated amphibians) have been transmitted to Policy.

Results of the detection probability method used in this study were published in the journal Forest Ecology and Management in 2012. Stream temperature and amphibian response results were presented at the American Fisheries Society conference in Portland, Oregon in August 2015 and at the National Council on Air and Stream Improvement meeting in September 2015, and at the CMER Science Conferences in October 2016 and May 2018. Results were presented to Policy in late 2017.

The extended monitoring, Phase 2 (2012 and later; through nine years post-harvest), included responses for riparian stand structure, tree mortality, wood recruitment and loading, stream temperature and cover, discharge, nutrient export, suspended sediment export, stream channel characteristics, stable isotopes, and stream-associated amphibian density. The timing of data collection varied among the many study variables depending upon the expected response time and expense. The final report was approved by ISPR and was approved by CMER on July 27, 2021. Temperature data collected through fall 2019 were included in the Phase 2 report as an addendum.

Because of the long generation time of stream-associated amphibians, the genetic component of this study spans the interval of 2006–2017. The final genetic report was approved by ISPR and CMER in 2019. A Findings Report was developed and presented to TFW Policy and the Forest Practices Board.

Continued monitoring of the rule effectiveness through time is consistent with the study design. Monitoring for stream-associated amphibians (Phase 3) is currently in implementation and will be conducted summer of 2023 and 2024 (budget allocations in the current CMER MPS span fiscal years 2022- 2025). Results from Phase 2 suggest significant declines in Coastal Tailed Frog populations 7- and 8-years post-harvest that were not apparent in the initial post-harvest period. Future monitoring will allow identification of longer-term effects of harvest on Coastal Tailed Frog populations and other stream-associated amphibians, including torrent and giant salamanders.

5.2.6.4 Type N Experimental Buffer Treatment Project in Soft Rock Lithologies (Soft Rock Project)

Description:
This study was a field experiment analogous to the Hard Rock project but implemented on more erodible (soft rock, largely marine sedimentary) lithologies. This project differs from the Hard Rock project in that it:

- employs a Multiple Before-After/Control-Impact design (e.g., multiple control sites);
- tests only the forest practices rule buffer treatment (no alternative buffers are tested);
- does not include any amphibian, fish, litterfall, or drift measurements; and
- includes benthic macroinvertebrate sampling rather than macroinvertebrate drift.

This project evaluated the effects of timber harvest in headwater basins on water temperature, streamflow, exports of suspended sediment and nutrients from the Type N basin, and benthic macroinvertebrate communities. Site selection was similar to the Hard Rock study except that sites were selected in lithologies that are likely to produce a fine-grained stream substrate. This project began in 2012 and data collection ended in summer 2017, except for stream temperature, which extended through fall 2020. Study sites included ten Type N stream basins (seven treatment sites and

three control sites) located in southwestern Washington.

Status:
A grant from the Environmental Protection Agency (EPA) was awarded to the Washington State Department of Ecology (Ecology) in October 2010 that partially funded the design and first two years implementation of the Soft Rock project. The Quality Assurance Project Plan was published in September 2011.

Site selection was completed in August 2012 and temperature monitors were installed. Montana flumes were installed in four basins by Oct 9, 2012 and instrumented by January 2013 to measure stage height and turbidity.

The final report covering the period from 2012-2017 was approved by ISPR and was approved by CMER on July 27, 2021. Extended data collection occurred through October 2020 to track the longer-term trajectory of water temperature. Harvest in the reference sites began in 2020 marking the end of monitoring in this study. The analysis of the 2017-20 temperature data was included as an addendum to the Extended Monitoring Report. The report is available online (CMER #2021.08.24).

5.2.6.5 Slash in Type N Streams Project

Description:
The purpose of this project is to evaluate the functional role of slash in Type N streams. In the Hard Rock project, PIs observed high loads of harvest-related slash in unbuffered stream reaches, along with what appeared to be higher densities of torrent salamander utilizing these reaches. However, preliminary results suggest that these increased densities in slash reaches did not extend through years 7 and 8 post-harvest. The function and physical characteristics of instream slash have not been studied extensively and has not been systematically studied from an amphibian use perspective. This project intends to evaluate the biotic and abiotic variables associated with instream slash in Type N streams. To evaluate how slash changes through time, we propose identifying study sites representing various stand ages and time since harvest that could be used in a chronosequence study of slash characteristics. To evaluate how amphibian use of slash changes through time, we propose the additional inclusion of study sites where baseline data for amphibian densities already exists (i.e., Type N Study sites).

Project Critical Questions:

- What are the physical characteristics and functions of accumulations of instream slash through time?
- How does amphibian use of reaches with accumulations of instream slash vary through time?

Status:
This project has not been initiated or scoped.

5.2.6.6 Windthrow Frequency, Distribution, and Effects Project

Description:
Results of the Westside Type N BCIF Project indicate that windthrow mortality in westside Type N buffers may be common and highly variable. Many land managers have observed this as well. In response to this concern, RSAG included a windthrow assessment into the three major Type N

riparian effectiveness projects (Hard Rock, Soft Rock, and ENREP), as well as the Westside Type F exploratory project.

Status:
The windthrow results from the two westside Type N studies are currently being considered by the TFW Policy Type N alternative prescription workgroup. Windthrow was also measured in the Westside Type F Riparian exploratory study and will be further incorporated into the Effectiveness study, which is currently being designed. RSAG has begun scoping a project to build a metadatabase of existing windthrow data from previous and ongoing CMER and DNR projects. This project is queued to use any available unspent funds.

5.2.6.7 Program Strategy (Eastside)

The purpose of the eastside program is to evaluate Type N riparian management prescriptions, including response of riparian vegetation, growth and mortality of buffer trees, level of riparian functions provided, biotic and water quality responses to prescriptions (both within the Type N system and in downstream fish-bearing waters), and the prescriptions' effectiveness in achieving performance targets and meeting water quality standards. Critical questions for this program, along with the projects designed to answer them, are shown in Table 12.

The Eastside Type N Forest Hydrology Project developed by SAGE contains a series of follow-up studies that will examine eastern Washington headwater streams with the final intent of effectiveness monitoring. Given the importance of flow as a transport mechanism between non-fish-bearing and fish-bearing streams and the unique functions these streams exhibit, SAGE, through the ENREP study, decided that determining the hydrology of Type N streams would be the first step in laying the groundwork for additional studies. By understanding forest hydrology, we will better understand spatially intermittent reaches and where they are likely to occur across eastern Washington, thus providing additional information to help correctly delineate the Type Np/Ns break.

The ENREP study will help determine if, and to what extent, the prescriptions found in the Type N Riparian Prescriptions Rule Group and/or a related commonly applied prescription affording more protection than the current rules require (i.e., full-length two-sided 50-foot no-cut RMZs) are effective in achieving performance targets and water quality standards, particularly as they apply to sediment and stream temperature in eastern Washington. ENREP moved forward into implementation, so the TWIG group has converted into an active project team.

Table 12. Type N Riparian Effectiveness Program – Eastside: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names	SAG
How do survival and growth rates of riparian leave trees change following Type Np buffer treatments?	Eastside Type N Buffer Characteristics, Integrity and Function (BCIF) Project	RSAG
Are riparian processes and functions provided by Type Np buffers maintained at levels that meet FP HCP resource objectives and performance targets for shade, stream temperature, LWD recruitment, litterfall, and amphibians?	Eastside Type N Riparian Effectiveness Project (ENREP)	SAGE
Are riparian processes and functions provided by the Type Ns Equipment Limitation Zone maintained at levels that meet FP HCP resource objectives and performance targets	Eastside Type Ns Intermittent Streams Project (ENSP)	

for stream temperature and sediment delivery?			
Program Research Questions	*What are the characteristics of eastern Washington Type N stream channels and riparian areas and how do they vary across eastern Washington?*	Eastside Type N Forest Hydrology Project Eastside Type N Riparian Effectiveness Project	SAGE
	Do different types of Type N channels explain the variability in the response of Type N channels to forest practices?		
What is the effect of buffering or not buffering spatially intermittent stream reaches in Type Np streams?		Eastside Type N Riparian Effectiveness Project	SAGE TWIG
How do the Type N riparian prescriptions affect water quality delivered to downstream Type F/S waters?		No projects yet scoped	SAGE
Are forest practices riparian prescriptions effective at protecting groundwater flow and temperature?		No projects yet scoped (see Groundwater Conceptual Model Project)	UPSAG RSAG SAGE WetSAG

5.2.6.8 Eastside Type N Buffer Characteristics, Integrity, and Function (BCIF) Project

Description:
The Eastside Type N Buffer Characteristics, Integrity, and Function (BCIF) Project, managed by RSAG, is designed to evaluate the effectiveness of the eastside Type N riparian prescriptions, including survival of buffer leave trees, stand condition and trajectory over time, and changes in riparian functions, including shade, LWD recruitment, and stream-bank protection. RSAG proposes to examine a random sample of eastside Type N riparian FPAs to evaluate the performance of Type N prescriptions as they are applied operationally over the range of eastside Type N streams.

Status:
RSAG attempted to implement this project in 2004 and again in 2006, but was unable to find an adequate number of study sites because there were very few FPAs where landowners proposed to apply the eastside Type N prescriptions. Most landowners opted to simply stay out of the 50-ft Type N management zone rather than implement the thinning or patch-cut prescription. RSAG documented these findings in a series of memos. Due to the lack of suitable study sites, this study has been placed on hold.

5.2.6.9 Eastside Type N Forest Hydrology Project (FHS)

Description:
The Eastside Type N Forest Hydrology Project was designed to determine the spatial characteristics of late summer surface-water discharge across eastern Washington FP HCP lands. The project explored whether there was a set of readily identified external characteristics that could be used to group and/or remotely identify stream reaches that exhibit similar hydrologic characteristics.

Status:
The study design for the FHS project was approved by CMER in December 2009. Field work was completed in 2012. The FHS report was completed in 2014, and sent to ISPR for review in late 2014. The report was updated and approved by SAGE and CMER in 2015 and was received by Policy in 2016.

5.2.6.10 Eastside Type N Riparian Effectiveness Project (ENREP)

Description:
The ENREP study will determine if, and to what extent, the prescriptions found in the Type N Riparian Prescriptions Rule Group and/or a related commonly applied prescription affording more protection than the current rules require (i.e., full-length two-sided 50-foot no-cut RMZs) are effective in achieving performance targets and water quality standards, particularly as they apply to stream temperature and discharge in eastern Washington.

The objectives of the ENREP study are: (1) quantify the magnitude of change in stream flow, canopy closure, water temperature, suspended sediment transport and wood loading within eastern Washington riparian management zones (RMZ) following harvesting within current rule constraints; and (2) evaluate the effects of these changes on downstream waters where possible.

This study uses a blocked Multiple Before-After/Control Impact (MBACI) design with reaches nested within Type Np basins. Each treatment basin is paired with a reference basin. Data will be collected two-years pre-treatment and at least two-years post-treatment.

Status:
The ENREP study design was approved by CMER to go to ISPR in November 2016. While the study design was at ISPR, CMER staff evaluated potential sites during the summer of 2017. The design was modified to incorporate site specific information as requested by ISPR and ISPR approved the study design on January 24, 2018. The study design, prospective findings reports, and implementation plan were approved by CMER on March 27, 2018 and project implementation began late summer 2018.

The initial GIS office screening identified 121 Type N basins that appeared to meet study criteria. Of these, landowners identified 26 for possible inclusion in the study. Field reconnaissance of the 26 basins revealed three suitable basin pairs for inclusion in the study, Springdale, Blue Grouse, and Tripps. After these initial basin pairs were identified, two additional basin pairs were located, Coxit and Fish Creek.

Two years of pre-harvest data (starting spring 2019) have been collected at the Springdale and Tripps basins. Harvest treatments were completed in 2021, and harvest year data has been collected at these basins. Two years of post-harvest data collection are planned for 2022 and 2023. At Blue Grouse, pre-harvest data collection began in 2019. Due to labor shortages and an extremely active fire season in the summer of 2021, harvest was delayed at Blue Grouse, and completed in February 2022. Given this delay, the data collection has captured three years of pre-harvest data. Monitoring was extended at the Blue Grouse basin through 2023 and 2024 to capture two years of post-harvest data.

Due to the two-year delay in locating the Coxit and Fish Creek sites, first year pre-harvest data collection began spring 2021. One year of pre-harvest data has been collected at these sites.

Harvest treatments are anticipated summer 2023.

5.2.6.11 Eastside Type Ns Effectiveness Project (ENSP)

Description:
The Eastside Ns Effectiveness Project will determine if and to what extent the prescription found in the Type N Riparian Prescription Rule Group for Ns streams in Eastern Washington maintain performance targets and water quality with a particular focus on effects in downstream typed waters. A substantial number of stream channels in the forested areas of Eastern Washington are managed as Ns streams (non-fish-bearing seasonally dry). Some of these channels flow directly into Type F waters (fish-bearing), while others occur directly above the point in the channel defined as the uppermost point of perennial flow. These channels are not protected by leaving treed buffers, and the effect to downstream channel stability and riparian functions remains largely untested.

This project's objective is to develop a literature review. The review will inform a field study to examine the effect of applying the Ns rules on the Type Np and Type F waters lying downstream.

Project Critical Questions:
The literature review seeks to answer the following critical questions:

- To what extent does applying the Eastern Washington Type Ns riparian prescriptions affect the water quality, quantity, and stream channel stability of downstream Typed waters?
- To what extent if any does not buffering Ns stream channels decrease the base-flow or increase magnitude or frequency of scouring flows in downstream Typed waters?
- To what extent if any does not buffering Ns stream channels increase water temperature, turbidity, or sediment in downstream Typed waters?
- To what extent, if any, does not buffering Ns streams affect the amount of channel stabilizing wood, and is there evidence this leads to changes in channel stability or sediment production and routing to downstream typed waters?

Status:
Not currently being scoped. Study design development is planned following the ENREP study.

5.2.6.12 Literature Review and Synthesis Related to the Salvage of Fire Damaged Timber

Description:
This project was intended to provide current peer-reviewed science related to the practice of salvaging fire damaged timber on Washington forests. The focus was on literature evaluating timber salvage after fire damage and its effects in and near riparian areas located in Eastern Washington and other regions throughout the country, and also studied what helps identify the best available science as it relates to various methods of timber salvage and the resulting regeneration of upland sites.

With the increased severity of wildfires, insect damage, and high wind events there is an associated increase in salvage FPAs. There is a need to understand if these approved salvaged harvests are adequate at maintaining water quality and performance targets. As required under WAC, approved salvage permits must meet or exceed the protections and functions provided by

existing rules.

This summary will serve as the basis for discussion within the AMP about the need and ability to identify and test best management practices for salvage logging.

Project Critical Questions:
The literature synthesis seeks to answer the following critical questions:

- What are the effects of salvage logging on riparian forest stands and how can ecological damage to riparian functions from salvage logging be reduced?
    1. Are there any significant differences between harvest methods in burned areas that potentially pose a greater risk to aquatic resources?
        a. To what extend does application of logging slash on skid trails affect sediment delivery to streams?
        b. Is there a difference in sediment delivery between salvage logging on snow covered versus non-snow covered land?
    2. Does soil disturbance from logging in burned areas increase erosion and delivery of sediment to streams?
        a. Do different logging methods change these impacts?
        b. What effects does hydrophobic soil have on erosion and sediment delivery?
- How can riparian forest stands and associated riparian functions be restored after fire?
    1. To what extent does leaving standing and dead trees within the RMZ contribute to riparian function?
        a. To what extent does down wood reduce erosion and sediment delivery to streams and wetlands? To what extent does the risk of sediment delivery change with stream and side slope gradients, different soil types, or with the intensity of the burn?
        b. To what extent do live standing trees and dead standing trees immediately adjacent to or over the stream bank contribute to bank stability? Are there any differences in the benefits provided by standing trees vs. stumps?
        c. To what extent does standing trees provide levels of shade that will mitigate the warming of streams or wetlands? Is buffer width critical and does this vary by stream size?
        d. To what extent are there differences between the rates of large woody delivery over time to streams where the burned RMZ is left in place, compared with one that is harvested and then replanted or allowed to reseed naturally after fire? Are there biogeographic areas that require or do not require replanting after salvage harvest?
        e. To what extent does excessive dead standing and/or down wood post fire affect the reforestation of the upland forest stand and the riparian area?
        f. To what extent do standing dead or down trees help promote the establishment of new seedlings post fire (whether planted or naturally re-seeded)?

Status:

The literature review proposal was approved by SAGE in December 2016. CMER and Policy approved this project and funding for the project in January 2017. A contractor was selected and the operating contract completed in March 2017. The project was completed and CMER approved in March 2018.

5.2.7 Type N Amphibian Response Program (Effectiveness)

5.2.7.1 Program Strategy

The restricted distribution of stream-associated amphibians (SAAs) and the lack of information about them required development of an amphibian response strategy that differs from that of many other rule groups or programs. The Type N Amphibian Response Program began with development of tools needed to implement the Type N buffer rule for sensitive sites (i.e., methods for identifying and characterizing SAA sensitive sites) and procedures to detect and determine the relative abundance of SAAs for monitoring purposes. During this time, other projects were undertaken that were designed to determine critical monitoring questions for some species (i.e., tailed frog literature review and meta-analysis) or to answer species-specific L-1 questions (i.e., related to Dunn's and Van Dyke's salamanders). This program is administered by LWAG. This program is ranked third among the 16 CMER programs.

The uneven abundance and distribution of SAAs limit study options for the amphibian response program. LWAG determined that an extensive monitoring project for SAAs would not provide useful information for the AMP, and the uneven distribution of SAAs prevented effective integration with other monitoring projects. LWAG concluded that any monitoring program must focus on those physical factors (e.g., geology) that appear to affect SAA distribution, abundance, and response to timber harvest (i.e., the Type N Experimental Buffer Treatment Project in Hard Rock Lithologies).

The purpose of this program is to address critical questions about the response of SAAs to forest practices, particularly the Type N riparian prescriptions. Many uncertainties exist about SAAs' distribution, life history, habitat-utilization patterns, and population dynamics. Uncertainties also exist on the effects of forest practices on SAA habitats and the response of SAA populations to these changes. Consequently, the Type N riparian rule assumes that buffering of perennial Type N streams around "sensitive" sites (sites thought to provide high-quality SAA habitat) will contribute to maintaining the viability of SAA populations. These assumptions and uncertainties have been examined and used to develop a series of sub-questions under the main critical question (Table 13).

Table 13. Type N Amphibian Response Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions		Project Names
Is stream-associated amphibian (SAA) population viability maintained by the Type N prescriptions?		
	Do SAAs continue to occupy and reproduce in the patch buffers? *Do SAAs continue to occupy and reproduce in the equipment limitation zone (ELZ)–only reaches?*	SAA Detection/Relative Abundance Methodology Project

Program Research Questions	*If SAAs do not continue to occupy the ELZ-only reaches, do they re-occupy those reaches before the next harvest?* *How does SAA habitat respond to the sensitive site buffers?* *How does SAA habitat respond to variation in inputs; e.g., sediment, litterfall, wood?* *How do SAA populations respond to the Type N prescriptions over time?*	Type N Experimental Buffer Treatment Project in Hard Rock Lithologies Van Dyke's Salamander Project Coastal Tailed Frog Extensive Project
	What are the common findings and inconsistencies in published studies on the effects of timber harvest on tailed frogs?	Tailed Frog Literature Review Project

Rule Group Critical Questions		**Project Names**
	What can be learned from a meta-analysis of published data and unpublished data on tailed frogs in managed forests? *Are published generalizations on the relationship between parent geology and tailed frog abundance correct and consistent?*	Tailed Frog Meta-Analysis Project Tailed Frog and Parent Geology Project
	What are the common findings and inconsistencies in published studies on the habitat associations of Dunn's and Van Dyke's salamanders? *Does territoriality confound interpretation of SAA relative abundance in relation to specified habitats?* *How does large wood and decay class affect the distribution and abundance of Van Dyke's salamander?* *How common are the riparian microhabitats that support Van Dyke's salamanders and how does harvest under current FP rules effect the persistence of those microhabitats and the species?*	Dunn's Salamander Project Van Dyke's Salamander Project
	What are the effects of various levels of shade retention on the stream-breeding SAAs? *Is there an optimum level of shade retention?*	Buffer Integrity – Shade Effectiveness Project
	What are the effects of three buffer treatments on SAAs two years post-harvest?	Amphibian Recovery Project Type N Experimental Buffer Treatment Project in Hard Rock Lithologies
	How do SAAs utilize intermittent stream reaches at or near the origins of headwater streams? *How do site-specific factors (e.g., streams dominated by ground water) affect abundance and condition of amphibian populations?* *What is the frequency of occurrence of discontinuous surface flow in streams across the landscape?*	Discontinuous Np Project
	What is the effect of road-generated sediment on in-stream amphibians?	No current project
	What is the effect of fertilizer and herbicides applied as a silvicultural treatment on amphibians? *What are the exposure risks of herbicides applied as a silvicultural treatment to amphibians?*	No current project

	Does the distribution of FP HCP-designated amphibians on FP-managed lands across Eastern Washington warrant inclusion in CMER research?	Eastside Amphibian Evaluation Project
	How should changes in detection across soil and air temperature ranges affect use of previously completed studies?	No current project
	How do Coastal Tailed Frog populations respond to the Type N prescriptions over time?	Coastal Tailed Frog Extensive Status Project

5.2.7.2 SAA Detection/Relative Abundance Methodology Project

Description:
The SAA Detection/Relative Abundance Methodology Project is designed to evaluate and develop a standard methodology for sampling SAAs in headwater forest streams. It addresses the need for a research/monitoring methodology to detect amphibians and determine their relative abundance. The most widely used methods produce high-variance estimates, and detection probabilities are unknown.

Status:
This project was completed in 2006, and details have been published in Journal of Wildlife Management.

5.2.7.3 Tailed Frog Literature Review Project

Description:
Of the seven SAAs addressed in the FP HCP, the two tailed frog species are the most extensively studied due to their wide distribution in the coastal Pacific Northwest. There are enough published studies on this species that a synthesis of those results will be useful in helping LWAG develop a research and monitoring program. A draft literature review was completed in 2011. The recent reclassification of the tailed frog into two species required the review to be restructured while in progress, to reflect that taxonomic revision.

Status:
The draft review was completed in 2011. It was submitted to LWAG for review in December 2011 and it went to CMER in March 2012. It was approved to go to ISPR in October 2012. It was returned from ISPR review in June 2013. The final report was finalized in 2015.

5.2.7.4 Tailed Frog Meta-Analysis Project

Description:
Published and unpublished data are being subjected to a meta-analysis that will relate tailed frog abundance with habitat conditions created by timber harvest. This analysis may or may not support the conclusions of the tailed frog literature review described above, and will likely identify other factors related to tailed frog distribution and response to timber harvest that will be useful in developing the Type N Amphibian Response Program. The recent reclassification of the tailed frog into two species required the meta-analysis to be restructured while in progress, to reflect that taxonomic revision.

Status:
The six data sets were formatted, checked for quality assurance / quality control (QA/QC), and analyzed in a pilot study that was published as a CMER report in 2002. LWAG decided not to continue development of a potentially larger project because of issues with non-conforming

datasets, and inability to integrate corrections addressing detectability, both of which prevented rigorous analysis.

5.2.7.5 Tailed Frog and Parent Geology Project

Description:
Recent studies in managed forests have emphasized the relationship between parent geology, stream substrate composition, and tailed frog abundance. A general hypothesis has emerged that tailed frogs are most abundant in streams on lithologies that produce hard or competent rock (e.g., volcanic basalt) versus those that do not (e.g., marine sandstones). However, a study in Olympic National Park found that tailed frogs were abundant on both marine and volcanic parent material, and a broader regional study, performed in 2008, did not find a clear pattern linked to lithologies. These studies were largely observational and the distinction between geologies was extrapolated from the results. The Tailed Frog and Parent Geology project would test the parent geology hypothesis throughout Washington.

Status:
This project has not been scoped.

5.2.7.6 Dunn's Salamander Project

Description:
The FP HCP indicates that LWD may be important for Dunn's and Van Dyke's salamanders. However, general habitat descriptions for both species emphasize the importance of streamside rocky substrates. A literature review to determine the basis for the LWD connection to these species was completed external to CMER in 2000. The initial field phase of this project, completed in cooperation with the Forest Service in 2001, was designed to provide additional information on the role of LWD in these species' habitats. The initial field phase collected data across too few sites to complete an effective analysis, so a second phase of field data took place in 2003.

Status:
Analysis of data from both phases has been completed and a final report was approved by CMER in 2011.

5.2.7.7 Buffer Integrity – Shade Effectiveness (Amphibians) Project

Description:
Timber harvests result in two important, immediate physical changes: reduction in shade levels and increased sedimentation. During harvests these changes are coupled, so it is typically not possible to partition their respective contributions. Understanding their individual effects is important because sediment is suspected of having largely negative effects, whereas shade reduction has potentially positive effects. The Buffer Integrity – Shade Effectiveness Project examined the effects of reducing shade on a scale that minimizes sedimentation effects. This project examined the effects of three levels of shade reduction on SAA density, body condition, and spatial distribution, as well as water temperature, primary productivity, litterfall and macroinvertebrates. This is a cooperative project between Longview Timberlands LLC and CMER. Longview Timberlands LLC completed a pilot study in 2003 and initiated a broader study in 2004. The study area was increased with CMER approval to include WDFW-monitored sites on the Olympic Peninsula. Though the original study was intended to address all major

groups of SAAs (i.e., tailed frogs, torrent salamanders, and giant salamanders), the available SAA-occupied sites on the eastern Olympia Peninsula lacked the giant salamander species—Cope's giant salamander—present on much of the peninsula. Hence, the Olympic portion of the study addressed only tailed frogs and torrent salamanders.

Status:
The first two years of pre-treatment sampling occurred in 2006 and 2007. Treatments were implemented during the winter of 2007–2008, and two years of post-treatment sampling were completed in 2008 and 2009. A draft report was completed in 2012, underwent CMER review, and went to ISPR in mid-2013. The report was revised several times, approved by ISPR in August 2018, and final approval by CMER occurred in October 2018.

5.2.7.8 Amphibian Recovery Project

Description:
In 1998, the National Council for Air and Stream Improvement (NCASI) funded a study by Dr. Rhett Jackson on the effects of three buffer treatments on headwater streams in the Willapa Hills and Olympic Peninsula. Many of the FP HCP SAAs occurred on these sites. The NCASI funding covered a year of pre-treatment data and immediate post-harvest sampling. CMER funding allowed for the collection of an additional two years of post-harvest data.

Status:
This project was completed in 2003, and four journal articles have been published. One of the publications addresses amphibian response and contains information pertinent to the Type N Amphibian Response Program.

5.2.7.9 Water Temperature and Amphibian Use in Type Np Waters with Discontinuous Surface Flow Project (formerly Amphibians in Intermittent Streams Project)

Description:
The Water Temperature and Amphibian Use in Type Np Waters with Discontinuous Surface Flow project (i.e., Discontinuous Np project) seeks to evaluate the influence of discontinuous surface flow in Type Np Waters on stream temperature and amphibian use. This project will inform the effectiveness of FP rules for riparian buffer placement on Type Np Waters, including insights on buffer placement to maximize resource protection to support the Overall Performance Goals of meeting water quality standards and the long-term viability of covered species. The scoping of this project will incorporate a synthesis of existing CMER data and relevant published literature. Determining the influence of intermittent reaches on water temperatures and FP-designated amphibian use would provide important information for evaluating the relative benefits of riparian buffers on intermittent reaches, ultimately informing the riparian buffer rule for Type N streams.

Project Critical Questions:
- What is the effect of buffering or not buffering spatially intermittent stream reaches in Type Np streams?
- How do stream-associated amphibians (SAAs) utilize intermittent stream reaches near the origins of Type N (headwater) streams?
- How do site-specific factors (e.g., streams dominated by ground water) affect abundance and condition of amphibian populations?
- What is the frequency of occurrence of discontinuous surface flow in streams across the

landscape?

Status:
Scoping is currently underway and anticipated to be completed in FY22.

5.2.7.10 Van Dyke's Salamander Project

Description:
The Van Dyke's salamander, found only in Washington State, is the least studied of the seven Forests and Fish FP-covered amphibian species; it is not adequately addressed by any previous or current study. Conflicting information exists regarding the population viability of Van Dyke's salamander on managed landscapes. This species has a cool-adapted life history, which may make it vulnerable to Forest Practices activities, especially under future probable climate change scenarios for the Pacific Northwest.

LWAG completed a literature review and assembled occurrence information to inform study design development. Additional effort to address duplicity and poor accuracy in the occurrence database is recommended to support a more comprehensive understanding of the historic distribution. Future work should be considered and a more accurate database of known occurrence information will inform alternative study design frameworks.

Project Critical Questions:

- How do SAA populations respond to the Type N prescriptions over time?
- How common are the riparian microhabitats that support Van Dyke's salamanders and how does harvest under current FP rules effect the persistence of those microhabitats and the species?
- What are the common findings and inconsistencies in published studies on the habitat associations of Dunn's and Van Dyke's salamanders?
- How does large wood and decay class affect the distribution and abundance of Van Dyke's salamander?

Status:
A literature review that also addressed known distribution, was completed in FY 2019. This project has not been scoped.

5.2.7.11 Eastside Amphibian Evaluation Project

Description:
Previous CMER-supported research informing the effectiveness of Forest Practices in meeting the Overall Performance Goal of maintaining long-term viability of other covered species focused entirely on managed landscapes in western Washington. The Type N Experimental Buffer Treatment Project in Hard Rock Lithologies focused entirely on managed landscapes in western Washington. The reason for this focus is because most FFR-designated FP-covered amphibians have westside distributions, and those with eastside distributions are believed to have little overlap with eastside managed FP landscapes. However, this latter assumption is based on limited coarse-level data available from Washington GAP Analysis modeling. A focused

inventory would be required to determine the actual distribution overlap in managed landscapes.

LWAG proposes to conduct a literature review and develop a distribution map overlaying the occurrences of FP HCP -designated amphibians with FP-managed lands in eastern Washington. Two FP-designated amphibians, Coastal Tailed Frog and Rocky Mountain Tailed Frog, are known to occur East of the crest of the Cascades. These products will help inform FP-designated amphibian distribution on eastside managed landscapes as well as priorities for future CMER work. The Eastside Amphibian Evaluation Project is a relatively simple occupancy study being considered to address the distribution of FFR-designated amphibians, to determine if their distribution on eastside managed landscapes deserves larger study attention. The study would incorporate the probability of detection to ensure accurate occupancy descriptions across the eastside FFR landscape. Note: This project is listed under Type N Amphibian Response Program, but its assessment may encompass at least some of the Type F landscape.

Project Critical Questions:

- Does the distribution of FP-designated amphibians on FP-managed lands across Eastern Washington warrant inclusion in CMER research?

Status:
This project is under consideration and has not yet been scoped.

5.2.7.12 Coastal Tailed Frog Extensive Status Project

Description:
The proposed Coastal Tailed Frog Extensive Status project is motivated by the negative response to harvest of Coastal Tailed Frog observed in the Type N Hard Rock project at the headwater sub-basin (harvest unit) scale 7- and 8- years post-harvest. A broader, landscape-scale assessment of Coastal Tailed Frog occupancy across the landscape will provide insight into the current status of this FP-designated species. This project would build on previous CMER work including a literature review on the species completed in 2015, baseline genetic neighborhood effort to explore population bottlenecking conducted in 2006-2008 as a part of the Type N Hard Rock project, and the stream-associated amphibian response data from the Type N Hard Rock project. Improved genetic analysis tools are available to evaluate Coastal Tailed Frog status for both long-term Type N Hard Rock Study sites and at broader spatial scales greater than individual Type N basins.

Project Critical Question

- How do Coastal Tailed Frog populations respond to the Type N prescriptions over time?

Status:
This project has not been initiated or scoped.

5.2.8 Extensive Riparian Status and Trends Monitoring Program

5.2.8.1 Program Strategy

The purpose of the Extensive Riparian Status and Trends Monitoring Program is to provide data needed to evaluate landscape-scale effects of implementing forest practices riparian prescriptions. This information will inform State and Federal regulatory agencies whether the

forest practices rules can meet Clean Water Act requirements and riparian resource objectives at the landscape level. Knowing what is on the landscape is also important to help CMER prioritize, plan, conduct, and interpret other CMER studies and monitoring work. It would aid in making decisions about where best to focus CMER research efforts and answer questions about the scope of inference and importance of study findings. Critical questions for this program are shown in Table 14.

An extensive temperature and riparian conditions effort was initiated in 2007-8. The projects of that program were designed to obtain an unbiased estimate of the distribution of stream temperature and shade and of riparian stand characteristics on streams across FP HCP lands and, with resampling, the projects were intended to identify trends in these indicators. Those projects were stratified by the east and west portions of the state and by F and N stream types. That effort was discontinued after the first sampling event when CMER recommended to Policy to pursue remote sensing techniques as an alternative to field-based data collection.

After discussions evaluating the results from the initial effort, "Policy directed RSAG to consider high-level options for how to move forward on extensive monitoring as well as options for other extensive studies. This should include perspectives considering the past and future as well as existing technologies. RSAG should also consider other monitoring approaches to landscape-level performance." (July 11, 2013 Policy meeting notes). RSAG was asked by CMER and the TFW Policy Committee to provide a "high level" assessment of using remote sensing and other tools to implement projects within this program. In response to the Policy request, RSAG moved forward with projects that would investigate the utility and cost- effectiveness of using remote sensing technology (i.e., LiDAR, aerial, and satellite imagery) for assessing the status and trends of riparian stand conditions and functions across all HCP lands. The RSAG investigations to date have provided a good understanding of the availability, feasibility, limitations and relative cost for using some of the newer remote sensing technologies to conduct extensive (status and trends) monitoring. Policy and CMER are currently working together to develop specific research questions, that will provide RSAG direction on how to proceed with future projects in this program.

Table 14. Extensive Riparian Status and Trends Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions*	Project Names
What is the current status of riparian conditions and the HCP-specified functions in and along Type F/N streams on a statewide scale, and how are conditions changing over time?	

Program Research Questions	*What is the distribution of maximum summer stream temperature and 7-day mean maximum daily water temperature on FP HCP lands, and how is the distribution changing over time as the forest practices prescriptions are implemented?* *What proportion of stream length, at the landscape scale, on FP HCP lands meets specific benchmarks for water temperature, and is this proportion changing over time as the forest practices prescriptions are implemented?* *What are current riparian stand attributes on FP HCP lands, and how are stand conditions changing over time as the forest practices prescriptions are implemented?*	Extensive Riparian Status and Trends Monitoring – Temperature, Type F/N Westside Extensive Riparian Status and Trends Monitoring – Temperature, Type F/N Eastside Extensive Riparian Status and Trends Monitoring – Vegetation, Type F/N West/Eastside
How does stream shading change with buffer width and intensity of management across a range of stand types and characteristics in Washington?		
Program Research Question	*How does stream shading change with buffer width, stand conditions, and treatments (e.g., basal area, density, age, height, and thinning)?*	Riparian Characteristics and Shade Response Study

** Currently being developed as a joint Policy/CMER effort.*

5.2.8.2 Extensive Riparian Status and Trends Monitoring – Temperature, Type F/N Westside (Initial Status Effort)

Description:
This project is intended to develop unbiased estimates of the frequency distribution of Type F/N stream temperatures across FP HCP lands in western Washington. Stream temperatures are monitored upstream and downstream from each study reach. Along with stream temperature measurements, air temperature, shade, riparian vegetation type, LWD, and several channel measurements are collected

Status:
Sampling has been completed. The final report was initially reviewed by RSAG and CMER then revised again based on comments received during ISPR of the Eastside Type F report. The revised report was reviewed by RSAG, CMER, and ISPR. The final report was approved by CMER on April 23, 2019.

5.2.8.3 Extensive Riparian Status and Trends Monitoring – Temperature, Type F/N Eastside (Initial Status Effort)

Description:
This project is intended to develop unbiased estimates of the frequency distribution of Type F/N stream temperatures across FP HCP lands in eastern Washington. Stream temperatures are monitored upstream and downstream from each study reach. Along with stream temperature measurements, air temperature, shade, riparian vegetation type, LWD, and several channel measurements are also collected.

Status:
Approximately 50 sites were sampled in Type F streams over the 2007 and 2008 summer seasons. The revised report was completed and approved by Policy in June 2013.

Initial site screening occurred in the summer of 2008 in Type N streams. Only 10% of the sites inspected had flow during the summer monitoring season (site requirement), when peak temperatures occur. The Policy committee decided to deprioritize the Eastside N strata as part of a negotiated settlement of the Master Project Schedule in 2014.

5.2.8.4 Extensive Riparian Status and Trends Monitoring – Vegetation, Type F/N Westside and Eastside Projects

Description:
This effort is currently undergoing further development. The Type F/N eastside and westside studies are expected to be performed concurrently. These projects will assess riparian conditions in Type N, F, and S stream reaches across FP HCP lands in the state in order to estimate conditions statewide. The method(s) of sampling has yet to be determined. The vegetation assessment component will consider the recommendations from the Extensive Riparian Vegetation Monitoring – Remote Sensing Pilot Study that was completed in the Mashel River Watershed by the Precision Forestry Cooperative (PFC) at the University of Washington. The feasibility of using the same sites used in the Extensive Riparian Status and Trends Monitoring temperature study will be investigated.

Status:
In 2006 a pilot study evaluated the accuracy of deriving riparian stand metrics from different scales of aerial photos compared to stand data from ground surveys. The contractor concluded that large-scale aerial custom photography could meet riparian assessment needs if combined with other remote sensing (e.g., Lidar) to accurately locate streams. Further study to evaluate the utility and cost effectiveness of using other remote sensing technology including satellite imagery was recommended, but no new work was planned in 2006.

A literature synthesis was completed by the PFC at the University of Washington in June of 2015. PFC reviewed articles on the use of remote sensing to evaluate the cost and value of various remote sensing tools to quantify 13 riparian forest metrics. This literature review was specifically requested by Policy in March of 2015 to inform decision-makers on what remote sensing methods they may want to test in a pilot project.

The purpose of that first pilot project was to determine if remote sensing can be used in conjunction with traditional field work to accomplish the purposes established in the CMER Work Plan and the Monitoring Design Team report (MDT 2002) for extensive status and trend vegetation analysis. This project looked at riparian vegetation on all stream types—S, F, Np and Ns—and all ownerships in the Mashel watershed under the "Extensive Riparian Vegetation Monitoring - Remote Sensing Pilot Study Agreement No. IAA 16-205". CMER and Policy approved this pilot project for riparian extensive vegetation monitoring, which began in November of 2015 and was completed in July of 2017. Scoping for a second pilot, the Extensive Riparian Vegetation Monitoring Implementation Pilot Study, was completed by PFC in June of 2018. This study was intended to explore the feasibility of applying the methodology and model to other regions of the state and provide a better understanding of remote sensing data availability, cost, and recommendations for how to implement an inventory of riparian vegetation conditions across FP HCP lands in Washington State. The scoping document and prospective findings report were delivered to Policy in 2019.

The key component of this study was to test the transferability of forest inventory models developed in the Mashel watershed to other watersheds. Although the original intent was to implement this pilot in eastern Washington and then the northwest coast, an opportunity arose to

test it using existing field data from the Olympic Experimental Study Forest. The transferability of Mashel models to predict DBH, basal area, and stand density were tested using forest inventory plot data that was collected by DNR in the Olympic Experimental State Forest (OESF). The final report was approved by CMER in January of 2020 and was presented to Policy in May of 2020.

Based on this previous work, RSAG and CMER developed and approved a Status and Trends Strategy and presented it to Policy in October of 2019. CMER has requested that Policy provide direction on the priority questions that need to be addressed prior to beginning any additional Extensive Status and Trends projects. A joint CMER/Policy workshop was held on extensive monitoring methods and efforts in use by other entities to help inform how to advance the FP Adaptive Management Program efforts. Further action on implementation depends on the outcome of ongoing CMER and Policy deliberations

5.2.8.5 Riparian Characteristics and Shade Response Study

Description:
The purpose of this study is to estimate how stream shade responds to a range of riparian harvest treatments within and among environments (ecoregions) common to commercial forestlands covered under the Forest Practices Habitat Conservation Plan (FPHCP). This study will use a before/after empirical research approach based on a two-factor experimental design to estimate stream shade response to different riparian buffer configurations. The two factors to be examined are: 1) stream-adjacent no-harvest zone width and 2) adjacent-stand harvest intensity.

Results from this study will help the Adaptive Management Program interpret and respond to ongoing and future monitoring studies that directly test both shade and temperature, and will provide information about how well alternative riparian buffer prescriptions meet shade targets. Four study alternatives were identified in the approved scoping document and presented to the TFW Policy Committee. In November 2018 Policy directed CMER to develop a study design based on CMER's preferred alternative.

Status:
A project Scoping Document was approved by Policy in November 2019. The Study Design was approved by ISPR January 2022, and approved by CMER on March 22, 2022. A field trial was conducted summer 2022 to validate the field methods, logistics, analytical work flow, and to enable refinement of the study cost estimates.

5.2.8.6 Wood Recruitment Volume and Source Distances from Riparian Buffers Project

Description:
Forest Practices Habitat Conservation Plan (FPHCP) uses riparian buffers to meet the functional resource objective for large wood recruitment/ habitat complexity. Source-distance curves and volume estimates developed with data from unmanaged forests in western Oregon (McDade et al. 1990) and various wood recruitment models (i.e. FEMAT) were used to design the FPHCP riparian buffers. It seems reasonable to expect that wood recruitment volumes and source distances in riparian buffers consisting of younger stands characteristic of managed forest lands would differ from unmanaged stands or modeled outputs, due to factors such as tree height, species composition, and disturbance in buffers exposed to wind and other disturbances when the adjacent stand is harvested. The buffer widths in the FPHCP were based on wood

recruitment source distances from a study on mature stands. The stands currently being managed under the FPHCP are predominantly younger riparian stands and there is uncertainty whether the results of McDade et al. 1990 are applicable to younger riparian stands with adjacent harvest over the course of their development. There has been a wealth of wood recruitment work since the 1990s that has improved our knowledge of wood source distances in conditions that tend to be present across HCP lands.

Status:
RSAG is writing a charter for this project. The charter includes problem statement, objectives, and questions of interest. The degree to which this topic can be answered within or in conjunction with other studies such as the Westside Type F Prescription Effectiveness Monitoring Project and how this work relates to any windthrow investigation (5.2.6.5) are part of the charter and scoping discussions.

5.3 TYPE F RIPARIAN PRESCRIPTIONS RULE GROUP

5.3.1 Rule Overview and Intent

The FP HCP recognizes differences in riparian systems and processes between eastern (eastside) and western (westside) Washington. However, though the Type F riparian rules prescribe different protection strategies for eastern and western Washington riparian management zones (RMZs), they also share some basic characteristics. The common characteristics are RMZs equal in width to a site-potential tree height and divided into three zones: core, inner, and outer. All zones are intended to provide key riparian functions, including bank stability, shade, wood recruitment, litterfall, and preventing sediment delivery to streams caused by surface erosion. The core zone is adjacent to the stream and is a no-harvest zone. The core zone is intended to provide most key riparian functions. The inner zone extends outward from the core zone and is primarily intended to provide additional shade and large woody debris (LWD) recruitment. The outer zone extends the RMZ out to one site-potential tree height.

During development of the Forests and Fish Rules, the protection of bull trout was determined to be an area of special concern because the species was listed under the Endangered Species Act (ESA) as threatened throughout its geographical distribution in Washington. A main factor contributing to bull trout's threatened status is the degradation of habitat, especially increasing stream temperatures. Bull trout require cooler stream temperatures than other salmonids. The water quality standards in place at the time of forest practices rule development were assumed to be too warm for bull trout. The proposed rule protection strategies for shade and stream temperature were assumed to be more at risk in eastern Washington than in western Washington because of the potential for more shade removal from within eastside RMZs, combined with warmer eastside air temperatures. Therefore, an additional shade rule to be applied within the bull trout habitat overlay (BTO) was prescribed for eastern Washington riparian rules in order to provide adequate stream temperature protection for bull trout (see section below on eastside Type F rules for further details). The additional shade rule does not apply to western Washington.

The specific rule protection strategies for western and eastern Washington are described separately in the sections below.

Westside Type F Rules:
The FFR described the goal of the riparian strategies for westside Type F (fish-bearing) streams as follows:

> "Riparian silvicultural treatments and conservation measures that are designed to result in riparian conditions on growth and yield trajectories towards what are called 'desired future conditions.' As used in this report, desired future conditions are the stand conditions of a mature riparian forest, agreed to be 140 years of age (the midpoint between 80 and 200 years) and the attainment of resource objectives.… These desired future conditions are a reference point on the pathway to restoration of riparian functions, not an endpoint of riparian stand development."

The western Washington Type F riparian rules are based upon the following assumptions:

- The desired future condition (DFC) basal area targets adequately describe mature riparian forest conditions (140 years old).
- Stands meeting the DFC targets will provide the aquatic habitat conditions needed to achieve functions and to meet the overall performance goals and resource objectives.
- The growth model used for DFC adequately projects riparian growth and mortality.
- Some hardwood-dominated riparian stands need to be converted to conifer in order to achieve DFC.

Western Washington RMZs consist of three zones, including the following:

1. A 50-ft.-wide no-harvest core zone.
2. An inner zone extending from 10 to 100 ft. beyond the core zone (depending on the site class and stream size) where the timber harvest management objective is to place the combined core and inner zone on a trajectory to grow into the DFC.
3. An outer zone extending beyond the inner zone to the edge of the RMZ where timber harvest is managed to protect special sites and wildlife habitat, and to provide for one site-potential tree height, required by the Federal Services under the FP HCP.

Eastside Type F Rules:
The goals for the eastern Washington Type F riparian rules are to provide for stand conditions that (1) vary over time within the range of historical disturbance regimes; (2) provide riparian functions needed to meet resource goals for fish, amphibians, and water quality; and (3) maintain forest health by minimizing risk of catastrophic damage from insects, disease, or fire.

The eastern Washington Type F riparian rules are based upon the following assumptions:

- The management strategies in the Type F rules will put stands in the RMZ on a trajectory that is within the range of natural variability.
- The defined elevation bands are reasonably accurate reflections of the spatial distribution of historical disturbance regimes and species compositions.
- The management strategies will minimize risk of catastrophic events within the RMZs.
- The management strategies will put stands on a trajectory that will provide the riparian functions needed to support harvestable populations of fish.
- The shade/temperature overlays are necessary to provide stream temperatures that meet the state water quality standards and the needs of bull trout.

Eastern Washington Type F rules consist of three riparian zones, including the following:

1. A 30-ft.-wide no-harvest core zone.
2. An inner zone that is 45 to 70 ft. wide (depending on site class and stream size).
3. An outer zone between 0 and 55 ft. wide.

The sum of the core, inner, and outer zones approximates the height of a site-potential tree, which varies with site class. Allowable harvest within the inner and outer zones is different for each of three elevation bands, referred to as timber habitat types in the rules. These elevation

bands were intended to emulate variations in natural disturbance regimes, variations in species distributions, and other riparian characteristics. Guidance for selecting RMZ leave trees based on size and species are intended to move riparian stand conditions toward larger trees of fire- and disease-resistant species.

Two shade rules exist for the eastside Type F riparian rule package. The first is the Standard Shade Rule, which defines the amount of shade needed to meet state water quality standards (in place at the time of rule development) using the nomograph in Section 1 of the Forest Practices Board Manual. The second is the all-available shade rule, which applies to areas within the BTO. The BTO is an area defined on a map that depicts the distribution of known and potentially suitable bull trout habitat in eastern Washington. When a timber harvest unit is located within the BTO, all available shade (as determined by a densiometer) must be retained within 75 ft. of the bankfull channel width or channel migration zone (CMZ), whichever is greater. Outside of the BTO, prescriptions fall under the Standard Shade Rule, which can allow for harvest of a portion of shade trees within the 75 ft., depending on elevation and the amount of canopy cover prior to harvest.

The FP HCP assumes that riparian forests managed in accordance with western and eastern Washington riparian rule strategies will provide adequate levels of key riparian functions (providing LWD, bank stability, shade, and nutrients and preventing sediment input to streams) necessary to meet the resource objectives and performance targets outlined in the FP HCP.

5.3.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:

- Heat/Water Temperature: Provide cool water by maintaining shade, groundwater temperature, flow, and other watershed processes controlling stream temperature.
- LWD/Organic Inputs: Develop riparian conditions that provide complex habitats for recruiting LWD and litter.
- Sediment: Provide clean water and substrate and maintain channel-forming processes by minimizing to the maximum extent practicable the delivery of management-induced coarse and fine sediment to streams (including timing and quantity) by protecting stream-bank integrity, providing vegetative filtering, protecting unstable slopes, and preventing the routing of sediment to streams.
- Hydrology: Maintain surface and groundwater hydrologic regimes (magnitude, frequency, timing, and routing of stream flows) by disconnecting road drainage from the stream network, preventing increases in peak flows causing scour, and maintaining the hydrologic continuity of wetlands.

Performance Targets:

- Stream Temperature: Meet water quality standards.
- Shade:
    - In type F and S streams, except eastside bull trout habitat, meet targets produced by the shade model or, if this model isn't used, reach 85–90% of all effective shade.
    - Eastside target is all available shade within 75 ft. of designated bull trout habitat

per predictive model.

- Riparian Condition:
    - In westside and high-elevation eastside habitats, riparian stands are on pathways to meet DFC targets (species, basal area, trees per acre, growth, and mortality).
    - On the eastside, only the high elevation zone has a desired future condition (DFC); and current stands on pathways to achieve eastside condition ranges for each habitat series.
- Pool Frequency: Meet target of less than 2 channel widths per pool.
- Sediment:
    - Mass wasting – target is virtually none triggered by new roads, and a favorable trend on old roads.
    - Timber harvesting-related—target is no increase over natural background rates from harvest on a landscape scale on high-risk sites.
    - Old roads are not to exceed 0.15-0.25 (ratio of road length delivering to streams/total stream length in miles) in the coast (spruce) zone and west of the crest; 0.08-0.12 east of the crest. Old roads are not to exceed 6-10 T/yr (ratio of road sediment production delivered to streams/total stream length in tons/year/mile) in coast (spruce) zone; 2-6 T/yr west of the crest; and 1-3 T/yr east of the crest.
    - Targets include no stream-bank disturbance outside road crossings on S/F streams; less than or equal to 10% of the equipment limitation zone (ELZ); and less than 12% embedded fines (< 0.85 millimeters).
- In-stream LWD:
    - Westside – 5% of recruitment potential for stands on the trajectory toward DFC, with additional recruitment from trees in the outer zone. See Schedule L-1 for details on numbers of pieces[1].
    - Eastside – To be developed, based on eastside disturbance regimes.

[1] Details for the number of in-stream LWD pieces are found in the Schedule L-1 version adopted by the Forest Practices Board on 02-14-01.

- Residual Pool Depth: See Schedule L-1 for details[2].
- Stream/ELZ disturbance: No stream-bank disturbance outside road crossings.
- Peak Flows: Westside – target is not to cause a significant increase in peak flow recurrence intervals resulting in scour that disturbs stream-channel substrates that provide actual or potential habitat for salmonids, attributable to forest management activities[3]. Increases in two-year peak flows related to forest management (roads and harvest) are less than 20%[4].
- Groundwater Temperature: To be developed.

5.3.3 Rule Group Strategy

Uncertainties exist about the validity of the above-mentioned assumptions and effectiveness of the rules to achieve resource objectives and performance targets; this uncertainty leads to a series of critical questions and programs to address them (Table 15). The programs include the following:

1. The DFC Validation Program, a rule tool program that addresses the validity of the westside DFC performance targets and the accuracy of the DFC model that is used to project stand trajectory to age 140. The purpose of this program is to validate the DFC approach for management of western Washington, conifer-dominated riparian stands on fish-bearing streams.
2. The Eastside Riparian Type F Rule Tool Program, which assesses current riparian stand and stream conditions on Type F streams across the eastside to provide a baseline for effectiveness monitoring and for establishing eastern Washington targets.
3. The Eastside Type F Riparian Effectiveness Program, which addresses the effectiveness of eastside Type F prescriptions in meeting riparian functions and resources conditions.
4. The Westside Type F Riparian Effectiveness Program, which addresses effectiveness of the Type F riparian rules in meeting performance targets and achieving resource objectives.
5. The Bull Trout Habitat Identification Program, which is a rule tool program. The primary goal of this program was to develop protocols and/or predictive models for determining sampling efficiency, presence/absence of bull trout, and habitat suitable to support bull trout. Site-specific data on bull trout presence/absence above barriers or habitat suitability would help to identify areas that might be added or removed from the bull trout habitat overlay, as defined in the rule. The work for this program has been completed and no further work is planned at this time.

[2] Details for residual pool depths are found in the Schedule L-1 version adopted by the Forest Practices Board on 02-14-01.

[3] From Schedule L-1, Appendix H to Forests and Fish Report.

[4] From Schedule L-1, version adopted by Forest Practices Board on 01-14-01.

6. The Hardwood Conversion Program, which addresses uncertainty regarding strategies and prescriptions for managing hardwood-dominated riparian stands by harvesting the hardwood and reforesting the area with conifer.
7. The Extensive Riparian Status and Trends Monitoring Program, which documents status and trends of riparian conditions on Type F streams on a landscape scale.
8. The Intensive Monitoring/Cumulative Effects Program, which is designed to evaluate the cumulative effects of multiple forest practices on a watershed-scale, and to improve our understanding of causal relationships and the biological effects of forest practices rules on aquatic resources.

Table 15. Type F Riparian Prescriptions Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Name	Task Type	SAG
Does the DFC model adequately project stand basal area growth to age 140? Do the basal area targets adequately describe mature riparian forest conditions?	DFC Validation Program	Rule Tool	RSAG
What is the current range of conditions for eastside riparian stands and streams? What are appropriate LWD performance targets? Can the shade/temperature relationships in the eastside temperature nomograph be refined? How does stream shading change with buffer width and intensity of management across a range of stand types and characteristics in Washington? Will application of the prescriptions result in stands that achieve eastside FP HCP objectives (forest health, riparian function, and historical disturbance regimes)?	Eastside Type F Riparian Rule Tool Program	Rule Tool	RSAG/ SAGE
How can habitat suitable for bull trout be identified?	Bull Trout Habitat Identification Program	Rule Tool	Former BTSAG
Are the Type F riparian rules effective in meeting the performance targets, resource objectives, and overall performance goals of the FP HCP? Are current Type-F buffer prescriptions effective in providing/maintaining fish habitat necessary to support fish populations?	Westside Type F Riparian Effectiveness Program	Effectiveness	RSAG ISAG

Rule Group Critical Questions	Program Name	Task Type	SAG
Are the Type F riparian rules effective in meeting the performance targets, resource objectives, and overall performance goals of the FP HCP? Will application of the prescriptions result in stands that achieve eastside FP HCP objectives (forest health, riparian function, and historical disturbance regimes)? Are both the standard eastside prescriptions and the all-available shade rule effective in protecting shade and stream temperature and in meeting water quality standards? Are there differences between the standard eastside rule and the BTO all available shade rule in the amount of shade provided and their effect on stream temperature? Is all available shade actually achieved with the densiometer methodology under the BTO shade rule? Are forest practices riparian prescriptions effective at protecting groundwater flow and temperature?	Eastside Type F Riparian Effectiveness Program	Effectiveness	SAGE RSAG ISAG
Where and how should hardwood conversion projects be conducted, and what are the ecological outcomes?	Hardwood Conversion Program	Effectiveness	RSAG
What is the current status of riparian conditions and functions in Type F and S streams on a regional scale, and how are conditions changing over time?	Extensive Riparian Status and Trends Monitoring Program	Extensive	RSAG
How do aquatic organisms respond to changes in habitat and water quality associated with changes in riparian inputs and functions? What are the cumulative effects of forest practices on fish habitat and/or fish populations at the watershed scale? How do riparian buffer prescriptions for forest health affect fish habitat and fish populations? Will more frequent drought and flood events, associated with climate change, influence the effectiveness of current riparian buffers?	Intensive Monitoring/ Cumulative Effects Program	Intensive	RSAG ISAG

5.3.4 DFC Validation Program (Rule Tool)

5.3.4.1 Program Strategy

To manage conifer and mixed riparian stands to achieve functions associated with mature stands, the DFC approach requires stand targets that reflect mature stand conditions and a model that can accurately predict the trajectory of young stands to maturity. The DFC Validation Program is administered by RSAG and is designed to address uncertainties about the DFC approach, including uncertainties about (1) how well the current targets reflect mature unmanaged riparian conditions for conifer and mixed stands; (2) what sorts of habitat conditions will be provided by

those mature riparian stands that meet the DFC targets; (3) the accuracy in riparian zones of site class maps used as the basis of the prescriptions and DFC modeling for a given location; (4) how accurately the DFC model predicts growth of riparian stands to age 140; (5) how the residual stands that result from the selected prescription options (and their associated leave tree requirements and constraints) affect future basal area ; and (6) how young stands of different composition and density develop in response to the prescriptions as they mature, and how this affects riparian function. The program consists of several projects designed to answer a series of critical questions to address these uncertainties (Table 16).

In addition to these projects, a component addressing some of these questions was included with the Westside Type F Riparian Effectiveness Exploratory project conducted in 2019 (5.3.7.2). Stand data from forty riparian buffers that included inner zone harvest (after the DFC model predicted excess basal area in the stands) were entered into the DFC model to learn how many remained on trajectory to the DFC targets after harvest and three years of post-harvest exposure. The report from that investigation is currently in review.

Table 16. DFC Validation Program: Rule Group Critical Questions and Associated Research Projects

Rule Group Critical Questions		**Project Names**
Does the DFC model adequately project stand basal area growth to age 140? Do the basal area targets adequately describe mature riparian forest conditions?		
Program Research Questions	*Do the DFC targets accurately reflect stand conditions for mature, unmanaged conifer-dominated west- side riparian stands?*	DFC Target Validation Project DFC Plot Width Standardization Project
	How are the westside Type F riparian prescriptions being applied by landowners? What is the effect of various prescription options and constraints on current harvest and projected future basal area?	FPA Desktop Analysis Project
	What is the accuracy of the DNR site class maps in riparian areas, and what factors influence map accuracy?	DFC Site Class Map Validation Project
	Does the DFC growth and mortality model accurately predict the trajectory of westside conifer-dominated riparian stands to age 140?	DFC Trajectory Model Validation Project
	What aquatic habitat conditions are associated with mature westside riparian stands?	DFC Aquatic Habitat Project DFC Plot Width Standardization Project
	How do mature stand structures develop from younger stands in a variety of stand compositions and densities?	Pathways of Riparian Stand Development to Maturity Project
	What growth trajectories and successional pathways are characteristic of hardwood-dominated riparian stands?	Red Alder Growth and Yield Model Project

5.3.4.2 DFC Target Validation Project

Description:
The purpose of this project was to collect data on stand characteristics from a random sample of

mature (140 years) unmanaged conifer-dominated riparian stands in western Washington; to compare basal area per acre from the field sample with the current DFC targets in rule; and to evaluate alternative parameters for characterizing DFC.

Status:
This project has been completed. Work on the DFC Target Validation Project began in 2000, and the project results were transmitted to Policy in March 2005. The results are available in a CMER document titled "Validation of the Western Washington Desired Future Conditions (DFC) Performance Targets in the Washington State Forest Practices Rules with Data from Unmanaged, Conifer-Dominated Riparian Stands." In response to the DFC report, Policy requested that CMER undertake three additional tasks: (1) conduct scoping for a project to standardize the width of the plots used in the DFC study to address concerns raised in the ISPR (DFC Plot Width Standardization Project); (2) prepare a scoping document to identify and evaluate potential approaches for validating the accuracy of the DNR site class maps in riparian areas (DFC Site Class Map Validation Project); and (3) complete a study, originated by the Northwest Indian Fisheries Commission (NWIFC) staff, to determine how the westside Type F riparian prescriptions are being applied by landowners and to evaluate how the different prescription options and constraints influence the amount of timber available for harvest and projected future basal area (the FPA Desktop Analysis Project). In 2009, the Board adopted rule changes based on the results of the DFC Target Validation Project and findings from the FPA Desktop Analysis, but decided not to pursue the first two additional tasks Policy had requested.

5.3.4.3 DFC Plot Width Standardization Project

Description:
In response to the DFC Target Validation Project described above, Policy requested that CMER undertake several additional tasks, including scoping a follow-up sampling effort to standardize the width of the plots used in the DFC study to address concerns raised in the ISPR regarding grouping plots by field-measured site class.

Status:
RSAG completed scoping of this document in the spring of 2006. CMER approved a scoping paper with options for follow-up sampling and simultaneously conducting aquatic habitat validation research; this paper was presented to Policy in the summer of 2006. Policy has not approved moving forward with this project.

5.3.4.4 FPA Desktop Analysis Project

Description:
This project was intended to determine how westside Type F prescriptions are being applied by landowners and to evaluate the effect of various riparian prescription options and constraints on timber available for current harvest and on projected future basal area. Although originated by NWIFC staff outside of the adaptive management program, Policy requested that CMER complete a desktop analysis of a random set of forest practices applications (FPAs) that had active management of the inner zone, and to conduct a field-verification project on a subsample of those FPAs. From FPAs approved for harvest in 2003 and 2004, 75 were randomly selected in each year, and the associated stand inventory data were entered in the concurrent DFC model. As part of the quality assurance process, data from 15 randomly selected FPAs were compared to field data collected by CMER staff (i.e., FPA Field Check Report).

Status:
A draft report on the desktop analysis was presented to RSAG in December 2005. Data collection for the field-verification project occurred in the winter of 2006, and a draft report was submitted to RSAG in the spring of 2006. Later in 2006, CMER approved a contract to finalize the desktop analysis, field check, and model and manual reports, along with a document that synthesized findings from each of the reports. This work was completed in 2007 and the desktop analysis and field check reports underwent ISPR in 2009. A final report was submitted to Policy and the Board in 2010.

5.3.4.5 DFC Site Class Map Validation Project

Description:
The third request from Policy was to prepare a scoping document that identifies and evaluates approaches for validating the accuracy of the DNR site class maps in riparian areas.

Status:
CMER staff prepared a scoping document that was approved by CMER and presented to Policy in the summer of 2006. Policy has not approved moving forward with this project.

5.3.4.6 DFC Trajectory Model Validation Project

Description:
This project will assess the accuracy of the desired future condition (DFC) model in predicting riparian stand growth and trajectory from harvest age to the DFC target (age 140). This project will be designed to validate the DFC model as a tool to predict trajectory to the DFC target for both conifer-dominated and mixed stands.

Status:
This study has neither been scoped nor designed. Development of this study was put on hold pending results from a proposed regional cooperative effort to study growth and mortality in riparian stands. RSAG does not plan to begin scoping on this project at this time.

5.3.4.7 DFC Aquatic Habitat Project

Description:
The purpose of this project is to determine the range of aquatic habitat conditions associated with the stated "desired future riparian stand conditions" at which this program is aiming.

Status:
This study has been neither scoped nor designed. The DFC Aquatic Habitat Project was ranked as a lower priority. Consequently, scoping on this project has not begun, although RSAG proposed conducting this study as part of the DFC Plot Width Standardization Project (Policy rejected this recommendation). RSAG does not plan to begin scoping on this project or implementing the DFC Plot Width Standardization Project unless directed by Policy.

5.3.4.8 Pathways of Riparian Stand Development to Maturity Project

Description:
The purpose of this project is to determine the development sequence of younger stands of various species compositions and densities to mature stands. The project is intended to inform management of uneven-aged stands and those of low density or mixed composition. The project

is an outgrowth of the DFC Target Validation Project, based on the realization that many young, low-density stands of mixed composition may not achieve DFC on a timeline consistent with policy objectives without some form of intervention. Extensive monitoring could provide better understanding of the development of such stands to identify appropriate management approaches.

Status:
RSAG does not plan to begin scoping this project at this time.

5.3.4.9 Red Alder Growth and Yield Model Project

Description:
The purpose of this project is to develop a growth and yield model for red alder. Existing models either do not include red alder among the species simulated or use equations that are based on too few field data. In this project, cooperators from across the Pacific Northwest have contributed data that were compiled and edited at the Oregon State University (OSU) Hardwood Silviculture Cooperative. A growth and yield model for red alder will be developed from these data in a second phase of the project. Red alder is a dominant component of many riparian forests, and although the model is not specific to riparian areas, it will provide better information on the growth dynamics of this species in riparian stands than is currently available.

Status:
CMER contributed project development funds to this cooperative effort in the past, and in the fall of 2006 received a request from the Washington Hardwood Commission to fund additional sampling at some existing sites. This request was approved and the work occurred in the winter of 2007. The model was completed by the Hardwood Commission (or OSU) in 2010.

5.3.5 Eastside Type F Riparian Rule Tool Program

5.3.5.1 Program Strategy

The Eastern Washington Riparian Assessment Project (EWRAP) consists of the following studies: Phase 1 and Phase 2 which also includes the Eastside Modeling and Evaluation Project, and the Eastside Type F Channel Wood Characterization Study. Both the Phase 1 and the channel wood characterization study are designed to sample the current condition of riparian and in-stream conditions (baseline conditions) on FP HCP lands. Phase 2 of EWRAP was designed to complete the analysis and answer the remaining critical questions from Phase 1. Included in Phase 2 was the EMEP which modeled the Phase 1 data addressing the rule group critical question, “Will application of the prescriptions result in stands that achieve eastside FP HCP objectives (forest health, riparian function, and historical disturbance regimes)?” By modeling the riparian data collected in Phase 1, SAGE can begin to explore what conditions are sustainable when the current forest practices rules are applied to various stand conditions in eastern Washington.

Uncertainties about the validity of assumptions and effectiveness of the rule led to the critical questions listed in Table 17.

Table 17. Eastside Type F Riparian Rule Tool Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What is the current range of conditions for eastside riparian stands and streams?	Eastern Washington Riparian Assessment Project – Phase 1 Eastside Modeling Evaluation Project – Phase 2
What are appropriate LWD performance targets?	Eastside LWD Literature Review Project Eastside Type F Channel Wood Characterization Study
Can the shade/temperature relationships in the eastside temperature nomograph be refined?	Eastside Temperature Nomograph Project
Will application of the prescriptions result in stands that achieve eastside FP HCP objectives (forest health, riparian function, and historical disturbance regimes)?	Eastside Disturbance Regime Literature Review Project Eastside Timber Habitat Evaluation Project

5.3.5.2 Eastside Disturbance Regime Literature Review Project

Description:
A literature review titled "A Review and Synthesis of Available Information on Riparian Disturbance Regimes in Eastern Washington" was produced to gain an understanding of what disturbance regimes existed in the past and how they affected riparian forests. The information from this review will help determine whether we can apply these past conditions to present riparian stands and meet the desired future conditions for riparian function.

The literature review indicates that, despite a very large information base on historical and current disturbance regimes within eastern Washington forests, differences in riparian and upslope forest disturbance regimes and post-disturbance responses are not well known. Much of the scientific literature describing eastern Washington disturbance regimes and forest responses is at the forest series or plant association group level and does not distinguish between riparian and upslope communities. The differences between current and historical disturbance regimes for fire are better defined than for insects, pathogens, and other disturbance types. No clear consensus exists on whether there is a difference between disturbance regimes and forest responses of riparian and upslope areas. In fact, available information on riparian ecosystem disturbance regimes and responses was often contradictory. Additional research is recommended on forest stand disturbance processes at the regional-scale, to supplement existing data and better define the role of disturbance in riparian and upslope forest habitats. The likelihood of duplicating historical disturbance regimes, to reestablish historical forest conditions, is low given current forest stand conditions and global climate change.

Status:
This document was approved by CMER in June 2002.

5.3.5.3 Eastside LWD Literature Review Project

Description:
A literature review titled "A Review of the Available Literature Related to Wood Loading Dynamics in and around Streams in Eastern Washington Forests" was undertaken to help gain an understanding of the dynamics of functional stream wood and, to a lesser degree, the linkage between the level of LWD recruitment and the health of aquatic habitat. Addressing the uncertainty will require additional information on the relationship of LWD recruitment and habitat function. There is uncertainty about the response of aquatic habitat to different types or

levels of LWD input and loading and about how much LWD riparian buffers need to produce.

SAGE's literature review consisted of 41 questions concerning channel wood issues in eastern Washington. Ten of the 41 questions were answered at least in part by studies in eastern Washington, but these were usually limited to a few specific regions of eastern Washington. The other questions could not be answered by literature currently available for eastern Washington.

Status:
This document was approved by CMER in 2004.

5.3.5.4 Eastside Temperature Nomograph Project (Rule Tool)

Description:
The Eastside Temperature Nomograph Project developed an eastern Washington-specific nomograph using existing data and identified gaps for future study. The study identified site characteristics necessary to produce a better predictive model of stream temperatures in eastern Washington.

Status:
The report was reviewed by SAGE and CMER and was not accepted as an approved project because technical shortcomings were identified. The document was retired to the file with comments noted. The data used in the analysis have been obtained and archived for potential future use and analysis.

5.3.5.5 Eastern Washington Riparian Assessment Project (EWRAP)

Description:
Eastern Washington has a wide range of climatic conditions, elevations, forest types, riparian zones, and management history. The focus of the Eastern Washington Riparian Assessment Project is to document the current range of conditions of riparian stands on eastside forestlands. Information gathered through this project provided CMER and Policy with a common understanding of status and characteristics of riparian stands in lands managed under the eastside Type F prescriptions. The data were analyzed to identify patterns in the distribution of riparian stand types across eastern Washington, and relationships between riparian stand conditions and factors such as precipitation, elevation, and geology.

Due to the perceived variability of forest stand attributes being high in eastside Type F streams, Phase 1 of this study was designed to test proposed methodologies; determine appropriate sample size with current riparian data; provide a data set that could be used for future studies, such as extensive monitoring and an in-stream characterization study; and to provide a baseline for future monitoring.

Variability was lower between sites than expected; thus, Phase 2 of this study is entirely a desktop project, which analyzes data from the 103 Phase 1 sites. This work characterized the accuracy of forest practices rules and habitat types, and included an assessment of how much harvest can occur on each site given stand densities and tree size.

Status:
The report for the Phase 1 was approved by CMER in 2007. The Phase 2 final report was completed in late 2015; it was approved by both SAGE and CMER and was approved with no action taken by Policy in 2016.

5.3.5.6 Eastside Modeling Evaluation Project (EMEP)

Description:
This project was initially part of Phase 2 of the EWRAP. Due to multiple contracting issues this component was never completed and was submitted to the Adaptive Management Program as a separate project from SAGE.

The EMEP modeling uses the riparian stand data collected from Phase 1 of the EWRAP project to assign fire and disease risk ratings (current and projected), under current rule or alternate plan, between eco-regions and within the 240-foot transect length from which riparian stand data were collected. Growth and yield models were used to extrapolate future stand conditions and provide detailed data about present and future stand structure and composition.

In summary, the EMEP was designed to model future riparian stand conditions based on current riparian stand conditions to estimate the extent to which current riparian stands might achieve the three FFR eastside riparian objectives (provide necessary riparian functions, are within the range of historic stand conditions, and to reduce risk of catastrophic damage due to disease or insect outbreaks).

Status:
ISPR approved the final report in July 2020. CMER approved the final report in November 2020. CMER findings report (answers to 6-questions) was approved and sent to Policy in February 2021. No further action was taken by Policy on this project.

5.3.5.7 Eastside Timber Habitat Evaluation Project (ETHEP) (Rule Tool)

Description:
Washington's Forest Practices Rules for non-federal forestlands in eastern Washington use a Timber Habitat Type (THT) system to apply riparian rule prescriptions along fish-bearing (Type S and Type F) streams (WAC 222-30-022). This system defines THTs according to three elevation zones: Ponderosa Pine (<2500 feet), Mixed Conifer (2500-5000 feet), and High Elevation (>5000 feet). Riparian harvest rules vary by THT, with specific leave tree requirements intended to emulate natural disturbance regimes that promote forest health and provide riparian functions.

There is uncertainty about the scientific basis underlying the THT rules. Results from Phase I and II of the Eastern Washington Riparian Assessment Project (EWRAP) support the concern over the accuracy of the THT divisions and if they are the appropriate framework for applying riparian prescriptions. Further study is needed to determine the appropriate framework for applying riparian prescriptions to achieve Washington Forest Practices Habitat Conservation Plan (FPHCP 2005) objectives for riparian function.

The purpose of this project is to develop an ecologically meaningful and reliable framework for applying riparian harvest rules along Type S and Type F streams in eastern Washington.

Status:
A scoping document was approved in SAGE in October 2015, but was not reviewed by CMER for movement to Policy due to feedback from subject area experts. A project team was formed in August 2018 to work on an updated scoping document for this project based on feedback from subject experts. A revised scoping document was approved by SAGE September 8, 2020, by

CMER in March 2021, and by Policy in June 2021. The Project Team initiated development of the Study Design in August 2021. Due to staffing issues, the Study Design is being finished under contract with the University of Idaho. The completion date is expected to be in early 2023.

5.3.5.8 Eastside Type F Channel Wood Characterization Study (ESICCS)

Description:
Characterizing eastern Washington's Type F streams is important, because information is scarce or simply does not exist that describes the current status of channel wood conditions and that condition's influence on in-stream habitat conditions. SAGE has identified three primary problems due to this lack of information. First, the scarcity of data limits the ability to make informed management decisions required of land managers and regulators. Second, a lack of information hinders the ability to address forest health risks (insects, disease, and fire) in upland and riparian forests. Finally, land managers and regulators have little guidance or context to evaluate alternate plans to meet necessary stream and riparian functions.

SAGE believes that better information is needed to determine the appropriate frequency and distribution of channel wood for meeting properly functioning aquatic habitat conditions. In addition, desired channel wood conditions need approximate the historical disturbance regimes.

Status:
Study design was approved by CMER in 2009 to accompany the EWRAP project, but the ESSICS project was removed as a priority due to budgetary constraints. It is unknown whether it will be completed.

5.3.5.9 Eastside Forest Health Strategy

Description:

The Eastside Forest Health Strategy workgroup recommends the development of a research and monitoring strategy investigating active RMZ management approaches that build on current RMZ prescriptions and are designed to balance disturbance resiliency and resource protection objectives outlined in the FP HCP (Schedule L-1 functional objectives and performance targets, Appendix N). Current riparian buffer prescriptions may be appropriate where RMZs are not fire dependent but may not be successful in achieving functional objectives and performance targets across the entire landscape subject to the Forest Practices Rules (FPRs). Determining the if, where, when, and how of additional management, is the responsibility of the Adaptive Management Program (AMP). Given diverse ownership, management objectives and limited AMP funding to test alternative prescriptions, the strategy will likely require a multi-scale approach (site, watershed, landscape) and close coordination with other landowners. Significant public and private funded efforts have been invested in forest health and fuels treatments in eastern Washington, but this emphasis has been primarily on upslope stands and not in regulatory RMZs.

It is generally agreed that the maximum extent of thinning allowed in current eastside RMZ rules are rarely implemented making it difficult to find enough examples to study their effectiveness related to fire and forest health. What we do know based on feedback from a non-random tally of stakeholders and analysis of existing condition with the results of the Eastside Modeling Effectiveness Project (EMEP), is that overstocked, suppressed and stagnant riparian stands are likely to remain in this condition for several decades. Absent of active management, these stands may eventually suffer from

insects/disease and fire, which could possibly lead to a catastrophic stand-replacing fire significantly impacting both ecological and monetary values of the RMZ.

The questions discussed by the subgroup fall into one or both of the following categories:

- Research to investigate alternative pre-fire riparian management strategies designed to reduce wildfire potential and improve forest health/fire resiliency and,
- post-fire actions that could help restore riparian function through active management.

The following questions should be considered by CMER/SAGE for guidance when scoping upcoming research:

1. To what degree do the current DNR water Types S/F and Np Rules, when applied to the RMZ, achieve functional objectives and performance targets (See Appendix A) related to forest health and fire resiliency?

2. What are the factors limiting implementation of RMZ prescriptions?
    a. What percentage of the time are landowners applying current RMZ Rules?
    b. What are the operational and forest stand limitations for applying current RMZ Rules?
    c. Are the current RMZ Rules the limiting factor for whether the prescriptions are applied to the RMZ?
    d. When and under what conditions are RMZs being managed under current Rules.
    e. Is the primary consideration for entry based on revenue or enhanced riparian function?

3. What variable/variables contribute to wildfires entering the RMZ and how do these factors affect fire behavior within the RMZs?
    a. Does post-harvest slash management impact the risk of wildfire entering an RMZ?
    b. How do the fires behave once it enters the RMZ?
    c. What percentage of landowners are applying PCT to the RMZ?
    d. Does PCT application in RMZs vary by landowner class?
    e. How does hydrology and geophysical characteristics (e.g., stream size, valley confinement, soil wetness, topographic position) influence susceptibility/risk to wildfire?
    f. How do PCT, commercial thinning, hydrology and geophysical characteristics (e.g., stream size, valley confinement, soil wetness, topographic position) influence susceptibility/risk to wildfire?

4. Are Wetland Management Zone (WMZ) prescriptions applied more often than RMZ prescriptions?
    a. If so, are there layout and/or operational benefits associated with the WMZ Rules?

If (a) is true, could these be used to modify the RMZ Rules to make them easier to apply on the ground while still maintaining similar stream functions/protections?

Status

In March 2019, CMER approved a proposal by SAGE titled "RMZ Response to Fire in Eastern Washington." This document outlined a strategy that started with a GIS exercise that identified areas that have been affected by wildfire from 2014 to present and calculated the estimated number of miles of RMZ burned in those fires. The second step in the strategy was to produce an inventory of Alternate Plans that have occurred within RMZ's in these burned areas. The last step, Step 3, would be to develop a field study to assess the relative effects of salvage or non-

salvage activity in burned RMZs. Step 1, the GIS exercise was completed in 2019, but no further work has been done to date.

Project Critical Questions:

1. What are the structure and composition of burned RMZ stands in the core and inner zones of the immediately after and 5-years post fire?
2. What are the percent shade immediately after and 5-years post fire?
3. What is the rate of tree mortality, ingrowth, tree breakage/fall and wood recruitment?

Status:
The project has yet to be developed or scoped.

5.3.6 Bull Trout Habitat Identification Program (Rule Tool)

5.3.6.1 Program Strategy

The Bull Trout Habitat Identification Program is a rule tool program. This program was developed to address possible modifications of the bull trout habitat overlay, as defined in the rule. Because knowledge of the current and potential distribution of the species is imprecise, large areas of forestland in eastern Washington may be included in the bull trout habitat overlay (BTO). These areas may result in excessive restrictions and in riparian conditions that do not meet the intent of the eastside riparian strategy. Site-specific data on bull trout presence/absence or habitat conditions were thought to be helpful in identifying areas to add or remove from the BTO.

Two primary tasks have been identified for this program: (1) develop sampling efficiency models and protocols for detecting bull trout; and (2) developing habitat prediction models for helping to make determinations of habitats unsuitable to support bull trout.

This program was originally administered by the former BTSAG. The work for this program has been completed. Because of the difficulty in stakeholder agreement regarding removing areas from the BTO, efforts have moved to comparing and assessing the effectiveness of the two shade rules in protecting and maintaining shade and stream temperature. Results from this effort could lead to modifications of the BTO, in part or as a whole. No further work is planned for this program at this time.

Table 18. Bull Trout Habitat Identification Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
How can habitat suitable for bull trout be identified?	Bull Trout Presence/Absence Protocols
	Bull Trout Habitat Prediction Models
	Yakima River Radiotelemetry

5.3.6.2 Bull Trout Presence/Absence Protocols

Description:
Because sampling efficiency and probability of detection for bull trout were believed to be less

than that known for other salmonids, work was focused first on developing sampling efficiency models for bull trout specifically. These sampling efficiency models were intended to prescribe the effort necessary to be able to detect bull trout, using three different survey methods (electroshocking, day snorkeling, and night snorkeling). The models also included the influence of physical channel features on the response of bull trout to sampling activities and compared probabilities of detection with and without the use of blocknets.

Status:
Sampling efficiency models for detecting bull trout have been developed as part of the presence/absence protocols. Two papers were finalized and approved by CMER, relating to sampling efficiency models: (1) "Development of Bull Trout Sampling Efficiency Models," by Thurow et al., March 2004; and (2) "Analysis of Movement Patterns of Stream-Dwelling Salmonids in Response to Three Survey Methods," by Peterson et al., July 2003. These papers provide valuable information on the probability of detection and associated effort needed to survey for bull trout presence under various habitat conditions; some of the findings could be included in a bull trout field protocol, but additional work would be needed to achieve the program goal of developing this protocol. The two CMER reports have been forwarded to Policy, who accepted the reports and decided that no further action was needed at this time.

5.3.6.3 Bull Trout Habitat Prediction Models

Description:
This project was designed to develop habitat suitability models for bull trout, which would help in identifying those areas on the BTO that might actually be "unsuitable" for supporting the species. According to the forest practices rules, if areas were found to be unsuitable for potentially supporting bull trout, those areas could be exempt from the requirements of the all available shade rule. This project focused on bull trout juveniles; it did not include adult bull trout. The model's preliminary results showed that the primary habitat predictor of suitable habitat for juvenile bull trout was stream temperature.

Status:
To date, preliminary draft models have been found to be too coarse for forest practices purposes. One report from this project was finalized and approved by CMER: "Models to Predict Suitable Habitat for Juvenile Bull Trout in Washington State," by Dunham and Chandler, July 2001. This report provided valuable information pertaining to habitat suitability for juvenile bull trout. However, the study only resulted in a preliminary model, which was too coarse of a screen for determining what would represent unsuitable bull trout habitat within forested lands. Predictive models tend to be more appropriate for determining "suitable" habitat rather than "unsuitable" habitat. Additional work is needed to incorporate additional variables, resulting in a finer screen for determining what might be suitable or unsuitable habitat. It is likely, however, that a model would not be adequate by itself to determine habitat suitability; additional field surveys would probably be needed on a site-by-site basis. The CMER report has been forwarded to Policy, who accepted the report and decided that no further action was needed at the time.

5.3.6.4 Yakima River Radiotelemetry

Description:
This project was designed to evaluate the migratory patterns of adult bull trout and to identify their distribution and habitat preferences in the Yakima River watershed. The information gained from this project informed bull trout presence/absence protocols and habitat prediction models.

Status:
This project was contracted through the US Fish and Wildlife Service (USFWS) and was only partially funded with CMER funds. The final report, "An Investigation into the Migratory Behavior, Habitat Use and Genetic Composition of Fluvial and Resident Bull Trout (*Salvelinus confluentus*) in the Yakima River Basin" was completed in December 2015. The report was delivered to the AMP in late 2017 and added to the IMS system even though there is not an official CMER report number.

5.3.7 Westside Type F Riparian Effectiveness Program

5.3.7.1 Program Strategy

The purpose of this program is to undertake research and monitoring to evaluate the effectiveness of westside Type F riparian prescriptions, to compare and evaluate alternative westside Type F buffer treatments, and to validate westside Type F performance targets. The program is designed to address scientific uncertainty about FFR/HCP prescriptions for westside Type F streams, including the following:

- Survival of buffer trees and rates of buffer tree mortality from competition, windthrow, disease, insects, and other factors.
- Post-harvest changes in conifer-dominated westside RMZs, and whether westside stands will remain on trajectory to achieve DFC performance targets.
- Uncertainty about the level of riparian functions provided by riparian stands produced by Type F prescriptions, and whether FP HCP resource objectives and performance targets will be achieved.
- Efficacy of alternative buffer designs in providing riparian functions and meeting resource objectives and performance targets.
- Validity of performance targets for Type F streams.

Table 19 lists the critical questions for the Westside Type F riparian effectiveness program, and identifies specific projects to address them.

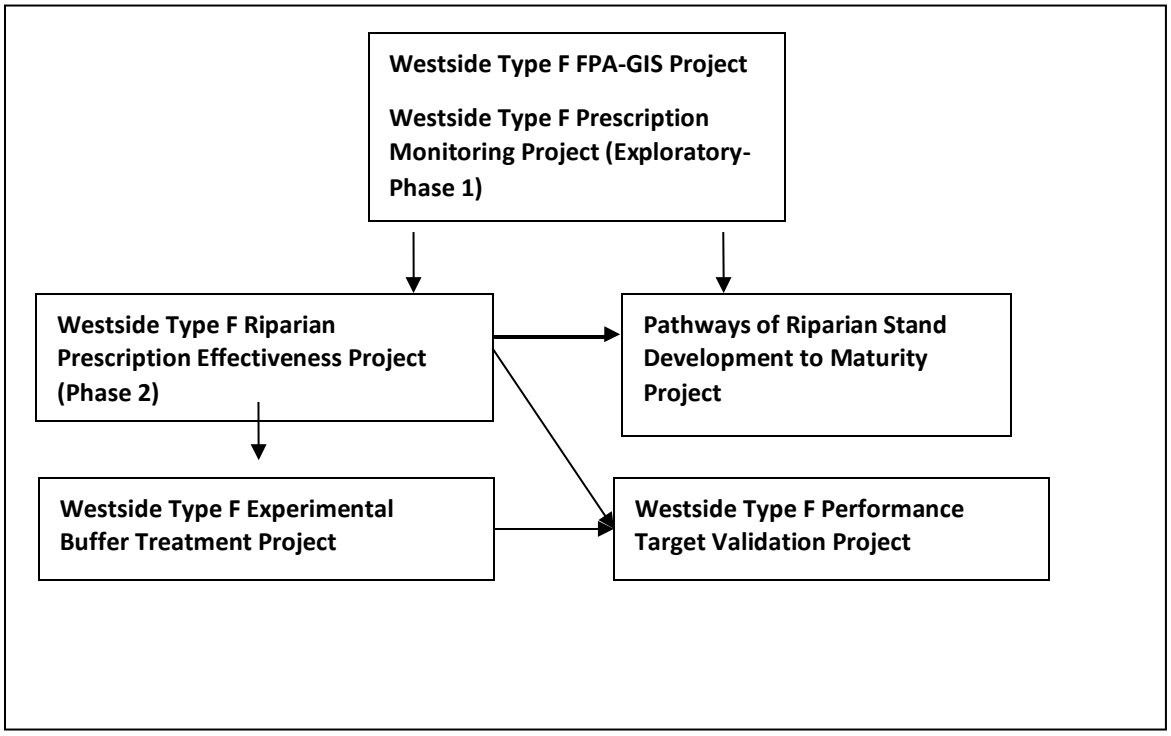
Table 19. Westside Type F Riparian Effectiveness Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Are the Type F riparian rules effective in meeting the performance targets, resource objectives, and overall performance goals of the FP HCP?	

Program Research Questions	***Riparian Stand Characteristics and Riparian Functions*** *How do the RMZ and no-RMZ harvest prescriptions affect riparian stand characteristics and riparian functions?* *How do the characteristics of riparian forest stands and associated riparian functions in areas with RMZ and without RMZ harvest change over time?* *Do riparian forest stands in areas with RMZ and without RMZ harvest remain on trajectory to achieve DFC targets?*	Westside Type F Riparian Prescription Effectiveness Monitoring Project (Phase 1-Exploratory) Westside Type F Riparian Prescription Effectiveness Monitoring Project (Phase 2-Experimental) Pathways of Riparian Development to Maturity Project (DFC Validation)
	Physical Stream Characteristics and Processes *How do physical stream characteristics and processes respond to changes in riparian functions in areas with RMZ and without RMZ harvest?* *Do physical stream characteristics and processes meet performance targets?*	
	Aquatic Biological Response *What is the aquatic biological response to changes in riparian functions in areas with RMZ and without RMZ harvest?*	
	Would alternative approaches to the westside Type F prescriptions be more effective in meeting FP HCP resource objectives and performance targets, while reducing costs or increasing flexibility for landowners?	Westside Type F Experimental Buffer Treatment Project
	Are Westside Type F performance targets valid and meaningful measures of success in meeting resource objectives?	Westside Type F Performance Target Validation Project
	Are forest practices riparian prescriptions effective at protecting groundwater flow and temperature?	Groundwater Conceptual Model Project

Implementation of these projects has begun in a sequence such that each project will help to inform the design and implementation of subsequent projects (Figure 1). The Westside Type F Riparian Prescription Exploratory Study is the first phase of the project in the sequence. This project began by analyzing information from forest practice applications and GIS data to determine how frequently westside Type F FPAs occur in different management categories (e.g., RMZ inner zone harvest, no RMZ inner zone harvest, site class, stream width). This investigation (Phase 1a) informed the scoping and study design phases of the Exploratory study. The FPA data will also be useful in the study design for the Pathways of Riparian Stand Development to Maturity Project in the DFC Validation Program, and the Westside Type F Performance Target Validation Project. The Exploratory Study is providing information about the status of riparian buffer stands after harvest using several riparian prescriptions and the variabilities associated with both independent and response metrics. Phase 2 will be a prescription effectiveness monitoring project, which is expected to be an experimental before-after control impact (BACI) study that will answer questions on the effectiveness of specific current FP HCP prescriptions in achieving resource objectives and performance targets. Once this series of studies is completed, the results will help RSAG decide if there is a need to design and implement further experimental treatment studies to test the effectiveness of alternative treatments that are currently not included in the FFR/HCP prescriptions.

Figure 1. Relationships among projects in the Westside Type F Riparian Effectiveness Program.



5.3.7.2 Westside Type F Riparian Prescription Effectiveness Projects

Description:

The purpose of these studies is to determine how stand conditions respond over time to the Westside Type F riparian prescriptions and to evaluate the effectiveness of the prescriptions in meeting FP HCP resource objectives and performance targets. These projects evaluate both stands where active management of the inner zone has occurred (based on meeting DFC basal area/acre targets) and stands where no management of the inner zone has occurred when the adjacent stand is harvested. The Phase 1 - Exploratory Field Study used an after-impact only approach that focused on assessing riparian stand conditions and selected riparian functions across a range of prescription variants and site conditions. This is providing a large-scale, coarse-level assessment of current riparian stand conditions that focuses on addressing scientific uncertainty about mortality, stand trajectory (DFC), and riparian functions associated with different prescription variants following harvest (see *Riparian Stand Characteristics and Riparian Functions* in Table 19). In this study we investigated buffer stands three to six years post-harvest (After-Impact) in 110 riparian buffers, each using one of eleven riparian buffer variants (out of 24 possible variants). The variants studied were based on those found to be most common in the preliminary FPA analysis (Phase 1a). This study is providing useful information on the status of conditions, but the lack of information on conditions preceding harvest prevents us from directly answering questions on the effects of the harvest. We will utilize results from the exploratory study to estimate the direction and magnitude of change associated with the prescription variants and determine the potential influence of site conditions on riparian stand conditions and functions following treatments in order to tailor and focus the Phase 2 experimental Effectiveness Project study design. An evaluation of the three-six year post-harvest stand potential to reach the 140-year DFC targets was part of this exploratory study (see 5.3.4.1 above).

The Phase 2 experimental study is intended to provide fine-scale assessments of treatment effects for a select set of prescription variants and site conditions and will focus on the response of

riparian stands, riparian inputs (such as heat energy and large wood), channel habitat, and aquatic biota to riparian harvest buffer prescriptions. The study purpose will be to answer the critical questions regarding effects of the harvest prescriptions on habitat conditions. The use of a BACI design will allow us to draw conclusions regarding the effects of the buffer treatments for the selected prescription variants. It will also improve our overall understanding of and decrease scientific uncertainty about the linkage between underlying site characteristics, riparian prescriptions, changes in riparian stands and riparian functions, and the aquatic resource response (habitat, wood recruitment, temperature, and aquatic organisms). This study could be completed in approximately eight years.

Status:
CMER assembled a technical writing and implementation group (the Westside Type F Riparian Prescription Effectiveness Monitoring TWIG) and a charter to initiate the scoping and study design process. The TWIG's initial tasks were to review and revise the critical questions for this project, review relevant literature, and develop and evaluate study design options to address the critical questions. In December 2015, Policy approved a "hybrid phased-approach" to answer the critical questions related to Riparian Stand Characteristics and Riparian Functions, Physical Stream Characteristics and Processes, and Aquatic Biological Response.

Phase 1a of the scoping and study design phase involved an office review and analysis of forest practice applications and GIS data to determine how frequently different riparian prescription variants were being implemented; regional distribution patterns; and limited information on the characteristics of the sites and adjacent streams where the prescriptions are being applied. Step 1 was completed in FY 2016.

Phase 1 included the design and implementation of the Exploratory Study. The Exploratory Study Design was reviewed and approved by ISPR and then approved by CMER in spring of 2018. This study was implemented in 2018-2020 and the report is currently in review.

The design of the Phase 2, an experimental (BACI) study, is in the preliminary design phase as we complete the analysis and review of the Exploratory Study being used to inform it.

5.3.7.3 Westside Type F Experimental Buffer Treatment Project

Description:
The purpose of this project is to test the effectiveness of alternative treatments, that are not part of the current FFR/HCP prescription package. RSAG will recommend whether to pursue this project after reviewing the results of the Westside Type F Riparian Prescription Effectiveness Project.

Status:
This project has been neither scoped nor designed.

5.3.7.4 Type F Performance Target Validation Project

Description:
This project will evaluate the validity of the Type F performance targets and the measures of success in meeting resource objectives.

Status:
This project has been neither scoped nor designed.

5.3.8 Eastside Type F Riparian Effectiveness Program

5.3.8.1 Program Strategy

The purpose of the Eastside Type F Riparian Effectiveness Program is to conduct research and monitoring to evaluate the effectiveness of the eastside Type F riparian rules in meeting resource objectives and riparian functions. The goals of the eastern Washington Type F riparian rules are to provide for stand conditions that (1) vary over time within the range of historical disturbance regimes; (2) provide riparian functions needed to meet resource goals for fish, amphibians, and water quality; and (3) maintain forest health by minimizing risk of catastrophic damage from insects, disease, or fire.

Six rule group critical questions are covered under the Eastside Type F Riparian Effectiveness Program (see Table 20). Four projects are identified to address those critical questions. The BTO Temperature (Eastside Riparian Shade/Temperature) Project evaluated the effectiveness of the two shade rules (the standard shade rule using the nomograph, and the all available shade rule within the bull trout habitat overlay) for protection of stream temperature. A companion study (the Solar Radiation/Effective Shade Project) focused on effectiveness of the BTO shade rule for actually achieving all available shade within the bull trout habitat overlay. The Eastside Type F Riparian Effectiveness Monitoring Project (BTO add-on) used the same sites as the Eastside Riparian Shade/Temperature Project and the Solar Radiation/Effective Shade Project to assess changes in stand conditions, buffer integrity, and LWD recruitment. In order to understand how effectively the forest practices rules protect groundwater temperature and flow, a conceptual model needs to be developed to understand where the areas of sensitivity might be. The Groundwater Conceptual Model Project would provide guidance on where effectiveness monitoring should be focused. Table 20 lists the rule group critical questions and the projects identified to address each of those critical questions.

Table 20. Eastside Type F Riparian Effectiveness Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Are the Type F riparian rules effective in meeting the performance targets, resource objectives, and overall performance goals of the FP HCP?	Bull Trout Overlay [BTO] Temperature (Eastside Riparian Shade/Temperature) Project Solar Radiation/Effective Shade Project Eastside Type F Riparian Effectiveness Monitoring Project (BTO add-on)
Will application of the prescriptions result in stands that achieve eastside FP HCP objectives (forest health, riparian function, and historical disturbance regimes)?	BTO Temperature (Eastside Riparian Shade/Temperature) Project Solar Radiation/Effective Shade Project Eastside Type F Riparian Effectiveness Monitoring Project (BTO add-on)
Are both the standard eastside prescriptions and the all available shade rule effective in protecting shade and stream temperature and in meeting water quality standards? Are there differences between the standard eastside rule and the BTO all available shade rule in the amount of shade provided and their effect on stream temperature? Is all available shade actually achieved with the densiometer methodology under the BTO shade rule?	BTO Temperature (Eastside Riparian Shade/Temperature) Project Solar Radiation/Effective Shade Project
Are forest practices riparian prescriptions effective at protecting groundwater flow and temperature?	Groundwater Conceptual Model Project

5.3.8.2 Bull Trout Overlay Temperature (Eastside Riparian Shade/Temperature) Project

Description:
The Eastside Riparian Shade/Temperature Project was designed to evaluate the effectiveness of both the all-available shade rule and the standard eastside riparian prescriptions in meeting FP HCP resource objectives. The project aimed at determining if a difference exists between shade and stream temperature provided by the BTO all available shade prescriptions and the standard shade requirements. The field study was originally implemented by BTSAG but is currently administered by RSAG. The study design specified a two-year, pre-harvest data collection period, a year for harvesting, and a two-year, post-harvest data collection period. This study was combined with the Solar Radiation/Effective Shade Project.

Status:
Post-harvest data collection was completed during the 2010 field season. The draft report has been through CMER and ISPR review. RSAG approved sending the post ISPR draft to CMER for approval in March 2014. The final CMER report #02-214.

5.3.8.3 Solar Radiation/Effective Shade Project

Description:
The Solar Radiation/Effective Shade Project was designed to evaluate whether all available shade is actually achieved under the BTO shade rule. This study was conducted in conjunction with the BTO Temperature (Eastside Riparian Shade/Temperature) Project.

Status:
This project is complete. CMER report #02-212.

5.3.8.4 Eastside Type F Riparian Effectiveness Monitoring Project (BTO add-on)

Description:
The original RSAG study design for eastside Type F riparian prescription effectiveness monitoring called for random sampling of Type F forest practices applications (FPAs) paired with untreated control sites to determine the effectiveness of the prescriptions as applied operationally across the range of conditions on FP HCP lands. The eastside was to be sampled as a separate stratum. However, the Eastside Riparian Shade/Temperature Project demonstrated the great expense and difficulty in finding suitable treatment and control sites in eastern Washington. Consequently, the decision was made to utilize the BTO temperature study sites for the eastside riparian prescription monitoring component, even though they were not randomly selected, in order to save money, expedite implementation of the project, and provide an integrated package of results for the adaptive management process. This was accomplished by collecting additional data on changes in vegetation, buffer integrity, and LWD recruitment at the BTO temperature study sites. (Consequently, the Eastside Type F Riparian Effectiveness Monitoring Project is sometimes referred to as the BTO add-on project.)

Status:
Changes in stand structure, tree mortality, ingrowth, and wood recruitment from fallen trees were compared one-two years and five years after harvest in response to the standard rule and the all-available shade riparian prescriptions. The final report was approved by CMER October 2019. The FP Board recommended no further action be taken at this time. Recommendations regarding the BT Solar/Shade study are still under consideration by TFW Policy.

5.3.8.5 Groundwater Conceptual Model Project

Description:
The Groundwater Conceptual Model Project was designed to investigate the potential impacts of timber harvest on groundwater temperatures; these groundwaters could have the potential to discharge to streams and thereby affect the temperature regime of fish habitat. A draft literature review has been completed. However, the draft conceptual model developed from the original contract did not meet the expectations or objectives described by the former BTSAG to identify areas that might be highly susceptible to groundwater heating after timber harvest. CMER and the USFWS were able to make additional progress on developing the intended conceptual models; however, due to limited staffing availability and higher priorities, the models have not yet reached completion.

Status:
This project has currently been put on hold, and it is unknown whether further CMER work will occur.

5.3.9 Hardwood Conversion Program (Effectiveness)

5.3.9.1 Program Strategy

The purpose of the Hardwood Conversion Program is to inform the FP HCP strategy for converting riparian stands from hardwood to conifer-dominated. These riparian stands may include a variety of hardwood species, although red alder (*Alnus rubra*) is typically the most common in western Washington. Presence of alder-dominated riparian stands on the landscape is sometimes the result of past forest management practices, which historically did not always include conifer reforestation after harvest.

Table 21 presents the critical questions and projects of the Hardwood Conversion Program. The program began by implementing the Riparian Hardwood Conversion Project to provide information for Policy about the effectiveness of hardwood conversion treatments to regenerate conifers successfully, and about the economic costs and benefits of hardwood conversion. In response to guidance from Policy, a component to examine stream temperature response was added to the project after the silvicultural study design had been adopted.

In spring of 2005, another project was initiated in response to a request from the Small Forest Landowners Advisory Committee that was developing a small forest landowner hardwood conversion template. This group requested information on the effect of hardwood conversion on stream temperature as a function of buffer width and stream length treated. In response to this request, Ecology submitted a proposal to CMER for the Hardwood Conversion Water Temperature Modeling Project. The project was carried out and is described below under Ecology Water Temperature Modeling Project.

Table 21. Hardwood Conversion Program: Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions		**Project Names**
Where and how should hardwood conversion projects be conducted, and what are the ecological outcomes?		
Program Research Questions	*How effective are different hardwood conversion treatments in reestablishing conifers in hardwood-dominated riparian stands?*	Riparian Hardwood Conversion Project
	When is hardwood conversion in riparian stands operationally feasible, and what are the economic costs and benefits of the hardwood conversion treatments?	

	What effects do hardwood conversion treatments in riparian stands have on shade, stream temperature, and LWD recruitment?	Riparian Hardwood Conversion Project – Temperature Component Annotated Bibliography: Riparian Hardwood Conversion[1]
	What is the effect of hardwood conversion practices on stream temperature as a function of buffer width and length of stream treated?	Ecology Water Temperature Modeling Project

[1]*In 2011, RSAG decided to terminate the Annotated Bibliography: Riparian Hardwood Conversion. See status update below for explanation.*

5.3.9.2 Riparian Hardwood Conversion Project

Description:
The Riparian Hardwood Conversion Project is a series of case studies at eight sites. Each site consists of landowner-designed and implemented site-specific harvests of hardwood trees in riparian buffers. In each case, harvest is followed by reforesting with conifers. Data about tree regeneration and residual stand condition are collected at each site. Data collection also includes annually asking participating landowners to document their silvicultural strategies and the costs and benefits associated with each conversion.

Status:
Harvest has occurred at all sites, and four years after harvest, monitoring of regeneration is complete. CMER reviewed a draft interim report describing the pre-harvest, harvest, silviculture, and costs and benefits of the harvests at six of the eight sites. This report is titled "The Draft Case Study Reports: Hardwood Conversion Study," and the principal investigator was Frank Brown of Pacific Rim Forestry. Final drafts of the eight case study reports were received in spring of 2012 and were reviewed and approved by CMER. An interim summary report synthesizing the results and findings from the eight case studies was reviewed and approved by RSAG and CMER in 2014.

RSAG requested and received Policy approval to revisit the eight sites in FY 2016 to collect year ten regeneration and general buffer condition data. The ten-year resample is in response to concerns that four-year post-harvest stocking data do not reliably determine the likely future conifer stocking levels at these sites. RSAG approved the case study reports and the synthesis report. The reports went to CMER for review and approval and was sent to ISPR in early 2018.

In 2017 Cramer Fish Sciences completed and CMER accepted a final report on the first two Hardwood Conversion Project critical questions. In early 2020 CMER completed answers to the standard six questions characterizing the findings of the Cramer Fish Sciences report. Both the report and answers to the six questions were sent to TFW Policy without recommendations for additional research.

In Summer 2020, RSAG completed an informal analysis of approved forest practice application (FPAs), both standard rules and alternate plans, for hardwood conversions. This analysis indicated that hardwood conversions peaked between 2009 and 2015. For the 2015 to 2019 period only 30 hardwood conversion FPAs were approved. Consequently, RSAG recommended that public resource risk was not sufficient to warrant a long-term study.

5.3.9.3 Riparian Hardwood Conversion Project – Temperature Component

Description:
The hardwood conversion temperature study was contracted through an interagency agreement with the Washington Department of Fish and Wildlife (WDFW) in June 2003. The objective of this study was to collect data that may help understand what effect hardwood conversion rules and alternate plans may have on water temperature. Specifically, this was designed to collect temperature and canopy data in association with hardwood conversion activities. The study evaluated changes in canopy cover and air and stream temperature 2 years before and 2 years after timber harvest.

Stream temperatures were measured upstream and downstream and at 25-m intervals along stream reaches at the same eight study sites used in the Riparian Hardwood Conversion Project. These temperature measurements occurred before and after harvests. Pre-harvest data collection began in 2003, with the final post-harvest data collected in 2006. The minimum buffer width was 25 ft., but ranged from 25 ft. to more than 100 ft. This project was contracted with WDFW.

Status:
A data collection report has been reviewed and approved by CMER. This report did not undergo ISPR since it provided the data and site descriptions only and did not include a statistical evaluation of harvest effects on stream temperature. High inter- and intra-site variability in both the treatment and control sites before and after harvest prevented CMER from using the data in a statistical analysis of treatment effects. CMER therefore agreed to finalize the study as a data collection report and archive all of the supporting documentation for potential future use. The data collected and reported in "Water Temperature Evaluation of Hardwood Conversion Treatment Sites Data Collection Report" (CMER #05-513, June 1, 2010) can be useful to scope and develop a study plan for a more comprehensive and long-term study addressing the water temperature and shade impacts of this common forest practice.

5.3.9.4 Annotated Bibliography: Riparian Hardwood Conversion

Description:
The proposed bibliography was meant to assemble literature citations, including comments about the value and findings of each citation. This bibliography would describe silviculture and effects of hardwood conversion on riparian functions, including shade, stream temperature, and nutrient inputs.

Status:
Initial drafts of the annotated bibliography were considered inadequate; and after several revisions and discussions by RSAG on the scope, intent and overall usefulness of the bibliography in the adaptive management program, RSAG decided to terminate this project in 2011.

5.3.9.5 Ecology Water Temperature Modeling Project

Description:
This study used an existing stream temperature and shade model to explore the relative effect on stream temperature of different hardwood conversion strategies. The management strategies that were evaluated include a one-sided harvest with continuous 30-ft. and 50-ft.-wide buffers with treated stream lengths ranging from 500 to 1,500 ft. A sensitivity analysis was performed on a range of modeled stream conditions (width, flow, gradient, groundwater, and hyporheic flow).

Status:
A draft report was completed in 2006 and was reviewed and approved by CMER. The report was completed in 2007 and submitted to the Small Forest Landowners Advisory Committee, who forwarded the report on to Policy with a recommendation of no further action warranted at this time.

5.3.10 Intensive Monitoring/Cumulative Effects Program (see Section 5.11)

5.4 CHANNEL MIGRATION ZONE RULE GROUP

5.4.1 Rule Overview and Intent

The channel migration zone (CMZ) is an area within a river or stream valley where the active channel is prone to move laterally. The intent of the CMZ rule is to maintain riparian forest functions (e.g., woody debris recruitment, bank reinforcement, shade, and litter) along migrating channels, in their present or future location. No timber harvest, salvage, or road construction (except for road crossings) is allowed within CMZs without an alternate plan that specifies the conditions that will provide equal and effective protection of public resources as described in the forest practices rules and the Forest Practices Act.

5.4.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:

- Same as for Type F riparian prescriptions (see Section 5.3).

Performance Targets:

- Same as for Type F riparian prescriptions (see Section 5.3).

5.4.3 Rule Group Strategy

The strategy for the CMZ Rule Group is to answer a set of critical questions that address uncertainties concerning CMZ delineation and effectiveness (Table 22). The first question arises from the need to identify and delineate the CMZ so that the prescriptions can be implemented as intended. The rule assumes that the CMZ can be identified and that the extent of the CMZ can be consistently delineated by landowners. This assumption has high uncertainty because, although many CMZs are relatively easy to evaluate, their boundaries may be difficult to estimate and delineate depending on the quality of remote sensing data and resolution of geomorphic features in the field. Incorrect delineation of the CMZ edge results in incorrect placement of the adjacent riparian management zone (RMZ), making the channel potentially vulnerable to losing riparian protection.

The second question addresses the future patterns of channel migration. The CMZ rule assumes that mechanisms of past channel migration will continue to occur in the future. Uncertainty exists for this assumption because changes in fluvial processes, and potentially land management (i.e., conversion, forest practices) as well as other factors (i.e., climatic drivers and riverine processes, including in-channel wood, sediment, and flow) could change the frequency and spatial extent of channel migration.

Table 22. CMZ Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Names	Task Type	SAG
What field/map criteria allow consistent, repeatable delineation of the CMZ lateral boundaries ("edge")?	CMZ Delineation Program	Rule Tool	UPSAG
Will the physical processes that drive channel migration change appreciably due to the application of forest practices rules?	CMZ Validation Program	Intensive	UPSAG

5.4.4 CMZ Delineation Program

5.4.4.1 Program Strategy

The purpose of the CMZ Delineation Program is to assess the available methods and criteria for accurately identifying and delineating CMZs. The program will develop materials and procedures to aid field managers in the consistent and accurate delineation of CMZs. The program consists of two projects: the first would provide a screening tool to locate areas with potential CMZs and provide a methodology to accurately delineate their boundaries once located. The second project would assess whether new methods result in accurate and consistent CMZ delineations (Table 23 and project descriptions below). The program is not being actively developed because of its low ranking in the CMER priority list.

Table 23. CMZ Delineation Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What field/map criteria allow consistent, repeatable delineation of the CMZ lateral boundaries ("edge")?	CMZ Screen and Aerial Photograph Catalog Project and CMZ Boundary Identification Criteria Project Consistency and Accuracy of CMZ Boundary Delineations

5.4.4.2 CMZ Screen and Aerial Photograph Catalog Project and CMZ Boundary Identification Criteria Project

Description:
The need for the CMZ delineation project, which was outlined in the 2005 Work Plan, may have been resolved with the 2004 revision of the Forest Practices Board Manual for CMZs (i.e., Section 2 in the Manual), which provides more detailed guidance. This is not an active project.

Status:
Aside from the preliminary scoping, no CMER work on these topics has been proposed.

5.4.4.3 Consistency and Accuracy of CMZ Boundary Delineations

Description:
The recent development of revised CMZ delineation guidelines (i.e., Board Manual, Section 2) leaves open questions as to whether new methods result in accurate and consistent CMZ delineations. Although this project has not yet been scoped, it would likely involve field evaluation of a sample of CMZ delineations.

Status:
The project is not yet scoped. This issue may be included in the DNR Forest Practices Compliance Monitoring Program.

5.4.5 CMZ Validation Program (Intensive)

5.4.5.1 Program Strategy

There is general interest in learning how the protection and recovery of mature forests in CMZs will influence channel migration rates, aquatic habitat formation, and other functions. These questions could presumably be addressed by field and/or remote-based (i.e., air photos, LIDAR) studies. Such issues have never been elevated among CMER priorities, and thus no studies have been scoped to date.

Table 24. CMZ Validation Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Will the physical processes that drive channel migration change appreciably due to the application of forest practices rules?	No projects scoped at this time

5.5 UNSTABLE SLOPES RULE GROUP

5.5.1 Rule Overview and Intent

The FP HCP goal for the management of potentially unstable slopes is to prevent forest practices from increasing or accelerating mass wasting (landslides) beyond the naturally occurring rates. The intent of the goal and its related rules is to protect water quality, aquatic habitat, and public safety by minimizing sediment delivery from management-related increases in mass wasting.

The rules as initially written assumed the following: (1) the administrative process of identifying, reviewing, and regulating forest practices on potentially unstable slopes will maintain a naturally occurring rate of mass wasting following forest practices; (2) implementation of the unstable slopes prescriptions will achieve the Schedule L-1 resource objectives of clean water and natural substrate and will maintain channel-forming processes; and (3) implementation of the unstable slopes prescriptions will meet FP HCP landscape-scale performance targets (there are no site-scale targets). The projects in this Rule Group are designed to test these assumptions.

The forest practices rules' default protective measure for potentially unstable slopes is avoidance. The rule protection strategy begins with definition of unstable landforms and the identification of unstable slopes. Based on the Forest Practices Board's recommendation, in 2014 DNR developed and implemented the Slope Stability Information Form to be completed by applicants that propose harvest on or near rule-identified landforms (RIL) and included with their forest practices application (FPA). This form provides additional information on the screening tools used by applicants and includes potentially unstable slopes within and adjacent to proposed forest practice activities. The strategy then is either to avoid the area or conduct a risk evaluation through the State Environmental Protection Act (SEPA) process (WAC 222-10-030).

WAC 222-16-050(1) defines "Class IV-special," which includes timber harvest or road construction, on RIL that have been field verified by the department and have the potential to deliver sediment or debris to a public resource or threaten public safety. Section 222-16-050(1)(d)(i) lists the five RIL categories and directs the reader to Section 16 of the board manual where RILs and their criteria are described in detail. The rule protection strategy relies on the ability of forest managers and regulators to recognize and mitigate for unstable slopes within the FPA and approval process. If forest practices are planned on potentially unstable slopes, the FPA process includes a report written by a qualified expert and SEPA review.

5.5.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:

- Sediment: Provide clean water and substrate and maintain channel-forming processes by minimizing to the maximum extent practicable the delivery of management-induced coarse and fine sediment to streams (including timing and quantity), by protecting streambank integrity and unstable slopes, providing vegetative filtering, and preventing sediments from routing into streams.

Performance Targets:

- Road-related: Virtually none triggered by new roads; favorable trend on old roads.
- Timber harvesting-related: No increase over natural background rates from harvest on a landscape-scale on high-risk sites.

5.5.3 Rule Group Strategy

Table 25 contains critical questions for the Unstable Slopes Rule Group and identifies a series of programs to address them. The initial strategy was to first implement an unstable-landform identification program to address the first two critical questions, and then to design and implement programs for mass wasting effectiveness monitoring and validation and to assess the effectiveness of landform recognition and mitigation at various scales. All effectiveness, extensive, and intensive tasks related to unstable slopes are or will be administered by UPSAG; rule tools are developed by UPSAG, adopted by the FP Board, and administered by DNR.

Table 25. Unstable Slopes Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Names	Task Type	SAG
What screening tools can be developed to assist in the identification of potentially unstable landforms that minimize the omission of potentially unstable landforms?	Unstable Landform Identification Program	Rule Tool	UPSAG
Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard? How does the rate of landsliding on managed lands compare to an estimate of the natural (background) rate? Are the forest practices unstable-landform rules effective at reducing the rate of management-induced landsliding at the landscape scale? Are the mass wasting prescriptions and mitigation measures effective in preventing landslides from roads and harvest units? Does windthrow on mass wasting buffers (leave areas) increase mass wasting?	Mass Wasting Effectiveness Monitoring Program	Effective-ness	UPSAG
What levels of cumulative sediment inputs are harmful to aquatic resources at the basin scale? How does turbidity associated with contemporary forest practices affect salmonid populations (e.g., growth, survival, movement)?	Mass Wasting Validation Program	Intensive	UPSAG ISAG
Does harvesting of the recharge area of a glacial deep-seated landslide promote its instability? Can relative levels of response to forest practices be predicted by key characteristics of glacial deep-seated landslide and/or their groundwater recharge areas?	Deep-Seated Landslide Program	Rule Tool	UPSAG

Rule Group Critical Questions	Program Names	Task Type	SAG
Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard?			

5.5.4 Unstable Landform Identification Program

5.5.4.1 Program Strategy

The purpose of the Unstable Landform Identification Program is to provide a set of screening tools to identify forested areas containing potentially unstable slopes and to focus field verification activities on potential problem areas, thereby improving our ability to avoid them.

The management strategy for regulating forest practices on unstable slopes consists primarily of an administrative process for identifying and reviewing forest practices on potentially unstable slopes. The main elements of the strategy include defining and screening unstable slopes and improving the FPA classification process. The success of the management strategy for unstable slopes is dependent on early recognition of potentially unstable slopes by forest managers to avoid or mitigate the hazards posed by them. The projects in this program are specifically referenced in the FP HCP as necessary for implementing forest practices that meet resource objectives.

This program consists of the five projects below, which provide statewide information on the distribution of unstable landforms. Because the projects develop screening tools that are used for information only and not as regulatory tools, program results to date have not required Policy action. Four projects have been completed and the fifth project is on hold (Table 26).

Table 26. Unstable Landform Identification Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names	Status
What screening tools can be developed to assist in the identification of potentially unstable landforms that minimize the omission of potentially unstable landforms?	Shallow Rapid Landslide Screen for GIS Project (westside completed, eastside not completed)	Partially completed
	Technical Guidelines for Geotechnical Reports Project	Completed
	Regional Unstable Landforms Identification Project (RLIP)	Completed
	Landform Hazard Classification System and Mapping Protocols Project	Completed
	Landslide Hazard Zonation Project	On hold

5.5.4.2 Shallow Rapid Landslide Screen for GIS Project

Description:
This project has three phases. The first phase compared different slope stability models. Based on the results of Phase 1, Policy directed DNR to develop a GIS-based screen of modeled slope stability based on digital elevation model (DEM) topography for the westside. This first phase was completed in 2001 and was released as Timber, Fish and Wildlife (TFW) Report 118 titled, "Comparison of GIS-Based Models of Shallow Landsliding for Application to Watershed

Management." The second phase produced a modeled slope stability screen, which is available on the DNR forest practices website (SLPSTAB). A third phase has been proposed to identify topographic model(s) appropriate for similar mapping on the eastside, but it was never initiated.

Status:

- Phase 1 — Complete
- Phase 2 — Complete
- Phase 3 — On hold

5.5.4.3 Technical Guidelines for Geotechnical Reports Project

Description:
This project developed technical guidelines for geotechnical reports used in the SEPA review process. The guidelines include identification of analytical tools and techniques that are appropriate for different projects and at different scales.

Status:
Complete.

5.5.4.4 Regional Unstable Landforms Identification Project (RLIP)

Description:
This project provided a coordinator to work with TFW cooperators within each DNR region in order to identify unstable landforms that do not meet the statewide landform descriptions. Its results also serve as an interim screen for deep-seated landslides by identifying lithologies that promote this type of slide; however, the project did not actually map individual deep-seated landslides but rather the areas where they occur in abundance. CMER and UPSAG recommended that the information created by the RLIP be incorporated into the Landslide Hazard Zonation (LHZ) Project. In 2005, data from this project were distributed to DNR regions.

Status:
Complete.

5.5.4.5 Landform Hazard Classification System and Mapping Protocols Project

Description:
This project developed a detailed protocol for mapping landslides and potentially unstable landforms in a consistent manner, leading to the assignment of hazard level to unstable slopes in the forested environment. This project was completed in 2004; the protocol has subsequently been used to implement the LHZ Project (described below). State lands geologists have also applied the protocols to analysis of large blocks of land under state ownership.

Status:
This project was completed in 2004 and has been utilized in the LHZ Project.

5.5.4.6 Landslide Hazard Zonation Project

Description:
The LHZ Project had three phases. During Phase 1, all mass wasting modules from completed watershed analyses and other information on unstable landforms, landslides, and unstable slopes

were collected and compiled in a GIS database. This database has been made available for free download to the public and is used as a screening tool in the forest practices application process. During Phase 2, mass wasting modules from incomplete watershed analyses were either finished, reviewed, and added to the database or were rejected. During Phase 3, the protocol was applied at the watershed scale following a list of priority watersheds based on the presence of steep slopes and FP HCP lands.

The current results of the LHZ Project are as follows: For Phase 2, there were 27 watershed administrative units (WAUs) identified as priorities for review and completion by the LHZ Project. Eighteen WAUs were found to be of acceptable standard, and nine WAUs were rejected during LHZ review because the mass wasting modules were incomplete or of substandard quality. During Phase 3, 39 LHZ projects (WAUs and/or State Land blocks) were completed. The LHZ Project was suspended in 2009 due to budgetary constraints, leaving an additional 33 of the WAUs on the Phase 3 priority list, although some were partially completed within State Land blocks. This phase may be discontinued in the future pending the results of the Unstable Slopes Criteria Project.

Status:

- Phase 1 — Complete
- Phase 2 — Complete (with nine WAUs rejected)
- Phase 3 — Suspended

5.5.5 Mass Wasting Effectiveness Monitoring Program

5.5.5.1 Program Strategy

The purpose of the Mass Wasting Effectiveness Monitoring Program is to assess the degree to which implementation of the forest practices rules is preventing or avoiding an increase in landsliding beyond natural background levels. Natural background rates are difficult to determine. The Mass Wasting Effectiveness Monitoring Program will address the critical question that defines the program: "Are the mass wasting rules effective in preventing an increase in landslides that deliver to public resources or impact public safety?" The program strategy is to (1) evaluate the effectiveness of identifying unstable slopes for applying prescriptions (avoidance or mitigation); and (2) evaluate effectiveness at two scales: the landscape scale (extensive monitoring) and the site scale (effectiveness monitoring).

Four projects are proposed to address five critical questions (Table 27). The first, the Unstable Slope Criteria Project (which replaced the Testing the Accuracy of Unstable Landform Identification Project), was re-scoped as a pilot project under the LEAN process in response to Board direction and Policy feedback. The second, The Mass Wasting Effectiveness Monitoring Project, was an examination of the landslide response to the December 2007 storm in Southwestern Washington. This project was submitted as a non-consensus report to Policy. The third, the Mass Wasting Landscape-Scale Extensive Monitoring Project, has been preliminarily scoped. The fourth, Mass Wasting Buffer Integrity and Windthrow Assessment Project, is on indefinite hold.

Table 27. Mass Wasting Effectiveness Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names

Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard?	Unstable Slope Criteria Project (which replaced the Testing the Accuracy of Unstable Landform Identification Project)
How does the rate of landsliding on managed lands compare to an estimate of the natural (background) rate? Are the forest practices unstable slopes rules effective at reducing the rate of management-induced landsliding at the landscape scale? Are the mass wasting prescriptions and mitigation measures effective in preventing landslides from roads and harvest units?	Mass Wasting Effectiveness Monitoring Project Mass Wasting Landscape-Scale Extensive Monitoring Project
Does windthrow on mass wasting buffers (leave areas) increase mass wasting?	Mass Wasting Buffer Integrity and Windthrow Assessment Project

5.5.5.2 Unstable Slope Criteria Project: An Evaluation of Hillslopes Regulated under Washington Forest Practices Rules

Description:

This project will evaluate the degree to which the landforms described in the unstable slopes rules identify potentially unstable areas that are likely to impact public resources or threaten public safety. The project is being designed to evaluate the original Forests and Fish Report Schedule L-1 research topic: "Test the accuracy and lack of bias of the criteria for identifying unstable landforms in predicting areas with a high risk of instability" (FFR p. 127). The project replaces the Testing the Accuracy of Unstable Landform Identification Project, based on feedback from Policy at the November 2010 meeting. At that meeting, UPSAG presented two interpretations of the original Forests and Fish Report Schedule L-1 topic and asked for direction as to how to proceed and prioritize efforts. The TWIG developed alternatives and understands that Policy's direction is to evaluate landslide susceptibility of different slopes/landforms in the interest of evaluating current rule-identified landforms and identifying/characterizing additional potentially unstable landforms.

Status:

The TWIG received CMER approval for a document titled "Unstable Slope Criteria Project – Research Alternatives" on February 28, 2017, and then presented the alternatives to TFW Policy on March 2, 2017. Policy chose the TWIG's recommended alternative on April 6, 2017.

The Unstable Slope Criteria Project consists of five distinct studies approved by Policy in April 2017

1. Compare/Contrast Landslide Hazard Zonation (LHZ) Mass Wasting Map Units with RIL (this project will be incorporated into subsequent projects per ISPR review comments).
2. Object-Based Landform Mapping with High-Resolution Topography
3. Empirical Evaluation of Shallow Landslide Susceptibility and Frequency by Landform
4. Empirical Evaluation of Shallow Landslide Runout
5. Models to Identify Landscapes/Landslides Most Susceptible to Management

The study design for the first phase of the project, Object-based Landform Mapping with High Resolution Topography, was approved by ISPR in 2019 and the Project Team is currently working on Project 2, Object-Based Landform Mapping with High-Resolution Topography Study, implementation. The report is schedule to be presented to CMER in fall 2022. A Study Design that will cover Empirical Evaluation of Shallow Landslide Susceptibility and Frequency by Landform (Project 3) and the Empirical Evaluation of Shallow Landslide Runout (Project 4) is being developed using

information learned in the Object-Based Landform Mapping with High-Resolution Topography Study. The Study Design is scheduled to be presented to CMER in spring 2023.

5.5.5.3 Mass Wasting Effectiveness Monitoring Project

Description:
This project was designed to statistically compare landslide rates among five harvest treatments and five road treatments. The treatments were sets of prescriptions associated with the period in which different forest practices rules were in effect. In late 2007, a storm produced a significant population of landslides. Landslide data were collected within 4-square-mile blocks, and all area encompassed by the blocks was classified into one of the five harvest and five road treatments. Harvest and road landslides were analyzed separately, and primary statistical analyses were made relative to the block response to account for differences in geomorphology and rainfall intensity. Tests were conducted to determine whether there are differences in the density of landslides associated with each of the harvest and road treatments. The statistical design aimed to answer two critical questions in Table 27: "Are the forest practices unstable slopes rules reducing the rate of management-induced landsliding at the landscape scale?" and, "Are the mass wasting prescriptions and mitigation measures effective in preventing landslides from roads and harvest units?" The detailed data collection at individual landslides was used to help evaluate the effectiveness of specific best management practices.

Status:
The final report was submitted to CMER and Policy in May 2013 as CMER Publication 08-802. The report was submitted to Policy as a non-consensus report, which includes minority reports.

5.5.5.4 Mass Wasting Landscape-Scale Extensive Monitoring Project

Description:
This project will be designed to evaluate trends in the number and volume (or area) of landslides over time at the watershed scale using landslide inventory methods similar to those of watershed analysis. In broad terms, the trend monitoring will include sites that sample statewide variability in the factors that control landslide occurrence. These sites will consist of tracts containing both FP HCP-regulated lands and other forestlands under no or less extensive management (representative of natural or background conditions). Landslide rates and volume fluxes from both will be compared. Data to infer status and trends may consist of an inventory of landslides using data collected through the LHZ Project, complemented with aerial photography and maps of terrain, topography, forest cover, and road networks. Once this project is prioritized, UPSAG will work towards designing a study that can isolate the mass wasting trends associated with the forest practices rules from the dynamic noise of the natural system.

Status:
Preliminarily scoped and on hold because it is currently considered to be infeasible.

5.5.5.5 Mass Wasting Buffer Integrity and Windthrow Assessment Project

Description:
This project will be designed to test the effect of windthrow in mass wasting leave areas on overall landslide rates. One school of thought suggests that mass wasting leave areas are especially prone to windthrow. If that is true, then mass wasting leave areas may be counterproductive for reducing sediment load to streams. However, downed timber from windthrow has been documented as being effective at slowing the rate of sediment movement on

the hillslope. How these two divergent effects affect actual sediment yield to streams is not known.

Status:
There has been no action on this project. In 2012, Policy requested that CMER further investigate the potential for windthrow on FP HCP lands for projects listed in the Work Plan. UPSAG recommends removing this project from the Work Plan in favor of focusing on more viable studies or incorporating it in the RSAG work plans.

5.5.6 Mass Wasting Validation Program (Intensive)

5.5.6.1 Program Strategy

No program strategy has been developed, but it is presumed that when UPSAG and/or ISAG have time to work on this program, the efforts of the Monitoring Design Team will be a useful starting point.

Table 28. Mass Wasting Validation Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What levels of cumulative sediment inputs are harmful to aquatic resources at the basin scale? How does turbidity associated with contemporary forest practices affect salmonid populations (e.g., growth, survival, movement)?	No projects have been developed

5.5.7 Deep-Seated Landslides Program

5.5.7.1 Program Strategy

The purpose of the Deep-Seated Landslides (DSL) Program is to develop science, tools, and/or guidance for assessing the potential of forest practices to change groundwater hydrology in landslide recharge areas and accelerate or reactivate deep-seated landslides in glacial sediments. The twelve listed projects develop tools or science that help us address the two critical questions: "Does harvesting of the recharge area of a glacial deep-seated landslide promote its instability?" and "Can relative levels of response to forest practices be predicted by key characteristics of glacial deep-seated landslides and/or their groundwater recharge areas?" (Table 29).

Policy and Forest Practices Board Requests:
At the budget retreat in 2006, Policy requested that UPSAG investigate pathways to resolve difficulties in the application of rules governing timber harvest on groundwater recharge areas of deep-seated landslides. In 2007, UPSAG hired a contractor to assist in scoping several alternative studies. UPSAG evaluated the scoped projects and presented their findings to CMER in the fall of 2007. No further progress on this program occurred until efforts were revitalized in the spring of 2014. The Forest Practices Board drafted several motions directing Policy and CMER to review and update their mass wasting research strategy. A Mass Wasting Subcommittee of TFW Policy was formed; three UPSAG members participated and a document titled "Unstable Slopes – Glacial Deep-Seated Landslides and Their Groundwater Recharge Areas: Considerations for the CMER Work Plan" was written. These considerations were added

to the FY 2017 CMER Work Plan. Notable additions include a second critical question, the initiation of the Literature Synthesis of the Effects of Forest Practices on Glacial Deep-Seated Landslides and Groundwater Recharge, and modifications to the Landslide Classification Project (Table 29).

Per Board request, Policy directed CMER via the UPSAG to develop a Deep-Seated Landslide Research Strategy (hereafter Strategy). This Strategy includes descriptions of twelve projects, identifies their respective priorities, timelines, and estimated costs; sequencing relative to each other; and describes the relationship between projects and their associated critical questions from the CMER Work Plan (2017-2019). The Strategy evaluates existing deep-seated landslide projects and revises, adds or replaces projects. The scope of the program was expanded to include non-glacial, or bedrock, deep-seated landslides. CMER and Policy approved the Strategy in 2018. Hence the suggestion to rename this program to apply to all deep-seated landslide types.

5.5.7.2 Deep-Seated Landslide Research Strategy

Description:
This project used the results of the literature reviews for forest harvest effects on glacial deep-seated landslides (completed August 2016) and non-glacial deep-seated landslides (completed June 2017) to form a research strategy to address key knowledge gaps identified during the literature reviews and to address questions from the Forest Practices Board and Policy regarding the potential effects of forest practices on deep-seated landslides (Table 29). This strategy included a description of projects, identified their priority, timeline, sequence, and estimated cost, and described the relationship between the project and the critical questions (Table 30). The strategy evaluated the existing CMER Deep-Seated Landslide Work Plan projects and revised, added or replaced projects.

Status:
The strategy is complete and composed of several projects. UPSAG is currently developing a Study Design based on the Policy-approved Scoping Document for the Landslide Mapping and Classification Project (4.5 and 4.6) under the Strategy. The Study Design is anticipated to be reviewed by CMER in spring of 2023.

Table 29. Summary of Deep-Seated Landslide Research Strategy projects and status

Project Title	Project Origin	Status
4.1 Model Evapotranspiration in Deep-Seated Landslide Recharge Areas	CMER Work Plan	Completed
4.2 Literature Synthesis of the Effects of Forest Practices on Glacial Deep-Seated Landslides and Groundwater Recharge	CMER Work Plan	Completed
4.3 Literature Synthesis of the Effects of Forest Practices on Non-Glacial Deep-Seated Landslides and Groundwater Recharge	Deep-Seated Landslide Proposal Initiation (PI)	Completed
4.4 Board Manual Revision	CMER Work Plan	Intermittent Process pending direction from the Board

4.5 Deep-Seated Landslide Mapping	CMER Work Plan	Current
4.6 Deep-Seated Landslide Classification	CMER Work Plan/ Revised by PI	Current
4.7 GIS-Based Landslide Stability and Sensitivity Toolkit	Recommendation from 4.2	Not scoped
4.8 Groundwater Recharge Modeling	CMER Work Plan	Scoped in 2007; On-hold
4.9 Physical Modeling of Deep-Seated Landslides	Recommendation from 4.3	Not scoped
4.10 Landslide Monitoring	Recommendation from 4.2	Not scoped
4.11 Evapotranspiration Model Refinement	CMER Work Plan	Scoped in 2007; On-hold
4.12 Empirical Evaluation of Deep-Seated Landslide Density, Frequency, and Runout by Landform	Unstable Slope Criteria TWIG	To be scoped with projects 4.5, 4.6, and 4.9 (see Strategy)

Table 30. Deep-Seated Landslides Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Does harvesting of the recharge areas of glacial or bedrock deep-seated landslides promote their instability?	Model Evapo-Transpiration in Deep-Seated Landslide Recharge Areas Project
	Evapo-Transpiration Model Refinement Project
	Literature Synthesis of the Effects of Forest Practices on Glacial and Non-Glacial Deep-Seated Landslides and Groundwater Recharge
	Groundwater Recharge Modeling Project
Can relative levels of response to forest practices be predicted by key characteristics of glacial or bedrock deep-seated landslides and/or their groundwater recharge areas?	Deep-Seated Landslide Map Project
	Deep-Seated Landslide Classification Project
	Board Manual Revision Project

5.5.7.3 Model Evapo-Transpiration in Deep-Seated Landslide Recharge Areas Project

Description:

This project developed an analytical model for assessing changes in evapo-transpiration resulting from timber harvest. The model was intended to be applied to timber harvest within the groundwater recharge area of deep-seated landslides in glacial sediments. The model has been developed but was not directly validated and refined because of insufficient field data to verify model parameters. As such, UPSAG and CMER did not recommend a policy change, even though the results of the model suggest that there is likely a significant, detectible change in water availability when converting an entire groundwater recharge area from mature forest to a clear-cut (Sias 2003). A follow-up validation/refinement study could be pursued as a second phase, as described below.

Status:

Complete, but there has been no use of the model due to a general lack of available data required to run the model in the forested environment.

5.5.7.4 Literature Synthesis of the Effects of Forest Practices on Glacial Deep-Seated Landslides and Groundwater Recharge

Description:
This project is a focused literature review to summarize the best available science on the effects of forest practices on deep-seated landslides in glacial materials. The literature review includes an annotated database, a GIS map product, and a synthesis report. UPSAG undertook this project in 2015 to provide updated background information to help address the question: "does harvesting of the groundwater recharge area of a glacial deep-seated landslide promote its instability?" The synthesis found that the sensitivity of glacial deep-seated landslides to forest practices is poorly understood and that many of the effects of forest practices must be inferred using measurements for different land-cover types (Miller 2016).

Status:
Completed. The Literature Synthesis of the Effects of Forest Practices on Glacial Deep-Seated Landslides and Groundwater Recharge was presented to UPSAG in June 2016 and approved by CMER and delivered to Policy in July 2016.

5.5.7.5 Literature Synthesis of the Effects of Forest Practices on Non-Glacial Deep-Seated Landslides and Groundwater Recharge

Description:
This project was a companion project to the literature synthesis focused on deep-seated landslides in glacial materials, but focuses on non-glacial materials. UPSAG undertook the project in October 2016 to address questions related to the effects of harvesting of the groundwater recharge area of non-glacial deep-seated landslides on slope stability. An Unstable Slopes Proposal Initiation (PI), generated by the Forest Practices Board led to a memo "Recommendations from TFW Policy Committee to Forest Practices Board", dated August 4, 2016, informing the questions posed for the literature synthesis. This literature review builds on the annotated database and landslide inventory created for the glacial deep-seated literature review and includes a separate synthesis report to address additional questions about slope stability in non-glacial materials.

Status:
Completed.

5.5.7.6 Board Manual Revision Project

Description:
This project involves revisions of the Forest Practices Board Manual (Section 16) to more clearly describe which deep-seated landslides are at risk and what intensity of study might be needed based on the activity level of the landslide described by the groundwater recharge rule. In 2014, DNR convened an "Expert Panel" to revise portions of the Board Manual. A section on landslide run out and potential delivery was later revised by a TFW stakeholder group of qualified experts. The Board adopted the revised version of Section 16 in March 2015, and the section on run out and delivery in November 2015, and the current version in May 2016. The 2014–2015 revisions to Section 16 provided new guidance regarding the amount of study needed to address different

situations. The 2016 revision added greater detail about deep-seated landslide characteristics and identification.

Status:
Intermittent process pending direction from the Board.

5.5.7.7 Glacial Deep-Seated Landslide Mapping Project

Description:
This project will build on ongoing Washington Geologic Survey (WGS) mapping efforts by providing a spatial inventory of deep-seated landslides where WGS does not focus its work, and increasing field work to acquire detailed attributes for a variety of geologic materials and environmental settings. This combined mapping effort is critical for establishing the population of landslide types, processes, and spatial extents for most of the subsequent strategy projects. The WGS is expected to continue mapping deep-seated landslides and UPSAG is coordinating mapping with WGS staff to augment their efforts with the information we need to implement the strategy.

Status:
In the Study Design phase with Deep-Seated Landslide Classification Project (see below).

5.5.7.8 Deep-Seated Landslide Classification Project

Description:
This project will categorize deep-seated landslides to identify characteristics that indicate that a landslide may besensitive to hydrologic changes from upslope timber harvest. The 2014 Policy recommendations clarify that the first step would bin glacial deep-seated landslides by landslide type, by stratigraphic section, by size of the landslide and size of its groundwater recharge area, and by proximity to a river channel as these attributes hypothetically have variable sensitivity to forest practices. Policy recommended a second step, as long envisioned by UPSAG, that the range of potential sensitivities be empirically analyzed to test the degree to which forest practices have influence on one or more of the bins. Policy approved the DSL Scoping Document in 2020 whichexpanded the project to include both glacial and bedrock deep-seated landslides.

Status:
Ongoing. UPSAG scoped (and CMER and Policy approved) a combined Deep-Seated Landslide Mapping & Classification Project in 2020. UPSAG is currently developing a Study Design based on the Policy approved Scoping Document for the Landslide Mapping and Classification Project (4.5 and 4.6) under the Strategy. The Study Design is anticipated to be provided to CMER for review in spring of 2023.

5.5.7.9 GIS-Based Landslide Stability and Sensitivity Toolkit

Description:
Miller (2016) suggested developing a series of GIS-based tools for assessing the stability and sensitivity to forest practices of deep-seated landslides. The products of this project could include a map of the stability assessment results to use as a forest practice screening tool, a GIS-based toolkit for use in developing and reviewing geotechnical reports, and statistical relationships between landslide characteristics and slope stability that can be periodically refined as more landslides are assessed with the tools. Maps can also be produced to show the data elements used for the calculated rankings. These may include elements such as mapped landslide boundaries,

landslide surface roughness, and delineation of the estimated contributing area, upslope geological and topographic features, proximity to streams, and other attributes that should be field-verified. Similar to the mapping project, the toolkit analysis may include glacial and bedrock deep-seated environments.

Status:
Not scoped.

5.5.7.10 Groundwater Recharge Modeling Project

Description:
This potential project would use groundwater modeling to determine whether there are ways of evaluating which parts of the groundwater recharge zone are most influential on landslide movement. This project might be useful if modeling efforts were focused on the common and probably sensitive types of stratigraphic and geomorphic situations, as might be identified by the Landslide Classification Project.

Status:
Scoped (Waldrick 2007) and on hold.

5.5.7.11 Physical Modeling of Deep-Seated Landslides

Description:
Physical models can be used to integrate available information about individual landslides based on geologic and hydrologic processes. Fully integrated models, starting with tools developed during GIS-Based Landslide Stability and Sensitivity Toolkit, and Groundwater Recharge Modeling Project, could be used to calculate the factor of safety of a landslide, the sensitivity to changes in pore pressure or toe erosion, a water budget and fluctuations in water supply for the landslide, the effect of forest cover on water supply, and the response in pore pressure caused by fluctuations in the water supply. In concert with the Landslide Classification Project, the distribution of calculated values can provide another way to characterize a population of landslides. Statistical methods can then be used to see how calculated values of stability, sensitivity, and precipitation correlate with the observed activity level.

Status:
Not scoped.

5.5.7.12 Landslide Monitoring Project

Description:
Miller (2016) recommended an approach using a combination of remote sensing (e.g., synthetic aperture radar) and field measurements to quantitatively measure activity of a population of landslides identified in the Landslide Classification Project over time. Field data, such as precipitation, hydraulic head and landslide displacement could be collected to test assumptions about groundwater response and landslide activity in response to forest practices in different geomorphic settings. This recommendation was expanded in Miller (2017) to include dating of the landslide using surface roughness or direct 14C dating of materials in the landslide.

Status:
Not scoped.

5.5.7.13 Evapo-Transpiration Model Refinement Project

Description:
This scoped project refines the evapotranspiration model (GAET), which was developed by Sias (2003) using better quantified parameters, or the experimental pursuit of important parameters that have yet to be quantified. This project was scoped to continue to inform the question: Does harvesting the recharge area of a glacial deep-seated landslide promote its instability? The model refinement project proposed to validate the GAET model using micrometeorological data from Vancouver Island, to establish model parameters and ranges for clearcut, intermediate and mature forests, and to field test the model. The field testing would yield information about model assumptions and direct researchers toward better quantification of important parameters. If field pilot testing is successful, then the model could be evaluated to determine if it is a cost-effective and robust tool for groundwater recharge modeling of forest practices.

At this time, our ability to interpret how additional water from loss of evapotranspiration influences shallow groundwater levels and then slope stability is limited. Refinement of the actual value for loss of evapotranspiration is not currently helpful, but may be after other research is accomplished. Specifically, if we do not know what 40 inches of water per year means to a deep-seated landslide (typically value produced by the model for loss of evapotranspiration in high rainfall areas of Western Washington), then refining the value to 36 inches or 44 inches is not useful. If Groundwater Modeling and Physical Modeling improve our understanding of the influence of additional water on deep-seated landslides of different types, activity levels and geologic materials, then this project or improvement of a different model may become important in the future.

Status:
Scoped (Sias 2007) and on hold.

5.6 ROADS RULE GROUP

5.6.1 Rule Overview and Intent

The intent of the forest practices rules for roads is to protect water quality and riparian/aquatic habitat by minimizing sediment delivery to typed waters from road erosion and mass wasting, as well as minimizing road-related changes in hillslope and stream hydrology. Fish passage at road crossing structures is treated as a separate rule group. The road rules protect water quality and riparian/aquatic habitats through prescriptions and best management practices (BMPs).

Implementation of these prescriptions through road maintenance and abandonment plans (RMAPs) is intended to minimize road surface sediment production, the hydrologic connection between the road system and the stream network, and the risk of road-related landslides caused by inadequately built and maintained roads. The road rules specify prescriptions for road construction, maintenance and abandonment, landings, and stream crossing structures. In addition, the Forest Practices Board Manual identifies BMPs for roads and landings. The rules required RMAP inventories for all forest roads to be developed by 2006 for large forest landowners and construction completed by 2016. This was later extended to be completed in 2021. The work was to be done in conjunction with planned timber harvest activity for small forest landowners.

Unstable slope rules also minimize management activities, including road construction, in landslide-prone locations. Monitoring conducted under the Unstable Slopes Rule Group programs includes mass wasting associated with roads. The Roads Rule Group programs are primarily directed toward monitoring surface erosion and hydrologic disconnection.

The basic assumptions of the road rules are the following:

1. Implementation of road prescriptions will result in achieving FP HCP performance goals and resource objectives, including the following:
    a. Meeting water quality standards.
    b. Providing clean water and substrate, and maintaining channel-forming processes by minimizing the delivery of management-induced coarse and fine sediment to streams by protecting stream-bank integrity, providing vegetative filtering, protecting unstable slopes, and preventing the routing of sediment to streams and associated wetlands.
    c. Minimizing the effects of roads on surface and groundwater hydrologic regimes (magnitude, frequency, timing, and routing of stream flow) to be accomplished by disconnecting road drainage from the stream network, preventing increases in peak flows causing scour, and maintaining the hydrologic continuity of wetlands.
2. Assessment and planning using RMAPs is the best method to assure effective implementation of BMPs, and this will achieve the above objectives.
3. Roads differ in their degree and importance of impact to the resources of concern, and landowners and other Forests and Fish cooperators can identify and prioritize roadwork based on these differences.
4. Appropriately identified BMPs are effective at achieving functional objectives.

5.6.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:

- Sediment: Provide clean water and substrate and maintain channel-forming processes by minimizing to the maximum extent practicable the delivery of management-induced coarse and fine sediment to streams (including timing and quantity) by protecting stream-bank integrity, providing vegetative filtering, protecting unstable slopes, and preventing the routing of sediment to the streams.
- Hydrology: Maintain surface and groundwater hydrologic regimes (magnitude, frequency, timing, and routing of stream flows) by disconnecting road drainage from the stream network, preventing increases in peak flows causing scour, and maintaining the hydrologic continuity of wetlands.

Performance Targets:

- Road sediment delivered to streams: New roads — Virtually none.
- Ratio of road length delivering to streams/total stream length (miles/mile):
    - Old roads not to exceed — Coast (spruce), 0.15–0.25;
    - West of crest, 0.15–0.25; east of crest, 0.08–0.12
- Ratio of road sediment production delivered to streams/total stream length (tons/year/mile):
    - Old roads not to exceed — Coast (spruce), 6–10 T/yr;
    - West of crest, 2–6 T/yr; east of crest, 1–3 T/yr.
- Fines in gravel: Less than 12% embedded fines (< 0.85 mm).
- Road runoff: Same targets as road-related sediment; significant reduction in delivery of water from roads to streams.

5.6.3 Rule Group Strategy

The effectiveness monitoring program for roads is planned for two scales: the sub-basin scale and the site scale (or prescription scale). The FP HCP contains performance targets at the sub-basin scale. At this scale, road monitoring assesses the effectiveness of the rules at meeting the FP HCP performance targets for surface erosion sediment delivery and hydrologic connectivity across ownerships and regions of the state. Site-scale effectiveness monitoring assesses the effectiveness of individual prescriptions.

Site-scale effectiveness monitoring provides more insight into the success of individual road prescriptions than does sub-basin-scale monitoring. The timetable for forest landowners to implement forest practices prescriptions is tied to RMAPs. The site-scale monitoring program requires site-specific road performance measures (developed per prescription objectives), tests for site-level effectiveness using RMAP-implemented areas as a sampling stratum, and field protocols for site-scale performance measures. This site-scale monitoring will inform the rules at several levels by determining the degree to which strategies are achieving resource objectives at the site scale, assessing the need to modify individual RMAPs to achieve resource objectives, and assessing the need to modify guidelines and rules for road maintenance and abandonment planning.

Assessment of the rules leads to five critical questions, which are addressed by three monitoring and validation programs (Table 30). The monitoring strategy is based on CMER's experience with road sediment problems, BMPs, and implementation realities, as well as on the data from many watershed analyses that were used to develop the forest practices road performance targets for sediments. The effectiveness monitoring strategy includes both a site-scale program and a basin-scale program. Validation of the road performance targets, which is more complex and time-consuming, will come later. This approach will first inform the uncertainties about BMP effectiveness and BMPs' ability to meet performance targets. If BMPs are ineffective, validation monitoring is unwarranted. If BMPs are proving to be effective, then validating the performance targets should begin (i.e., do we have the right target?).

Table 31. Roads Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Names	Task Type	SAG
Are road prescriptions effective at meeting sub-basin-scale performance targets for sediment and water? (Exclusive of mass wasting prescriptions, which are covered under the Unstable Slopes Rule Group)	Road Sub-Basin-Scale Effectiveness Monitoring Program	Effectiveness	UPSAG
Does the RMAP process correctly identify and prioritize road problems for repair? Are road prescriptions effective at meeting site-scale performance targets for sediment and water? (Exclusive of mass wasting prescriptions, which are covered in the Unstable Slopes Rule Group section)	Road Prescription-Scale Effectiveness Monitoring Program		
Have the correct performance targets for sediment delivery and connectivity been identified? What levels of cumulative sediment inputs are harmful to the resource at the basin scale? How does turbidity associated with contemporary forest practices affect salmonid populations (e.g., growth, survival, movement)?	Roads Validation Program and Cumulative Sediment Effects	Intensive	UPSAG / ISAG

5.6.4 Road Sub-Basin-Scale Effectiveness Monitoring Program

5.6.4.1 Program Strategy

The purpose of the Road Sub-Basin-Scale Effectiveness Monitoring Program is to determine the degree to which the road rule package is effective at meeting performance targets for surface erosion, sediment, and water established at the sub-basin scale and as a whole across the state. This program is ranked fourth in priority among the 16 CMER programs.

The Road Sub-Basin-Scale Effectiveness Monitoring Program currently consists of three projects that are related to critical questions in Table 31. Two projects, the Road Surface Erosion Model Update Project and the Road Surface Erosion Model Validation/Refinement Project, revise and validate the analytical model to estimate road surface erosion (the Washington State Road Surface Erosion Model, or WARSEM) that is used in the monitoring program to estimate sediment contributions and connectivity from selected road segments and road systems. The

third project, Road Sub-Basin-Scale Effectiveness Monitoring Project, uses WARSEM to measure changes in the road conditions known to generate sediment and hydrologic connectivity between those road segments and the stream-channel network.

Because the rules provide a 20-year window for implementation of RMAP upgrades, this program is long-term and results will provide a periodic evaluation of the trend and the trajectory toward meeting the performance targets through the RMAP efforts.

Table 32. Road Sub-Basin-Scale Effectiveness Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions		**Project Names**
Are road prescriptions effective at meeting sub-basin-scale performance targets for sediment and water?		Road Sub-Basin-Scale Effectiveness Monitoring Project
Program Research Questions	*Are field or analytical methods needed to support the monitoring program?*	Road Surface Erosion Model Update Project
	How accurate is the road surface erosion model in predicting average road sediment from runoff at the site scale?	Road Surface Erosion Model Validation/Refinement Project

5.6.4.2 Road Sub-Basin-Scale Effectiveness Monitoring Project

Description:

This project is intended to provide data that can be used to assess the degree to which sub-basin-scale performance targets, and therefore resource objectives, are being met throughout the state. This project also characterizes the extent of road conditions that reduce surface erosion (e.g., improved surfacing, reduced runoff to streams). Data collected at the sub-basin scale will determine the status and assess trends of key indicators of road connectivity using WARSEM sediment delivery through time. This project does not address performance targets for road performance relative to mass wasting erosion processes, which are more readily evaluated through other monitoring projects. Forest road systems in randomly selected sample areas that are proportionally distributed statewide in areas under forest practices rules, independent of ownership, are being monitored. Small forest landowner properties are included in the study whenever they fall within the sampling blocks. Data are collected to determine the degree to which roads meet established performance targets and the strength of the relationship between those reported measures and the percentage of sample area under implemented RMAPs. Because road monitoring at the sub-basin scale extends through the 20-year road rule implementation period, this piece was put in place before model validation and performance target validation.

Status:

The original vision was to have a first sample before significant RMAP work had been accomplished, a second sample mid-way through RMAP efforts, and a third sample after RMAP was completed. However, the first sample was collected in 2006/2007. These results were reviewed by ISPR and approved by CMER in early 2010, and represent a point mid-way through RMAP efforts. In response to this timing and budgetary considerations, a second (and now final) sample intended to show trend and efficacy is scheduled to occur in 2028, well after RMAP completion in 2021.

5.6.4.3 Road Surface Erosion Model Update Project

Description:

The Surface Erosion Module of the Washington Forest Practices Board Manual on Standard Methodology for Conducting Watershed Analysis (version 4.0, November 1997) contains an empirically derived road erosion model widely used for estimating surface erosion and sediment delivery to streams from forest roads.

The primary purpose of the Road Surface Erosion Model Update Project was to refine and adapt the manual's model for use in forest road monitoring and as an assessment method. Revisions included standardizing input variables and developing repeatable application protocols. This project also included developing, testing, and refining standardized protocols for field application of the revised road surface erosion model for use at the site and road-segment scale.

Status:
This project was completed in 2003 and produced the Washington State Road Surface Erosion Model (WARSEM).

5.6.4.4 Road Surface Erosion Model Validation/Refinement Project

Description:
WARSEM is based on a range of empirically derived data available in 2003. The Road Surface Erosion Model Validation/Refinement Project would measure sediment from selected Washington road sites to evaluate the accuracy of modeled sediment delivery rates. This study could be designed to also evaluate the effectiveness of individual sediment control strategies, such as sediment traps, silt fences, or enhanced cutslope vegetation, but the Road Prescription-Scale Effectiveness Monitoring Project, currently in the implementation phase, may accomplish sufficient empirical research.

Status:
Timing of scoping and study design is planned to follow completion of the Roads Prescription-Scale Effectiveness Monitoring Project. The need for this project will depend largely on results from the Road Prescription-Scale Effectiveness Monitoring Project and on the expansion of available relevant road erosion data sets and/or modeling tools due to research occurring outside of CMER.

5.6.5 Road Prescription-Scale Effectiveness Monitoring Program

5.6.5.1 Program Strategy

The dual purposes of the Road Prescription-Scale Effectiveness Monitoring Program are to (1) determine the degree to which maintenance activities within RMAPs have been appropriately identified; and (2) assess the effectiveness of specific BMPs in meeting their intended objective(s).

As described in Table 32, an important issue related to road effectiveness monitoring is the degree to which maintenance activities targeted in the RMAP assessments are appropriately identified and prioritized based on rule language to fix the "worst first." Monitoring this aspect of the prescription strategy for roads is important because individual or collective prescriptions that are effective in meeting resource protection goals, if not applied to the right locations, may not achieve resource objectives and yet might still incur cost to the landowner. Equally important is the assessment of the degree to which BMPs are effective in meeting their stated objective of either reducing sediment delivery or disconnecting roads from DNR typed waters. This program is ranked ninth in priority among the 16 CMER programs.

We anticipate that the results of these studies will inform the forest practices adaptive management process about the effectiveness of RMAP rules in achieving the FP HCP goals. Should RMAPs prove to be ineffective, Policy may have to revisit the rules to refine requirements and application.

Table 33. Road Prescription-Scale Effectiveness Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Does the RMAP process correctly identify and prioritize road problems for repair?	Effectiveness of RMAP Fixes Project
Are road prescriptions effective at meeting site-scale performance targets for sediment and water?	Road Prescription-Scale Effectiveness Monitoring Project

5.6.5.2 Effectiveness of RMAP Fixes Project

Description:
The primary purpose of this project is to evaluate the degree to which RMAP road repairs have been appropriately identified and implemented. The project is envisioned to follow the completion of the Road Sub-Basin-Scale Effectiveness Monitoring (for surface erosion and connectivity issues) and Mass Wasting Effectiveness Monitoring projects (for road instability issues), so that results of these studies can be used to refine the list of treatments to be investigated and inform a sampling design for the RMAP project described here.

This project would determine the extent to which identified road problems were located in areas where RMAP repairs had been implemented and to determine why site-scale benefits were not achieved in these areas.

Status:
This project has not been scoped.

5.6.5.3 Road Prescription-Scale Effectiveness Monitoring Project

Description:
The objectives of monitoring forest roads at the prescription scale are to (1) evaluate the effectiveness of road maintenance categories in meeting road performance targets; and (2) identify sensitive situations where prescriptions are not effective. This project would address surface erosion sediment reductions from site-specific measures recognizing that significant efforts in both empirical research and modeling have been accomplished and can be built upon.

Status:

In 2014, CMER formed a technical writing and implementation group (TWIG) to begin scoping this project. In September 2014, Policy approved the initial scoping document. A second draft of the Best Available Science and Alternatives Document was submitted to CMER and accepted in January 2016. In February 2016, Policy picked Alternative #4, the TWIG's preferred alternative. The Study Design was submitted for CMER review in December 2016 and approved on February 28, 2017. ISPR occurred over the next year and the Study Design was finalized and approved by CMER on February 27, 2018. Site selection occurred in 2018, and installation of all 80 sites was accomplished in the summer/fall of 2019. In 2022, the project completed its third year of the main experiment which has included the collection and assessment of plot discharge, fine sediment, and annual coarse sediment

data. The first year of the Ditch Line Hydraulics Parameterization experiment was completed in May 2021, with the first half of the second year's assessment being completed in October 2022 (i.e., Siltstone Province has been completed and Volcanic Province will be completed in 2023). The first year of the Short-Time-Scale Parameterization experiment was completed in March 2022. The second year of the Micro-Topography Parameterization experiment was completed in June 2022. Maintenance of sites, data collection, and data analysis are ongoing with all fieldwork projected to be completed in 2026 and all data analysis completed in 2027.

5.6.6 Roads Validation Program and Cumulative Sediment Effects

5.6.6.1 Program Strategy

Validation of road effects and performance targets is envisioned to occur with CMER research in coordination with external cumulative effects research. This is because of the need to coordinate research on sediment generation with parallel studies of potentially affected biota, including fish and amphibians.

Table 34. Roads Validation Program and Cumulative Sediment Effects: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Have the correct performance targets for sediment delivery and connectivity been identified?	Intensive Watershed-Scale Monitoring to Assess Cumulative Effects
What levels of cumulative sediment inputs are harmful to the resource at the basin scale? How does turbidity associated with contemporary forest practices affect salmonid populations (e.g., growth, survival, movement)?	

5.6.6.2 Intensive Watershed-Scale Monitoring to Assess Cumulative Effects

Description:
For a preliminary study description, see this Work Plan's Section 5.11.

Status:
Initial scoping began in 2008. Additional effort depends on prioritization.

5.7 FISH PASSAGE RULE GROUP

5.7.1 Rule Overview and Intent

Fish passage blockages at road crossing structures are to be addressed as part of the road maintenance and abandonment plan (RMAP) process. Road crossing structures will be inventoried and evaluated, and those functioning as fish barriers are to be prioritized based on the quantity and quality of a potential fish-bearing stream being affected upstream of the barrier. Those structures that do not provide fish passage must be repaired or replaced within 15 years, typically on a "worst first" basis. WDFW's hydraulic code rules, the associated barrier-assessment manual, and DNR's forest practices rules apply to crossing structures on forest roads.

The fish passage rule is based on the following assumptions:

- Achieving the objective of no fish barriers is critical for recovery of depressed stocks and the health of fish at all life history stages.
- Implementation of the forest practices rules will result in achieving the objective to maintain or provide passage for fish in all life history stages and to provide for the passage of some woody debris likely to be encountered.
- Assessment, prioritization, and implementation of RMAPs will achieve the objectives in a timely manner.
- Current stream crossing replacement standards are adequate to address fish passage at all life history stages.
- Hydraulic rules are effective at achieving resource objectives.
- Performance targets can be developed for fish at all life history stages.
- Stream-simulation methods provide passage for fish (definition WAC 222-16-010) at all life history stages.

5.7.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:

- Maintain or restore passage for fish in all life stages and provide for the passage of some woody debris by building and maintaining roads with adequate stream crossings.

Performance Targets:

- Eliminate road-related access barriers over the time frame for road management plans.
- Test the effectiveness of fish passage prescriptions at restoring and maintaining passage.

5.7.3 Rule Group Strategy

Based on an analysis of the forest practices rules, CMER identified assumptions and uncertainties underlying the rules. ISAG developed critical questions in 2003 to address these

uncertainties. Two programs were set up to address these critical questions (Table 34). The Fish Passage Effectiveness/Validation Monitoring Program aims to validate the assumptions and test the effectiveness of the forest practices rules in providing passage at road crossings for fish (as defined by WAC 222-16-010) at all life history stages. The Monitoring Design Team (MDT) defines extensive monitoring as a population-scale assessment of the effectiveness of the forest practices rules in attaining forest practices-related performance targets across FP HCP lands (MDT 2002). The implied FP HCP performance target for fish passage, based upon the requirements for RMAPs, is to eliminate fish blockages on FP HCP-regulated lands. The purpose of this program is to evaluate status and trends in fish passage conditions at forest road crossings.

Table 35. Fish Passage Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Names	Task Type	SAG
Are the corrective measures effective in restoring fish passage for fish at all life history stages?	Fish Passage Effectiveness/ Validation Monitoring Program	Effectiveness	ISAG
What is the current status of fish passage on a regional scale, and how are conditions changing over time?	Extensive Fish Passage Monitoring Program	Extensive	ISAG

ISAG presented the proposed CMER research strategy for fish passage to Policy. Stakeholders differed in their perspectives on what the CMER research strategy should focus on; therefore, Policy designated a subgroup to determine which important issues and/or critical questions should be prioritized for the Fish Passage Rule Group. The Policy subgroup decided that if and when important policy and/or management issues are determined, Policy will then define an appropriate research and monitoring strategy for CMER.

The following sections describe ISAG efforts to date on the fish passage research and monitoring strategy.

5.7.4 Fish Passage Effectiveness/Validation Monitoring Program

5.7.4.1 Program Strategy

There are key questions concerning the adequacy of current fish passage design methods, existing fish passage criteria, and the definition of a fish passage barrier. This is particularly true for the forest practices rules for passing "all species and life stages." Some of these questions are applicable to high-gradient headwater streams where only resident fish species are present. This was a particular area of interest for ISAG because information on these headwater streams is lacking.

The primary purpose of the Fish Passage Effectiveness/Validation Monitoring Program is to address scientific uncertainties surrounding fish passage in headwater streams. The Fish Passage

Effectiveness/Validation Monitoring Program was originally (2005) composed of three principal elements:

1. Fish movement capability
2. Fish life history and movement ecology
3. Designs for road crossing structures that provide fish passage (barrier solutions)

As part of this strategy, ISAG worked on study designs for two primary projects: the Fish Passage Capability – Culvert Test Bed Project; and the Effectiveness of Design Criteria for Stream Simulation Culverts. ISAG also developed questions about headwater fish ecology and movement that would be answered by a literature review.

ISAG completed the study designs for the two proposed studies in 2007. CMER delivered the study designs to Policy. Policy was uncertain about the direction and focus of the proposed fish passage research strategy, as well as the proposed studies. A Policy subgroup was formed to further assess the fish passage research and monitoring strategy. During the interim, Policy directed CMER to send both study designs through the ISPR process. After CMER reviewed the results of the ISPR in May 2008, Policy decided to not proceed with either study (i.e., the Culvert Test Bed Project or Stream Simulation Project).

In June 2009, Policy agreed that (1) no fish passage research should be planned for FY 2010; (2) further discussion should occur on extensive fish passage monitoring; and (3) Policy should consider waiting for more information to come out of efforts currently underway within WDFW relative to fish passage under the hydraulic permit application (HPA) habitat conservation plan (HCP) development and fish passage effectiveness research. By 2018, WDFW was no longer pursuing an HCP for their HPA program. However, WDFW has continued fish passage effectiveness research and in late 2018 was working to complete a 5-year progress report for the implementation and effectiveness monitoring of hydraulic projects, specifically culverts and marine shoreline armoring. Since 2007, the two studies and the literature review have been funded through sources outside of the Forest Practices Adaptive Management Program (AMP). A pilot for the Culvert Test Bed Project, funded through the National Council for Air and Stream Improvement (NCASI), was implemented in the summer of 2009. The Stream Simulation Project, funded through DNR and carried out by WDFW, was implemented on DNR state lands. The literature review for headwater fish ecology and movement was funded by WDFW and contracted with the Forest Service. Although the study designs for these studies were primarily developed through CMER, these studies are no longer considered CMER studies. The scientific results, however, may still be considered in future efforts in the AMP.

Table 36. Fish Passage Effectiveness/Validation Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions		Project Names
Are the corrective measures effective in restoring fish passage for all life history stages?		
	What is fish passage capability (e.g., probability of passage) through culverts under different flow	Formerly proposed CMER study: Fish Passage Capability – Culvert Test Bed Project

Program Research Questions	*and slope conditions for native headwater species and life stages?*	
	How well does laboratory-derived passage-capability criteria apply to fish passage through culverts in the field?	No project defined yet
	Are the solutions (existing tools) we are implementing working to provide fish passage as needed?	Formerly proposed CMER study: Effectiveness of Design Criteria for Stream Simulation Culverts
	Are our assumptions about fish movement and fish passage in headwater streams correct?	Formerly proposed by CMER: Literature review of headwater fish ecology and movement
	What variables effect the rates of fish recolonization and degree of habitat utilization in stream habitats upstream from fixed anthropogenic blockages?	No project defined yet

5.7.5 Extensive Fish Passage Monitoring Program

5.7.5.1 Program Strategy

In 2005, ISAG completed an extensive study design for fish passage monitoring. CMER delivered the study design to Policy. Policy decided not to fund the project due to budget considerations and also limitations in scope due to the absence of small forest landowners in the sampling design. Implementation of the study design has been delayed indefinitely. A single critical question has been developed for the program (Table 36).

Table 37. Extensive Fish Passage Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What is the current status of fish passage on a regional scale, and how are conditions changing over time?	Extensive Fish Passage Trend Monitoring Project

5.7.5.2 Extensive Fish Passage Trend Monitoring Project

Description:
A study design for fish passage trend monitoring was developed using guidelines consistent with the Forests and Fish Report and supplied by ISAG. The contractor (WDFW) reviewed possible monitoring approaches and presented a recommended study design and methodology that was reviewed and approved by ISAG and CMER.

In addition to the WDFW study proposal, ISAG explored the potential of collecting data on stream crossing conditions in conjunction with the UPSAG Road Sub-Basin-Scale Effectiveness

Monitoring Project. ISAG recognized that this approach would not provide all of the information needed to address the critical question but considered it a cost-effective opportunity to get supplemental information about culvert conditions from a statewide random sample. ISAG developed a set of questions for assessing culvert suitability and these questions were added to the UPSAG road survey.

Status:
Due to budgetary considerations and potential limitations in scope, Policy has delayed implementation of the WDFW design indefinitely. The UPSAG road survey was completed in 2008, and culvert conditions data were collected from approximately 1,300 stream crossings. These data have not been analyzed, and further investigation is pending Policy direction.

5.8 PESTICIDES RULE GROUP

5.8.1 Rule Overview and Intent

The objectives of the Pesticides Rule Group are to manage pesticide use to achieve water quality standards, meet label requirements, and avoid harm to riparian vegetation. In the context of the forest practices rules, pesticide means "any insecticide, herbicide, fungicide or rodenticide, but does not include nontoxic repellents or other forest chemicals."

The pesticide rules include a series of regulations that cover (1) aerial application of pesticides, (2) ground application of pesticides with power equipment, and (3) hand application of pesticides. The rules for aerial application of pesticides prescribe a setback (offset) to prevent application of pesticides within the core and inner zones of Type F and S streams, or the wetland management zone (WMZ) of Type A or B wetlands. In these cases, the offset is from the outer edge of the inner zone or the WMZ. Offsets are also prescribed for flowing Type N streams and Type B wetlands smaller than 5 acres; however, in these cases the offsets are measured from the edge of the bankfull channel or wetland. The offset distances vary depending on water type, the type of nozzle used, and wind conditions at the time of application. Separate guidelines govern ground application of pesticides with power equipment and hand equipment within RMZs and WMZs.

The main assumption is that the pesticide rules will be effective in achieving the objectives of meeting water quality standards, label requirements, and preventing damage to vegetation in RMZs and WMZs. A level of uncertainty exists for the aerial application of pesticides because of the potential difficulties caused by terrain and wind conditions.

5.8.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:

- Provide for clean water and native vegetation (in the core and inner zones) by using forest chemicals in a manner that meets or exceeds water quality standards and label requirements by buffering surface water and otherwise using best management practices.

Performance Targets:

- Entry to water: No entry to water for medium and large droplets; minimized for small droplets (drift).
- Entry to RMZs: Core and inner zone — Levels cause no significant harm to native vegetation.

5.8.3 Rule Group Strategy

Three critical questions have been developed to eventually shape corresponding effectiveness and validation programs (Table 37).

Table 38. Pesticides Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Name	Task Type	SAG
Do the pesticide rules protect water quality and vegetation within the core and inner zones of Type S and F RMZs, the WMZs of Type A or B wetlands, and Type N streams and buffers?	Forest Chemicals Program	Effectiveness	RSAG
What is the exposure of aquatic organisms to herbicides that reach Type S, F, and N waters, and Type A and B wetlands? (How much gets in and for how long is it present?)	Forest Chemicals Program	Validation	LWAG ISAG
Do sublethal effects exist that affect the survival of a population of aquatic organisms from herbicide level reaching Type S, F, and N waters, and Type A or B wetlands?	Forest Chemicals Program	Validation	LWAG ISAG

5.8.4 Forest Chemicals Program (Effectiveness and Validation)

5.8.4.1 Program Strategy

The purpose of the Forest Chemicals Program is to address uncertainty concerning the effectiveness of the chemical application rules in protecting water quality and vegetation in riparian and wetland buffers. Alternative strategies with lower costs will also be considered.

CMER held a science conference in October 2016 to inform the members about the current use and related science concerning chemicals used in Forest Practices. This program is ranked last among the 16 CMER programs. No projects are proposed at this time.

5.9 WETLANDS PROTECTION RULE GROUP

5.9.1 Rule Overview and Intent

The intent of the WAC 222 wetland rules is to achieve no net loss of wetland function (e.g., water quality, water quantity, fish and wildlife habitat, timber harvest and regeneration) by avoiding, minimizing, and/or preventing sediment delivery and hydrologic disturbances from roads, timber harvest, and timber yarding, and by buffering wetlands with wetland management zones (WMZs)). The application of WAC 222 rules is assumed to achieve and protect aquatic conditions and processes that meet resource objectives and consequently achieve the three Forests and Fish Report (FFR) performance goals. WetSAG understands that there is uncertainty regarding this assumption because the functional relationships between forest practices, wetland functions, and aquatic resource responses have not been well studied and are not fully understood.

Areas of uncertainty include: (1) how to quantify the functions and connectivity of wetlands to streams and functions related to fish and amphibian habitat; (2) how wetlands contribute to base-flow, or provide flood storage and attenuate downstream peak flows; (3) how wetlands contribute to water quality; (4) the effects of road management practices on sediment delivery to wetlands; and (5) the contribution of large woody debris (LWD) and exchange of nutrients between wetlands and streams.

The rules contain several additional assumptions:

- Implementation of the wetland prescriptions for timber harvest (WAC 222-30-010) will result in no net loss of wetland functions over the length of a timber harvest rotation, assuming that some wetland functions may be reduced until the midpoint of a timber rotation cycle.
- Application of the mitigation sequence in WAC 222-24-015 for road construction will result in no net loss of wetland function.
- Appropriately identified best management practices (BMPs) are effective at achieving resource objectives.
- Forested wetlands will successfully regenerate following timber harvest.

Several uncertainties exist about the validity of these assumptions based on a lack of applied research and accurate wetland mapping and typing. These uncertainties include the following:

1. The response of wetlands and wetland functions to management practices and the level of protection provided by prescriptions is not known.
2. The DNR wetland typing system (A, B, Forested) does not reflect the full complexity of different wetland functions across the landscape, potentially reducing the ability to target rule protection to aquatic resources (e.g., water quality, hydrology, and rule-covered species) in different, specific types of wetlands.

3. Forested wetlands as a class are not recognized by WAC 222-16-30 as "typed" waters. Some forested wetlands receive alternate protections such as those that are inundated fish habitat. However, other forested wetlands not covered under these alternate protections may not receive water quality protection measures and BMPs during road construction or harvest.
4. It is not known to what degree current rules for wetland mitigation related to road construction will achieve the "no net loss of wetland functions."

Quantifying "no net loss" is difficult because there are no criteria available for determining:

- The range of wetland functions affected by road construction or harvest;
- Net loss or gain of these functions over time;
- Net loss of one or more functions with concurrent net gains in other functions;
- The cumulative impact across the FP HCP landscape of filling or draining individual wetlands that are less than 0.10 acre in size;
- The cumulative effect of creating or expanding wetlands through forest practices activities.

The forest practices rules (WAC 222-16-035) classify wetlands into three general categories: Type A, B, and Forested depending on soils, vegetation, canopy closure, wetland size, and acreage of open water.

Mapping and delineation requirements in WAC 222-16-036 must be performed as outlined in the Forest Practices Board Manual, Section 8, for several wetland groups:

- Wetlands greater than 0.1 acre that will be impacted by filling and where mitigation for such filling is required;
- Forested wetlands greater than three acres;
- All forested wetlands in a riparian management zone, unless entry within the riparian management zone is not proposed as part of the harvest application.

Wetland management zones (WMZs) and harvest methods in WAC 222-30-020 are as follows: WMZs are prescribed for all Type A and Type B wetlands greater than 0.5 acre, or 0.25 acre for bogs. WMZ widths vary based on the wetland type and area; harvest is allowed within the maximum-width WMZ. The specific leave tree requirements within WMZs differ for eastern and western Washington. The use of ground-based harvesting equipment is restricted within WMZs. Harvest methods are limited to low-impact harvest or cable systems within forested wetlands, and landowners are encouraged to leave a portion of the wildlife reserve tree requirement within the wetland.

Road construction in wetlands (WAC 222-24-015) is as follows: A mitigation sequence applies to road construction to address no net loss of wetland function. The preferred option is to prevent

impacts by locating roads outside of wetlands (avoidance). However, where this is not possible, the mitigation sequence and Board Manual guidelines seek to minimize and mitigate potential impacts.

5.9.2 Rule Group Resource Objectives and Performance Targets

Resource Objectives:
The wetland WMZ and road prescriptions are intended to accomplish the following stated FP HCP functional objectives under the Hydrology Resource Objective as stated in Schedule L-1:

- Maintain surface and groundwater hydrologic regimes (magnitude, frequency, timing, and routing of stream flows) by disconnecting road drainage from the stream network.
- Prevent increases in peak flows causing scour, and maintain hydrologic continuity of wetlands.

Performance Targets:
There are two performance targets under the Hydrology Resource Objective that include wetlands:

- Westside: Do not allow forest management activities to cause a significant increase in peak flow recurrence intervals resulting in scour that disturbs stream channel substrates providing actual or potential habitat for salmonids.
- No net loss in the hydrologic functions of wetlands.

A number of other FP HCP resource objectives specific to streams may also apply to wetlands but are not explicitly stated in either Schedule L-1 of the FFR or in the FP HCP. Schedule L-2 refers to the following functional objectives, performance targets, and projects regarding wetlands:

1. Heat Temperature Functional Objective: Provide cool water by maintaining shade, groundwater temperature, flow, and other watershed processes controlling stream temperature.
    a. Performance targets: Stream temperature, groundwater, and shade.
2. Large Woody Debris/Organic Inputs Functional Objective: Provide complex and productive in- and near-stream habitat by recruiting large woody debris and litter.
    a. Performance targets: Riparian conditions, litterfall, in-stream LWD targets, residual pool depth.
3. Hydrology Functional Objective: Maintain surface and groundwater hydrologic regimes (magnitude, frequency, timing, and routing of stream flows) by disconnecting road drainage from the stream network, preventing increases in peak flows causing scour, and maintaining the hydrologic continuity of wetlands.
    a. Performance targets: Peak flows and wetlands.

These objectives are discussed in more detail in the Wetlands Rule Group critical questions outlined below. Not all Performance Targets listed in the FP HCP are fully developed. The Wetland Research and Monitoring Strategy includes suggestions for some new wetland performance targets that will better inform the degree to which Resource Objectives outlined in the FP HCP are being met.

These performance targets are as follows:

1. Return to pre-harvest levels of wetland functions
2. No net loss of water storage and streamflow maintenance
3. Return to pre-harvest levels of water storage and streamflow maintenance
4. No net loss of temperature regulation and water quality maintenance
    a. Provide cool water by maintaining shade, groundwater temperature, flow, and other watershed processes controlling water temperature
5. Provide complex and productive in-stream and wetland habitat by recruiting large woody debris and litter
6. No net loss of hydroperiod maintenance
7. No significant increase in peak flow recurrence intervals of downgradient streams such that scour disturbs stream channel substrates providing actual and potential habitats for salmonids
8. No net loss of native species diversity
9. No net loss of state listed sensitive species or communities

5.9.3 Rule Group Strategy

An updated literature review was completed in 2013 and included all available literature on forest practices and wetlands in the Pacific Northwest (Adamus 2013). The results of the literature review were used to create a Wetland Research and Monitoring Strategy that outlined a comprehensive, scientifically sound approach to addressing whether forest practices rules are effective at protecting wetlands and wetland functions. This strategy guided the revision of the Work Plan's program and project structure, as well as the critical questions.

The strategy separated the effects of forest practices on wetlands into three categories; forest harvest, roads, and silvicultural chemicals. Forest harvest addresses effects of harvest within and outside of wetlands on both the wetland and downstream processes. Roads address the effects of road construction in a wetland as well as runoff from roads into adjacent wetlands. Additionally, the effectiveness of the wetland mitigation sequence was incorporated into the Forest Roads and Wetlands program since mitigation is generally triggered by road construction. Silvicultural chemicals will address the impacts of the application of pesticides and fertilizers in and adjacent to wetlands.

There are six wetland programs:

- Forested Wetlands Effectiveness Program
- Wetland Management Zone Effectiveness Monitoring Program
- Forest Roads and Wetlands
- Wetlands Intensive Monitoring Program
- Wetlands Mapping Program
- Silvicultural Chemicals and Wetlands

The Wetland Research and Monitoring Strategy prioritizes programs that are consistent with both Policy guidance and research needed to better develop and test hypotheses. The aim of the strategy is to examine the effectiveness of the rules at maintaining no net loss of wetland functions. Therefore, the highest priority reflects the hypothesized largest potential impact to wetland functions given the current forest practices rules. Subsequently, the remaining projects are organized in a phased approach. For example, Wetland Intensive Monitoring will be a subsequent project because it will be designed around the results and improved fundamental understanding yielded by the Forested Wetlands Effectiveness and Monitoring Program and the Wetland Management Zone Effectiveness Program.

Priority will be placed on scoping projects identified in the Clean Water Act (CWA) assurances milestones, specifically the Forested Wetlands Effectiveness Program and the Wetland Management Zone Effectiveness Program.

The Forested Wetlands Effectiveness Program is the top priority program because forested wetlands receive the least amount of protection compared to other wetland types (A and B). Forested wetlands can be clearcut and drained during reforestation under the Forest Practices Rules. The hydrologic and ecological functions that forested wetlands provide are not well understood and it is even less well-known how harvest in and around forested wetlands impacts those functions. The level to which forest regeneration restores pre-harvest wetland functions is also not known. Any improvements in understanding forested wetlands and how they change following timber harvest activities will help Policy to better understand the effectiveness of Forest Practices Rules.

Projects under the Wetland Management Zone Effectiveness Program are prioritized to follow the Forested Wetlands Effectiveness Program because it is not known whether buffering Type A and B wetlands under the current prescriptions successfully allows for no net loss of wetland functions. The Wetland Management Zone Effectiveness and Forested Wetlands Effectiveness Programs will provide fundamental information about the nature of forested, Type A and Type B wetlands. This information will inform research questions in future studies and foster a systematic understanding of wetlands across the landscape.

After wetland functions have been characterized more thoroughly, the Forest Roads and Wetlands Program will commence to determine the effects of forest roads on those functions. The effects of silvicultural chemicals on wetland functions will follow. The final program will be the Wetlands Intensive Monitoring Program, which is dependent on information yielded by preceding studies.

The assumptions and uncertainties described above guided the development of critical questions and research and monitoring programs to address them (Table 38). The revised project plan and

priorities are consistent with the Ecology CWA assurances milestones for the Adaptive Management Program.

The Wetlands Rule Group strategy began in 2005 by conducting a comprehensive literature review with the Forested Wetlands Literature Review and Workshop Project. These efforts were undertaken to establish the current scientific basis for evaluating forested wetland functional relationships for salmonids, FPHCP-covered species, and water quality and quantity. WetSAG then conducted a pilot study, the Statewide Forested Wetlands Regeneration Pilot Project, to evaluate regeneration of forested wetlands after harvest.

In combination, these efforts concluded that many research gaps exist around forested wetlands and that, in order to locate wetlands in a systematic and unbiased manner and study the effects of forest practices activities on these wetlands, the mapping data available needed improvement. A recommendation that emerged from the Statewide Forested Wetlands Regeneration Pilot Project led to creation of an additional pilot project, the DNR GIS Wetlands Data Layer Project. This second project added 165,000 polygons to the Forest Practices Application Review System (FPARS). Work on a process for continued improvement of the wetland data layer was redirected by Policy to DNR Forest Practices Division. A lack of funding and staff resources currently limits or prevents much progress on this task at DNR. A crosswalk between Forest Practices Wetland Classification and Hydrogeomorphic (HGM) Wetlands Classifications will be created in the future under the Hydrogeomorphic (HGM) Wetlands Classification System Project (which was folded into the Wetlands Intensive Monitoring Project). The HGM classification system defines wetlands based on landscape position and the source and connectivity of water to other water bodies. The crosswalk will facilitate better characterization, description, and assessment of impacts to wetland functions.

The 2010 strategy of completing the study design for the pilot project and Phases 1 and 2 of the Wetlands Mitigation Effectiveness Project was reprioritized in 2011 based on CMER review of the study design, FPA review, and discussions during field visits in follow-up meetings that led to returning the focus to the Forested Wetlands Effectiveness Program. Two main issues led to the recommendation of delaying the Wetlands Mitigation Effectiveness Program and reprioritizing how WetSAG proceeds in the wetland research program.

1. It is difficult, if not impossible, to know whether a landowner's decision on locating road segments is based on meeting the mitigation sequence; making the assessment on the effectiveness of the sequence problematic.
2. The effects of harvesting forested wetlands are uncertain and the risks to wetland functions may be greater than the effects of road construction/maintenance under current rules.

Ecology is charged with overseeing the CWA assurances milestones. In July 2009, Ecology developed the document 2009 Clean Water Act Assurances Review of Washington's Forest Practices Program, which outlines specific CMER projects targeted at answering critical questions associated with the CWA. Based on this review, research projects were reprioritized to improve the adaptive management program in meeting the intent of the CWA. Ecology's document also lists timelines and anticipated completion dates for those CMER projects. One of the CWA milestones was to develop a revised research strategy.

The first step in developing a revised research strategy was to conduct an up-to-date literature review. The Forest Practices and Wetlands Systematic Literature Review looks at how forest

practices affect the capacity of wetlands to sustain fish, amphibians, and water quality in a watershed context. The Literature Review was intended to evaluate risk and uncertainty to wetland functions associated with harvesting and road construction in and around wetlands. The Literature Review identifies data gaps and developed testable hypotheses for other WetSAG projects to inform the scoping and design of future field studies. Projects identified in the CWA assurances milestones that needed to be addressed in a revised research strategy include the Forested Wetlands Effectiveness Study, Temperature and hydrologic connectivity will be addressed as metrics in all projects.

Table 39. Wetlands Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Names	Task Type	SAG
Are current forest practices rules for timber harvest in and around forested wetlands effective at meeting the Forest and Fish aquatic resource objectives and performance targets, and the goal of no-net-loss of functions of those wetlands? Are forested wetlands regenerating sufficiently to maintain no net loss of wetland functions?	Forested Wetlands Effectiveness Program	Effectiveness	WetSAG
Are current forest practices rules-specified wetland buffers (WMZ) for Type A and B wetlands effective at meeting the Forest and Fish aquatic resource objectives and performance targets, and the goal of no-net-loss of functions of those wetlands?	WMZ Effectiveness Monitoring Program	Effectiveness	WetSAG
Are road construction and maintenance activities in wetlands adequately mitigated to achieve no net loss of wetland functions? How and to what degree does forest road construction and maintenance near wetlands alter the water regimes, water quality, and habitat functions of the wetlands and downstream waters?	Forest Roads and Wetlands	Effectiveness	WetSAG
What are the magnitude and duration of effects of silvicultural chemicals on wetland processes, functions, and aquatic resources within the wetlands and connected waters? Do the pesticide and fertilizer Rules protect processes, functions, and aquatic resources within wetlands and connected waters?	Silvicultural Chemicals and Wetlands	Effectiveness	WetSAG LWAG
What are the spatial and temporal cumulative effects of multiple forest practices on wetlands connected waters at the watershed-scale level? What are the causal relationships and effects of forest practices on wetlands and connected waters?	Wetlands Intensive Monitoring Program	Intensive Monitoring	WetSAG
Under Review	Wetlands Mapping Program	Rule Tool	WetSAG

5.9.4 Forested Wetlands Effectiveness Program

5.9.4.1 Program Strategy

This program consists of three projects (Table 39) that address uncertainty concerning the net loss of hydrologic function, water quality, fish and amphibian use, and recovery capacity of forested wetlands following timber harvest.

Table 40. Forested Wetlands Effectiveness Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions		Project Names
Are current forest practices rules for timber harvest in and around forested wetlands effective at meeting the Forest and Fish aquatic resource objectives and performance targets, and the goal of no-net-loss of functions of those wetlands? Are forested wetlands regenerating sufficiently to restore wetland functions?		
Program Research Questions	*1. What are the effects, and their magnitudes and durations, of forest practices on water regimes, water quality, plant and animal habitats, and watershed resources in forested wetlands and linked (via surface or subsurface flow) downstream waters?* *a. How does timber harvest in forested wetlands alter processes that influence hydrologic regimes in those wetlands, in downgradient waters, and the connectivity between them?* *b. How does timber harvest in forested wetlands alter processes that influence water quality in those wetlands and in downgradient waters?* *c. How does timber harvest in forested wetlands alter processes that influence plant and animal habitat functions in wetlands, in connected waters, and in surrounding uplands?* *2. How well do current forest practices rules in forested wetlands meet the Forest and Fish aquatic resource objectives and performance targets, and the goal of no-net-loss of functions of those wetlands by half of a timber rotation cycle?*	Forested Wetlands Effectiveness Project
		Forest Practices and Wetlands Systematic Literature Review
	How do post-harvest stand conditions and associated wetland functions compare with pre-harvest stand conditions and functions?	Statewide Forested Wetlands Regeneration Pilot Project

5.9.4.2 Forested Wetlands Effectiveness Project

Description:
The Forested Wetland Effectiveness Project (FWEP) is a keystone program within the WetSAG's workplan as it provides a scientific foundation from which to evaluate how forest harvest undertaken under current forest practice rules changes forested wetland hydrology and ecology. CMER and Policy recommended prioritizing this program following a WetSAG field trip with Ecology Wetlands Program staff that raised concerns about the potential effects of timber harvest on the function of forested wetlands and their hydrologically connected streams. Currently, the rules give limited protection to forested wetlands, and little is known about the effects of harvest on forested wetland hydrology and ecology. This project will look at the effectiveness of forest practices prescriptions to protect, maintain, and restore aquatic resources, namely water quality and wetland hydrologic and ecological functions.

This study is predicated upon hypotheses and questions developed in the Forest Practices and Wetlands Systematic Literature Review (below) and is designed to inform numerous WetSAG priority projects that will follow in future years. The FWEP will include two potential stages:

1. A Chronosequence Study designed to evaluate how forested wetland hydrology and ecology change over half a timber rotation cycle, using a space-for-time approach. This study is observational and capitalizes on DNR's forest practice application database to find sites of various ages, evaluating whether or not harvested forested wetlands' condition and function converge with unharvested wetlands over the half-timber rotation timeframe.

2. A before-after-control-impact (BACI) study that will prescribe manipulative forest harvest treatments and measure how forested wetlands' ecological and hydrologic functions change in real time following harvest. By tracking forested wetlands prior to harvest, during harvest, and immediately following harvest, this study will build on the chronosequence portion of the FWEP, reducing uncertainty associated with harvest practices, regeneration, and landscape variability that may arise in an observational study.

Status:
The project alternative was approved by Policy in early 2017. The study design was developed by the Forested Wetlands Effectiveness Project Technical Writing and Implementation Group (FWEP TWIG). The history of the FWEP and anticipated future timeframes through this biennium are listed below.

- Chronosequence Study Design-
  Design- Final design presented January 2018 and revised in July for CMER before being sent to ISPR in August 2018

  Review and Approval- The study design received ISPR approval in October 2019 and CMER approval in December 2019. The study design was presented to the TFW Policy committee along with the prospective six-questions document in August 2020.
  Implementation- Development of the data management plan is ongoing. Preliminary wetland mapping and development of Wetland Intrinsic Potential (WIP) maps occurred in Early 2022. Initial site reconnaissance began in Spring 2022 with site selection planned for completion in May 2023. Site instrumentation will be complete by June of 2023. Data collection will be ongoing through water year 2025.

- BACI Study Design-
  Design- The BACI study design will be developed in 2026 after the completion of the Chronosequence.
  Review and Approval- To be determined
- **Implementation**- To be determined

5.9.4.3 Forest Practices and Wetlands Systematic Literature Review

Description:
1. Adamus (2014): The Forest Practices and Wetlands Systematic Literature Review was intended to address the uncertainty about how harvesting wetlands and constructing roads in and adjacent to wetlands affects the capacity of wetlands to contribute to watershed processes

that support fish, amphibians, and water quality. This project reviewed and synthesized scientific literature to identify and evaluate effects on wetland functions, with a primary focus on harvesting trees from forested wetlands and on road construction and maintenance activities. This project will allow WetSAG to develop testable hypotheses for future WetSAG projects; to evaluate risk and uncertainty about protecting wetland function; to inform prioritizing, scoping, and designing of future field studies; and to fill data gaps identified in the previous wetland literature review.

A Wetland Research and Monitoring Strategy was developed based on findings from the literature review; priority will be placed on scoping projects identified in the Strategy.

Status:
This project was completed in 2014 and the report is available online (CMER #12-1202). This report was augmented by FWEP TWIG (Beckett et al. 2016) as part of the FWEP scoping process.

2. Hough-Snee (2019): Previous literature reviews did not link specific forest practice actions to forested wetlands as they occur in different biological and climatic regions of Washington State and the larger Pacific Northwest. Due to Washington State's diverse climate, ecology, geology, and hydrology, an updated systematic literature review paired studies from across North America with management and application domains by topic. This review synthesized recent, key forested wetlands studies to Washington State Department of Natural Resources administrative regions within which forestry activities occur. This provided a geospatial bibliography from which managers can identify patterns in the literature that describe how forestry activities impact forested wetland ecology and hydrology across Washington State.

Status:
This project was completed in 2020 and the report is available online (CMER #2020.02.25).

5.9.4.4 Forested Wetlands Literature Review and Workshop Project

Description:
The Forested Wetlands Literature Review and Workshop Project was intended to perform a literature review and synthesis of relevant forested wetland research. The project focused on literature with an emphasis on interactions between commercial forest management activities and forested wetland functions, emphasizing topics listed in the WDNR Forests and Fish Report.

Status:
This project was completed in 2005 and the report is available online (CMER #04-406).

5.9.4.5 Statewide Forested Wetlands Regeneration Pilot Project

Description:
The pilot project was largely conducted in western Washington (with a single eastside site) and finalized in 2004. This pilot study was initiated to characterize regeneration in forested wetlands, develop research methodologies, examine current methodologies of forested wetland regeneration, and determine the success of their implementation. The pilot study had two primary objectives:

1. Develop a process for identifying suitable sites to sample. This included working with landowners to identify forested wetlands that have been harvested.
2. Develop and test methods for site selection, a test sampling protocol, measures of

regeneration success, and methods for data analysis; and collect some preliminary information about regeneration in forested wetlands to guide study design for a full-scale study.

Status:
This pilot project was completed in July 2004. CMER approved the "Forested Wetland Regeneration Pilot Summary Report" (CMER #03-303).

This project showed the difficulty in finding forested wetlands in an unbiased manner. A full-scale study was not recommended by WetSAG upon completion of the pilot study and no such study is planned at this time. Future studies of wetland prescription effectiveness, wetland and stream temperature interactions, and hydrologic connectivity will further explore wetland functions and impacts associated with timber harvest.

5.9.5 Wetland Management Zone Effectiveness Monitoring Program

5.9.5.1 Program Strategy

The Wetland Management Zone Effectiveness Monitoring Program will be designed to assess the effectiveness of wetland management zones (WMZs) in meeting FP HCP resource objectives and performance targets (5.9.2). The WMZ rules are based on a number of assumptions, including the following:

- Meeting the wetland performance targets will achieve functional objectives.
- We can determine the effectiveness of BMPs, to a generalized degree, and standardize how we measure and document this effectiveness.
- Reaching BMP objectives at the site scale (i.e., applying WMZs and disconnecting road drainage to Type A and B wetlands) will lead to meeting sub-basin and watershed-scale functional objectives. (Note: Forested wetlands do not receive WMZs but may influence functional objectives at the sub-basin and watershed scale.)

These uncertainties form the basis for the critical questions that the program will be designed to address (Table 40).

Table 41. Wetland Management Zone Effectiveness Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions		Project Names
Are current Forest Practice Rules-specified wetland buffers (WMZ) for Type A and B wetlands effective at meeting the Forest and Fish aquatic resource objectives and performance targets, and the goal of no-net-loss of functions of those wetlands?		
Program Research Questions	*What are the magnitude and duration of effects of timber harvest occurring upslope of Type A and B wetlands on processes, functions, and aquatic resources within and downstream of those wetlands?* *How effective are current forest practice wetland buffers at facilitating no net loss in wetland functions following timber harvest?*	Wetland Management Zone Effectiveness Project

5.9.5.2 Wetland Management Zone Effectiveness Monitoring Project

Description:
This project will evaluate wetland functions to determine if the target of no net loss of hydrologic function, Clean Water Act assurance targets, and hydrologic connectivity are being achieved. This would include informing two of the Schedule L-2 research questions listed below:

- TH8: Test whether the wetland prescriptions are effective in preventing downstream temperature increases beyond targets.
- LWD15: Evaluate the effectiveness of current WMZs in meeting in-stream LWD targets.

Status:
The effectiveness of buffers was researched during the Forest Practices and Wetlands Systematic Literature Review. However, most of the existing literature addresses stream buffers, which are not the same buffering prescriptions required for wetlands under current Forest Practices Rules. This project is in early scoping stages by WetSAG. The Project Charter was brought to CMER for review in April 2022, gaining CMER approval the same month. Development of a scoping document is slated for FY 2023-2024 and development of a study design is slated for FY 2024-2026.

5.9.6 Forest Roads and Wetlands Program

5.9.6.1 Program Strategy

The Forest Roads and Wetlands Program seeks to examine the effects of road construction, operation, and maintenance in and near wetlands. This program was created as a separate program outside of the Forest Roads Rule Group in order to examine the implications for wetlands specifically. The effects of roads are separated from timber harvest in order to understand how roads influence water regime, water quality, and habitat functions of all typed wetlands. The decision to separate the effects of roads was guided by the Wetland Research and Monitoring Strategy.

In order to achieve "no net loss of wetland function" when filling or draining more than 0.10 acre of wetland during road construction, forest practices rules require implementation of a mitigation sequence including avoidance and minimization (WAC 222-24); and replacement or restoration if filling more than 0.5 acre of wetland. Information on the effectiveness of these mitigation requirements is not currently available.

The Forest Roads and Wetlands Program has two projects: Road Effects on Wetlands and the former program, now-project, Wetlands Mitigation Effectiveness. The wetland mitigation sequence is primarily triggered by filling of wetlands for the construction of roads and landings. Because of this, and because the mitigation sequence is inextricably linked to forest roads, they are under the same program.

To address the performance target of "no net loss of hydrologic functions of wetlands" and Clean Water Act assurances, the Wetland Mitigation Effectiveness Project will evaluate several critical questions, including whether avoidance, minimization and replacement of lost functions are successful in achieving stated goals and objectives. This information can then be used to recommend any changes to the current process of wetland mitigation.

The Road Effects on Wetlands Project will test the effectiveness of Forest Practice Rules at meeting the performance target functional objectives and Clean Water Act Assurances.

Table 42. Forest Roads and Wetlands Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions		Project Names
Are road construction and maintenance activities in wetlands adequately mitigated to achieve no net loss of wetland functions? To what degree does forest road construction and maintenance near wetlands alter the water regimes, water quality, and habitat functions of the wetlands and downstream waters?		
Program Research Questions	*Is the implementation of the wetland mitigation sequence ensuring no net loss of wetland functions?*	Wetland Mitigation Effectiveness Project
	What are the magnitude and duration of effects of forest roads near wetlands on hydrologic regimes, water quality, habitat and aquatic organisms within and downstream of the wetlands?	Roads Effects on Wetlands Project

5.9.6.2 Roads Effects on Wetlands

Description:
The Roads Effects on Wetlands project is a new project under the Wetlands Rule Group, and was identified as an important project in the Strategy. This project will seek to identify wetland functions that are altered by road construction, operation, and maintenance, and to determine the magnitude and duration of those changes.

Status:
This is a new project (and program) under the Wetlands Rule Group. During the Forest Practices and Wetlands Systematic Literature Review, the effects of forest roads on wetlands was examined in current literature. Few studies exist on how forest roads impact wetlands. The literature synthesis inferred that road impacts to wetlands may include increased delivery of sediments, changes in water regimes, and impacts to biota.

At this time, no further scoping is being done, but will be done in the future.

5.9.6.3 Wetlands Mitigation Effectiveness Project

Description:
The Wetlands Mitigation Effectiveness Project will answer the question of whether the current forest practices road construction rules are effective at preventing net losses to wetland functions. Also, studies may be needed depending upon the frequency of mitigation sequence occurrences in forest practice activities. Documentation of how often and what types of wetlands are being impacted by road construction and mitigation sequences are not readily available.

This project was initially scoped as a single study with multiple phases. After CMER review, it evolved into four projects that make up the Forest Roads and Wetlands Program. The projects include the following:

- Development and testing of site selection, data collection, and data analysis methods.
- A pilot study to refine and finalize the field methods developed in the first project; the

study is intended to test the usefulness of using FPA maps to identify wetlands in site selection, and test the feasibility of using remote sensing tools (LIDAR, aerial photography, etc.) to identify and classify wetlands.

- A statewide survey in which the tested and finalized methods will be used to describe and quantify forest road and wetland interactions, and assess and rank risks to wetland functions from specific road construction/maintenance activities.
- Further actions to build on the results of the statewide study and directly test whether following the "wetland mitigation sequence" when constructing or maintaining roads in or near wetlands prevents a net loss of wetland functions.

Status:
The scoping document was approved by CMER in June 2008. The study design for the pilot project was developed and CMER review was initiated in the spring of 2010. The review generated a lot of discussion on several of the project's design elements as well as some of the basic questions being addressed by the project. As a result, WetSAG set aside implementing the Wetlands Mitigation Effectiveness Project and instead conducted a Forest Practices and Wetlands Systematic Literature Review in 2014. In the future, Policy would like WetSAG to revisit this study if the practice of roads mitigation pertaining to wetlands becomes more common.

5.9.7 Wetlands Intensive Monitoring Program

5.9.7.1 Program Strategy

The Wetlands Intensive Monitoring Program will assess the spatial and temporal cumulative effects of multiple forest practices across a landscape. The program is meant to look at the long-term or residual, as well as the synergistic, effects of forest practices carried out under forest practices rules. Upon recommendation from the Wetland Research and Monitoring Strategy, this program will be delayed until the completion of other wetlands programs. In order to determine what functions will be assessed in this program, baseline information needs to be collected through the execution of other programs—the functions that have significant change or are subject to change because of interactions with the effects of multiple forest practices or accumulation across time and space will be considered in the Wetlands Intensive Monitoring Program. Until baseline information is collected during other programs, the projects for this program will not be fleshed out.

Table 43. Wetlands Intensive Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What are the spatial and temporal cumulative effects of multiple forest practices on wetlands and connected waters at the watershed scale? What are the causal relationships and effects of forest practices on wetlands and connected waters?	Wetlands Intensive Monitoring Project

5.9.7.2 Wetlands Intensive Monitoring Project

Description:
Wetland functions are broadly defined in WAC 222-24 and -30 as water quality, water quantity,

fish and wildlife habitat, and timber production, without specific species-related, wetland-type habitat criteria, narrative, or quantitative standards. Little to no research has been conducted within wetlands specific to forestlands or forest management in the Pacific Northwest relative to the species, resources, and critical processes (i.e., movement of surface and subsurface water) occurring within different types of wetlands and covered by the FP HCP. Without baseline information about expected species use, development and maintenance of structural habitat components, and connectivity of water through surface or subsurface flowpaths, and without numeric or narrative standards, it is not possible to evaluate whether the three performance goals of the FP HCP are being met through the application of forest practices regulations.

This project will evaluate the full suite of wetland functions in different ecoregions on both the eastside and the westside, stratified by HGM classification, forest practices type, Ecology wetland rating, and size. The HGM Wetlands Classification System Project was folded into this project.

Status:
To be scoped in the future and to be informed by the Wetland Management Zone Effectiveness Monitoring Project, Forested Wetlands Effectiveness Project, and Forest Practices and Wetlands Systematic Literature Review Project.

5.9.8 Wetland Mapping Program

5.9.8.1 Program Strategy

This program is intended to address gaps in existing data on the location, distribution, size, and geophysical characteristics of wetlands, especially for forested wetlands. More accurate spatial data are enhancing the design and implementation of projects examining the effects of forest practices rules on wetland functions. In addition to aiding the location of potential wetlands to include in studies, the data can provide context for (1) focusing research on wetlands and associated typed-waters that may be vulnerable to harvest and road impacts, and (2) assessing the spatial applicability (inference) of study findings to other landscapes. The use of remote sensing and associated geospatial modeling with GIS is proving to be a viable tool to help fill these data needs. Although the WIP tool provides likely locations of wetlands, no suitable GIS model is currently available for grouping wetlands by functional type or landscape position.

Table 44. Wetland Mapping Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
How should wetlands be located, classified, and mapped?	Wetland Mapping Tool

5.9.8.2 Wetland Intrinsic Potential Tool (WIP)

- Phase 1 developed a beta wetland intrinsic potential (WIP) identification model that interfaces as an ArcMap tool.
- Phase 2 calibrated the wetland identification model (i.e., using field data) to predict the probability of wetlands (including forested wetlands) on forest lands of western Washington.

Phase I developed the GIS-based wetland identification tool by linking pixel-based and object-based approaches for delineating forested wetlands. Pixel-based approaches utilize topographic attributes inferred from high-resolution elevation data (e.g., LiDAR DEMs) with soils and geologic mapping to identify hydrogeomorphic attributes associated with wetlands. Object-based approaches use a variety of data sources, potentially including the pixel-based results, with eCognition[5] software to delineate visual (from optical imagery) and topographic features associated with forested wetlands. To apply these tools, the project team built an add-in tool kit for ArcGIS that enables a user to (1) generate the pixel-based attributes, (2) optionally import eCognition-produced files, and (3) map potential wetlands. The wetland intrinsic potential identification tool works either with or without object-based, eCognition-provided data files, although inclusion of the object-based results provides better wetland identification and more accurate delineation than can be achieved with the pixel-based results alone.

Phase 2 of this project refined the WIP tool through new data collection, inclusion of additional remote sensing methods and statistical analysis, and calibration of the WIP tool in new areas. The tool development included revisions with new datasets and methods, testing the tool on multiple watersheds, comparing the ability to transfer a model to different geographic watersheds, troubleshooting the revised tool, and updating the user manual and report from Phase 1. The importance of local "training" data for each geographic area/watershed was emphasized.

Status:
Phase 1 was approved for funding by Policy in November 2015. Phase 1 was completed in April 2018. Adaptive Management funding for this project enabled CMER to join with a larger wetlands mapping project led by Ecology with funding from EPA and in collaboration with other state and federal agencies. Phase 2 began in July 2018 and was completed in early 2021 (Wetland Mapping Tool Project Phase 2 Report, CMER document # 2021.04.27). The WIP tool has been successfully used in locating study sites for the FWEP Chronosequence study.

5.9.9 Silvicultural Chemicals and Wetlands Program

5.9.9.1 Program Strategy

The Silvicultural Chemicals and Wetlands Program was developed in response to direction from the Wetland Research and Monitoring Strategy. It focuses on the forest practices rules on pesticide, herbicide, and fertilizer application on or near wetlands. The wetlands strategy did not specifically mention forested wetlands as being a priority ecotype when examining the effects of forest chemicals, and the Pesticide Rule Group does not cover the effects of fertilizers used during tree regeneration. This program seeks to examine the effects of forest chemicals on wetland functions.

[5] eCognition is a commercial software program widely used for object-based analyses.

CMER held a science conference in October 2016 to inform the members about the current use and related science concerning chemicals used in Forest Practices. No projects are proposed at this time.

Table 45. Silvicultural Chemicals and Wetlands Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What are the magnitude and duration of effects of silvicultural chemicals (e.g., pesticide and fertilizers) practices on wetland processes, functions, and aquatic resources within the wetlands and connected waters? Do the pesticide and fertilizer rules protect processes, functions, and aquatic resources within wetlands and connected waters?	None scoped.

5.10 WILDLIFE RULE GROUP

Historically, Policy has funded a number of wildlife research projects since the late 1980s. These projects have addressed general multispecies and statewide issues, as well as species-specific concerns about the effects of forest practices.

Although the FP HCP is focused on water quality, fish, and stream-associated amphibians (SAAs), both Policy and CMER acknowledge that wildlife issues are important and need attention. To address this concern, CMER recently funded additional sampling and analyses of a study that examines wildlife use of two streamside buffer designs. However, because CMER's focus is currently on FP HCP priorities, the only funding available for additional wildlife projects is from the State General Fund.

5.10.1 Rule Overview and Intent

Forest practices rules directed at wildlife conservation take two approaches: (1) general statewide requirements; and (2) species-specific strategies. In addition, forest practices rules may benefit wildlife through the retention or enhancement of habitat, such as riparian buffers, upland management areas, channel migration zones, etc. The only statewide forest practices rule specifically directed at wildlife conservation is the provision for managing wildlife reserve trees (WAC 222-30-020[11]). Specifications for retaining wildlife reserve trees, green recruitment trees, and downed logs are provided for both eastern and western Washington.

Species-specific forest practices rules are closely tied to state and federal endangered and threatened species programs. Habitat of listed species is defined as critical habitat (state), and any proposed forest practices activity in critical habitat becomes a Class IV special forest practices under the State Environmental Policy Act (SEPA) (WAC 222-10-040), requiring consultation, evaluation, an environmental impact statement (where appropriate), and mitigation. There are currently 10 species for which these rules apply (including the bald eagle [*Haliaeetus leucocephalus*], grizzly bear [*Ursus arctos*], northern spotted owl [*Strix occidentalis*], and marbled murrelet [B*rachyramphus marmoratus*]).

In some cases, the Forest Practices Board (Board) has endorsed a species-specific approach that avoids rule-making. This approach usually involves developing and adopting management plans or specifying "voluntary" guidelines. The Federal listing of the lynx (*Lynx canadensis*) prompted the state and a few large private landowners in northeastern Washington to develop and adopt lynx management plans. Similarly, the state listing of the Taylor's checkerspot butterfly (*Euphydryas editha taylori*) resulted in landowner commitments to develop management plans to protect, and possibly help restore, the few occupied sites. After the state listing of the western gray squirrel (*Sciurus griseus*), landowners agreed to apply forest practices guidelines developed by the Washington Department of Fish and Wildlife (WDFW) in areas known to contain the species. These species-specific rules and associated guidelines are very complex, with details on

habitat definitions, monitoring methods, and provisions for site protection varying by species. In addition, the Board often adopts rule options that allow landowners to develop their own species-specific management plans.

5.10.2 Rule Group Resource Objectives and Performance Targets

No resource objectives or performance targets exist for wildlife rules.

5.10.3 Rule Group Strategy

Wildlife research pertaining to fish and amphibians (aquatic and riparian-dependent) are covered under the Type N Riparian Prescriptions Rule Group, specifically within the Sensitive Site Program and the Type N Amphibian Response Program. The Wildlife Rule Group contains only one active program, which focuses on wildlife species within upland management areas (UMAs) or riparian management zones (RMZs). This rule group's critical question is listed in Table 46.

Table 46. Wildlife Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program	Task Type	SAG
What roles do RMZs, UMAs, and other forest patches play in maintaining species and providing structural and vegetative characteristics thought to be important to wildlife?	Wildlife Program	Effectiveness Validation	LWAG

5.10.4 Wildlife Program

The purpose of the Wildlife Program is to (1) determine the species of wildlife that use managed forests; (2) estimate habitat conditions associated with wildlife use of managed forests; (3) assess the efficacy of regulations designed to provide habitat for wildlife in managed forests; and (4) identify emerging forestry-wildlife issues and develop research projects that address those issues.

5.10.4.1 Program Strategy

With the current emphasis of CMER on the Forest Practices Adaptive Management Program, there is little opportunity to fund projects for wildlife other than those species that are covered under the FP HCP (i.e., aquatic species and riparian-dependent amphibians). LWAG has identified and prioritized several wildlife issues (upland and/or riparian) that need attention.
These issues are described in the rule group critical question in Table 47 and are primarily addressed with the RMZ Resample Project.

Table 47. Wildlife Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What roles do RMZs, UMAs, and other forest patches play in maintaining species and providing structural and vegetative characteristics thought to be important to wildlife?	RMZ Resample Project

5.10.4.2 RMZ Resample Project

Description:
In 1990, CMER funded a BACI-based manipulative study to examine the effects of two buffer configurations (state regulations and "smart buffers") on birds, small mammals, and amphibians. The study produced two years of pre- and post-harvest data and a final report that was completed in 2000. The results were species-specific and equivocal, and raised numerous questions about the long-term response of wildlife to the treatments. Because the smart buffer was similar to the forest practices buffer for Type F streams, and more than five years had elapsed since last sampling in the RMZ, another two years of sampling was initiated in 2003 to document changes over time. The extension was intended to provide additional data on riparian conditions and some SAAs.

Status:
The final report was completed in 2008 and was reviewed by LWAG, CMER, and ISPR. The contract with the consultant that collected the data and prepared the final report was not renewed; therefore, the final report has not been revised based on ISPR comments. LWAG developed a memorandum that summarized the complex issues surrounding the inability to finalize the RMZ Resample report and its tentative conclusions, and LWAG provided suggestions for addressing any useful information that might be extracted from the project's results. That memorandum and the ISPR comments were attached as an addendum to the final report and submitted to CMER for final approval. Since that time, LWAG has examined the report and available data, and determined that only the bird and amphibian data have potential for further analysis and for useful additional products. The bird data have a higher priority for further analysis, due to the methods used for data collection. A report on the bird data was developed in 2013, has gone through LWAG, CMER, and ISPR review, and been finalized and approved by Policy. The product was a peer-reviewed, submittal-ready report that was accepted in PLOS in December 2015.

5.10.5 Other Wildlife Programs/Projects

Wildlife research priorities were developed as part of the original TFW stakeholder process. These research priorities were in place prior to adoption of the current adaptive management program developed in concurrence with the Forests and Fish Report. Under the current Forest Practices Adaptive Management Program, and to fulfill requirements of the FP HCP, research is prioritized and funded to primarily address aquatic resources. However, TFW stakeholders continue to see the importance of addressing effectiveness and monitoring of nonaquatic wildlife, and they hope to incorporate priority wildlife research in the future. Table 48 lists the critical wildlife research questions developed by TFW stakeholders.

Table 48. Wildlife Rule Group Critical Questions and Associated Programs (Developed as Part of TFW)

Rule Group Critical Questions	Program	Task Type
What are the values of snags retained in upland management units and riparian management zones (RMZs)? Is there a threshold response by wildlife to snag density? What are the fates of wildlife reserve trees (WRT) and green recruitment trees (GRT) in managed forests? What are the most effective ways of retaining and replacing snags?	Effectiveness of snags for wildlife	Effectiveness Validation
What are the effects of variation in stand establishment practices, herbicides, thinning, fertilization, and rotation lengths on vegetation and wildlife? Does the concept of the steady-state shifting mosaic apply, and how does that process affect wildlife?	Conifer management effects on wildlife	Effectiveness Validation
What roles do RMZs, upland management areas (UMAs), and other forest patches play in maintaining species and providing structural and vegetative characteristics thought to be important to wildlife? What are the functions of large legacy trees (snags, down wood, high stumps) as compared to the smaller complements produced in intensively managed forests? What are the roles and fates of special sites (e.g., rock outcrops, cliffs, talus slopes, isolated small wetlands, etc.) in managed forests?	Legacy features and their effect on wildlife	Effectiveness Validation
What are the movement patterns, processes, and distances of amphibians in managed forests? Do amphibians persist in refugia following timber harvest, or is subsequent occupancy related to movements from other areas? How quickly do amphibians recolonize areas, particularly habitat outside the stream network? What are the roles of ponds created by beaver, slumps, rotational failures, road ditches, sediment traps, and off-channel habitats in the distribution and abundance of still-water-breeding amphibians?	Amphibian movement and distribution effectiveness monitoring	Effectiveness
Rule Group Critical Questions	**Program**	**Task Type**
What are the status and trends of bats in managed forests?	Forest Bats	Extensive
What are the roles of WRTs and GRTs in bat ecology? What are the relationships between forest management and bat foraging and roosting?	Forest Bats	Effectiveness
What is the relationship between the abundance and productivity of wildlife and gradients in the composition and structure of ponderosa pine stands?	Ponderosa Pine Habitat	Effectiveness
What are the effects of forest practices on the western gray squirrel and oviposition sites of egg-laying reptiles? What are the roles of isolated oak trees and small patches of oaks? What are the appropriate management approaches to maintaining and restoring oak woodlands at stand and landscape levels?	Oak Woodland Habitat	Effectiveness

5.11 INTENSIVE WATERSHED-SCALE MONITORING TO ASSESS CUMULATIVE EFFECTS

Intensive monitoring is watershed-scale research designed to evaluate the cumulative effects of multiple forest practices and to provide information that will improve our understanding of causal relationships and the biological effects of forest practices rules on aquatic resources. The evaluation of cumulative effects of multiple management actions on a system requires an understanding of how individual actions influence a site, and how those responses propagate through the system. This understanding will enable the evaluation of the effectiveness of management practices applied at multiple locations over time. This sophisticated level of understanding can only be achieved with an intensive, integrated monitoring effort. Evaluating biological responses is similarly complicated, requiring an understanding of how various management actions interact to affect habitat conditions, and how system biology responds to these habitat changes. This program was identified in the Monitoring Design Team (MDT) Report (MDT 2002) as an essential component of an integrated monitoring program. CMER and Policy will be scoping intensive monitoring needs for the adaptive management program.

5.11.1 Resource Objectives and Performance Targets

Resource objectives and performance targets have not yet been identified.

APPENDIX A: CMER PROJECTS, OBJECTIVES, AND TARGETS

Rule Group/ Program / CMER Projects	Status	Task Type	Direct Measure of FFR Goals: Fish	Amphib	WQ	Direct or Indirect Measurement[1] of Objectives & Targets (D = direct; I = indirect; L = literature; ? = probable if implemented in future): In-Str Temp	Rip/ Wet Shade	Rip/ Wet Stand[2]	In-Str/ Wet LWD	Rip/ Wet Litter	In-Str/ Wet Hab[3]	Strm Bnk ELZ[4]	Mass Wast-ing	Rd Sed Runoff	Peak Flow	Wet-land	Fish Passage	Other Important Issues: Wind-throw	Ground-water	Intermit Flow[5]
Stream Typing Rule Group																				
Stream Typing Program (Rule Tool)																				
Last Fish/Habitat Prediction Model Development	complete	RIT	yes	---	---	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---
Annual/Seasonal Variability	complete	R&D	yes	---	---	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---
Last Fish/Habitat Prediction Model Field Performance	complete	RIT	yes	---	---	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---
Default Physicals Criteria Assessment	scoping	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fish/Habitat Detection Using Envionmental DNA (eDNA)	in prog	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Evaluation of physical features that define fish habitat in forested landscapes (PHB)	in prog	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Stream Typing Program (Extensive Status and Trends Monitoring)		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Recoverable/Restorable Fish Habitat	delayed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Type N Riparian Prescriptions Rule Group																				
Type N Delineation Program (Rule Tool)																				
Perennial Initiation Point Survey: Pilot Study	complete	RIT	---	---	---	---	---	---	---	---	D	---	---	---	---	---	---	---	---	D
Sensitive Site Program (Rule Tool)																				
SAA Sensitive Sites Identification Methods	complete	RIT	---	yes	---	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---
SAA Sensitive Sites Characterization	complete	RIT	---	yes	---	---	---	---	---	---	D	---	---	---	---	---	---	---	---	D
Type N Riparian Effectiveness Program																				
Westside Type N Buffer Characteristics, Integrity, and Function (BCIF)	in prog	EFF	---	---	---	I	D	D	D	---	I	D	---	---	---	---	---	D	---	---
Type N Exp Buffer Treatment Feasibility Study	complete	R&D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Type N Exp Buffer Treatment in Hard Rock Lithologies- Phase 1	complete	EFF	yes	yes	yes	D	D	D	D	D	D	D	---	D	D	---	---	D	---	D
Type N Exp Buffer Treatment in Hard Rock Lithologies (Extended Monitoring: Amphibian Demographics/Channel Metrics)- Phase 2	in prog	EFF	yes	yes	yes	D	D	D	D	D	D	D	---	D	D	---	---	D	---	D
Type N Exp Buffer Treatment in Hard Rock Lithologies (Extended Monitoring: Temperature, Sediment, Vegetation, Litterfall)- Phase 2	in prog	EFF	yes	yes	yes	D	D	D	D	D	D	D	---	D	D	---	---	D	---	D
Type N Exp Buffer Treatment in Hard Rock Lithologies (Extended Monitoring: Amphibian Demographics and responses of interest)- Phase 3	delayed	EFF	---	yes	---	?	?	?	?	---	?	---	---	---	?	---	---	?	---	---
Type N Exp Buffer Study in Soft Rock Lithologies	in prog	EFF	---	---	yes	D?	D?	D?	?	?	?	D?	---	D?	D?	---	---	D?	I	I?
Windthrow Frequency, Distribution, and Effects	delayed	EFF	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	D?	---	---
Eastside Type N Buffer Characteristics, Integrity, and Function (BCIF)	delayed	EFF	---	---	yes	D?	D?	D?	D?	---	---	D?	---	---	---	---	---	D?	---	---
Eastside Type N Forest Hydrology	complete	RIT	---	yes	yes	I	---	I	---	---	---	---	---	---	---	---	---	---	I	D
Eastside Type N Riparian Effectiveness (ENREP)	in prog	EFF	---	yes	yes	D	D	D	D?	D	D	D	---	D?	D?	---	---	D	---	D
Eastside Ns Effectiveness	delayed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Literature Review and Synthesis Related to the Salvage of Fire Damaged Timber	complete	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Seep Sensitive Sites, and Amphibian	delayed	RIT	---	yes	---	?	?	---	D	---	D	---	---	---	---	---	---	---	D	?
Slash in Type N Streams	delayed	EFF	---	yes	---	?	D	I	D	D	D	---	---	---	---	---	---	I	---	---
Type N Amphibian Response Program (Effectiveness)																				
SAA Detection/Relative Abundance Methodology	complete	R&D	---	yes	---	---	---	---	---	---	D	---	---	---	---	---	---	---	---	D
Type N Exp Buffer Treatment in Hard Rock Lithologies[6]	complete	EFF	yes	yes	yes	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tailed Frog Literature Review	complete	R&D	---	yes	---	L	L	L	L	L	L	L	L	L	L	---	---	L	---	L
Tailed Frog Meta-Analysis	complete	R&D	---	yes	---	---	---	---	---	---	I	---	---	---	---	---	---	---	---	I
Tailed Frogs and Parent Geology	delayed	R&D	---	yes	---	---	---	---	---	---	D?	?	?	?	---	---	---	?	---	?
Dunn's Salamander	complete	R&D	---	yes	---	---	D	D	---	D	---	---	---	---	---	---	---	---	---	---
Buffer Integrity - Shade Effectiveness	complete	EFF	---	yes	yes	D	D	---	---	---	D	---	---	---	---	---	---	I	---	---
Amphibian Recovery	complete	EFF	---	yes	yes	D	D	D	D	---	D	I	---	---	---	---	---	D	---	I
Amphibians in Intermittent Streams	delayed	R&D	---	yes	---	?	?	---	?	---	D?	---	---	---	?	---	---	---	---	D?
Van Dyke's Salamander	delayed	R&D	---	yes	---	?	?	?	?	?	?	?	?	?	?	?	?	---	---	D?
Eastside Amphibian Evaluation	delayed	R&D	---	yes	---	?	?	?	?	?	?	?	?	?	?	?	?	---	---	D?
Extensive Riparian Status and Trends Monitoring Program																				
Extensive Riparian Status and Trends Monitoring- Temperature, Type F/N Westside	in prog	EXT	---	---	yes	D	D	I	D	---	D	D	---	---	---	---	---	---	---	---
Extensive Riparian Status and Trends Monitoring- Temperature, Type F/N Eastside	delayed	EXT	---	---	yes	D	D	I	D	---	D	D	---	---	---	---	---	---	---	---
Extensive Riparian Status and Trends Monitoring- Vegetation, Type F/N Westside and Eastside	in prog	EXT	---	---	---	?	?	?	---	?	---	---	---	---	---	---	---	?	---	---
Riparian Characteristics and Shade Response Study	scoping	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Wood Recruitment Volume and Source Distances from Riparian Buffers	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Rule Group/ Program	CMER Projects	Status	Task Type	Direct Measure of FFR Goals			Direct or Indirect Measurement[1] of Objectives & Targets (D = direct; I = indirect; L = literature; ? = probable if implemented in future)												Other Important Issues		
				Fish	Amphib	WQ	In-Str Temp	Rip/ Wet Shade	Rip/ Wet Stand[2]	In-Str/ Wet LWD	Rip/ Wet Litter	In-Str/ Wet Hab[3]	Strm Bnk ELZ[4]	Mass Wast-ing	Rd Sed Runoff	Peak Flow	Wet-land	Fish Passage	Wind-throw	Ground-water	Intermit Flow[5]
Type F Riparian Prescriptions Rule Group																					
DFC Validation Program (Rule Tool)																					
	DFC Target Validation	complete	RIT	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---	---	---	---
	DFC Plot Width Standardization (scoping)	delayed	R&D	---	---	---	---	---	?	?	---	?	---	---	---	---	---	---	---	---	---
	FPA Desktop Analysis (includes field analysis)	complete	RIT	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---	---	---	---
	DFC Site Class Map Validation (scoping)	delayed	RIT	---	---	---	---	---	?	---	---	---	---	---	---	---	---	---	---	---	---
	DFC Trajectory Model Validation	delayed	R&D	---	---	---	---	---	?	?	---	---	---	---	---	---	---	---	---	---	---
	DFC Aquatic Habitat	delayed	R&D	---	---	---	---	---	?	?	---	?	---	---	---	---	---	---	---	---	---
	Pathways of Riparian Stand Development to Maturity	delayed	R&D	---	---	---	---	---	?	---	---	---	---	---	---	---	---	---	---	---	---
	Red Alder Growth and Yield Model (coop. contribution)	complete	R&D	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---	---	---	---
Eastside Type F Riparian Rule Tool Program																					
	Eastside Disturbance Regime Literature Review	complete	R&D	---	---	---	---	L	L	L	L	---	---	L	---	---	---	---	L	---	---
	Eastside LWD Literature Review	complete	R&D	---	---	---	---	L	L	L	L	---	---	---	---	---	---	---	L	---	---
	Eastside Temperature Nomograph	incomplete	RIT	---	---	yes	D	D	---	---	---	---	---	---	---	---	---	---	---	---	---
	Eastern WA Riparian Assessment (EWRAP)	complete	R&D	---	---	---	---	D	D	D	D	D	---	---	---	---	---	---	D	---	---
	Eastside Modeling Evaluation (EMEP)	in prog	RIT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Eastside Timber Habitat Evaluation (ETHEP)	scoping	RIT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Eastside Type F Channel Wood Characterization	delayed	R&D	---	---	---	---	D	I	D	I	D	---	---	---	---	---	---	D	---	---
Bull Trout Habitat Identification Program (Rule Tool)																					
	Bull Trout Presence/Absence Protocols	complete	RIT	yes	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Bull Trout Habitat Prediction Models	complete	RIT	yes	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Yakima River Radiotelemetry	complete	R&D	yes	---	---	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---
Westside Type F Riparian Effectiveness Program																					
	Westside Type F Riparian Prescription Monitoring	in prog	EFF	---	---	---	?	?	?	?	---	?	?	---	---	---	---	---	?	---	---
	Westside Type F Experimental Buffer Treatment	delayed	EFF	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Type F Performance Target Validation	delayed	EFF	---	---	---	---	---	?	?	---	?	?	---	---	---	---	---	---	---	---
Eastside Type F Riparian Effectiveness Program																					
	BTO Temperature (Eastside Riparian Shade/Temperature)	complete	EFF	---	---	yes	D	D	D	---	---	---	---	---	---	---	---	---	---	---	D
	Solar Radiation/Effective Shade	complete	EFF	---	---	---	I	D	---	---	---	---	---	---	---	---	---	---	---	---	---
	Eastside Type F Riparian Effectiveness Monitoring (BTO add-on)	in prog	EFF	---	---	---	---	---	D	D	---	I	D	---	---	---	---	---	D	---	---
	Groundwater Conceptual Model	delayed	R&D	---	---	---	I	---	---	---	---	---	---	---	---	---	---	---	---	I	---
Hardwood Conversion Program (Effectiveness)																					
	Riparian Hardwood Conversion	in prog	EFF	---	---	---	---	---	D	---	---	---	---	---	---	---	---	---	?	---	---
	Riparian Hardwood Conversion - Temperature Component	complete	EFF	---	---	yes	D	D	---	---	---	I	---	---	---	---	---	---	---	---	---
	Annotated Bibliography: Riparian Hardwood Conversion	incomplete	R&D	---	---	---	?	---	L	---	---	---	---	---	---	---	---	---	---	---	---
	WDOE Water Temperature Modeling	complete	R&D	---	---	---	I	I	I	---	---	---	---	---	---	---	---	---	---	---	---
Intensive Monitoring/Cumulative Effects Program: No projects yet identified.																					

Rule Group/ Program / CMER Projects	Status	Task Type	Direct Measure of FFR Goals: Fish	Amphib	WQ	Direct or Indirect Measurement[1] of Objectives & Targets (D = direct; I = indirect; L = literature; ? = probable if implemented in future): In-Str Temp	Rip/ Wet Shade	Rip/ Wet Stand[2]	In-Str/ Wet LWD	Rip/ Wet Litter	In-Str/ Wet Hab[3]	Strm Bnk ELZ[4]	Mass Wast-ing	Rd Sed Runoff	Peak Flow	Wet-land	Fish Passage	Other Important Issues: Wind-throw	Ground-water	Intermit Flow[5]
Channel Migration Zone Rule Group																				
CMZ Delineation Program																				
CMZ Screen and Aerial Photo Catalog and CMZ Boundary Identification Criteria	delayed	RIT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Consistency and Accuracy of CMZ Boundary Delineations	delayed	RIT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CMZ Validation Program: No projects yet identified.																				
Unstable Slopes Rule Group																				
Unstable Landform Identification Program (Rule Tool)																				
Shallow Rapid Landslide Screen for GIS (Westside)	complete	RIT	---	---	---	---	---	---	---	---	---	---	I	---	---	---	---	---	---	---
Shallow Rapid Landslide Screen for GIS (Eastside)	delayed	RIT	---	---	---	---	---	---	---	---	---	---	I?	---	---	---	---	---	---	---
Technical Guidelines for Geotechnical Reports	complete	RIT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Regional Unstable Landforms Identification (Deep-Seated Screen)	complete	RIT	---	---	---	---	---	---	---	---	---	---	I	---	---	---	---	---	---	---
Landform Hazard Classification System and Mapping Protocols	complete	R&D	---	---	---	---	---	---	---	---	---	---	I	---	---	---	---	---	---	---
Landslide Hazard Zonation (priority 1 and 2 watersheds)	complete	RIT	---	---	---	---	---	---	---	---	---	---	D	---	---	---	---	---	---	---
Landslide Hazard Zonation (priority 3 watersheds)	delayed	RIT	---	---	---	---	---	---	---	---	---	---	D	---	---	---	---	---	---	---
Glacial Deep-Seated Landslides Program (Rule Tool)																				
Model Evapo-Transpiration in Deep-Seated Landslide Recharge Areas	complete	RIT	---	---	---	---	---	---	---	---	---	I	I	---	---	---	---	---	I	---
Evapo-Transpiration Model Refinement	delayed	R&D	---	---	---	---	---	---	---	---	---	---	I?	---	---	---	---	---	---	---
Glacial Deep-Seated Landslides and Groundwater Recharge Literature Synthesis	complete	RIT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	L	---
Groundwater Recharge Modeling	delayed	R&D	---	---	---	---	---	---	---	---	---	---	I?	---	---	---	---	---	D	---
Glacial Deep-Seated Landslide Map	delayed	RIT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Landslide Classification	delayed	RIT	---	---	---	---	---	---	---	---	---	---	I?	---	---	---	---	---	I	---
Board Manual Revision	complete	RIT	---	---	---	---	---	---	---	---	---	---	I?	---	---	---	---	---	I	---
Mass Wasting Effectiveness Monitoring Program																				
Unstable Slopes Criteria	in prog	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Non-Glacial Deep-Seated Landslides and Groundwater Recharge Literature Synthesis	complete	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Deep-Seated Landslide Research Strategy	scoping	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mass Wasting Effectiveness Monitoring (aka Post-Mortem)	complete	EFF	---	---	---	---	---	---	D	---	I	I	D	D	I	---	---	---	---	---
Mass Wasting Landscape-Scale Extensive Monitoring	delayed	EFF	---	---	---	---	---	---	---	---	---	---	D?	---	---	---	---	---	---	---
Mass Wasting Buffer Integrity and Windthrow Assessment	delayed	EFF	---	---	---	---	---	---	---	---	---	---	D?	---	---	---	---	D?	---	---
Mass Wasting Validation Program (Intensive): No projects yet identified.																				
Roads Rule Group																				
Road Sub-Basin-Scale Effectiveness Monitoring Program																				
Road Sub-Basin-Scale Effectiveness Monitoring (Phase 1)	complete	EFF	---	---	I	---	---	---	---	---	---	---	---	D	I	---	I	---	---	---
Road Surface Erosion Model Update	complete	RIT	---	---	---	---	---	---	---	---	---	---	---	D	---	---	---	---	---	---
Road Surface Erosion Model Validation/Refinement	delayed	R&D	---	---	---	---	---	---	---	---	---	---	---	D?	---	---	---	---	---	---
Road Prescription-Scale Effectiveness Monitoring Program																				
Effectiveness of RMAP Fixes	delayed	EFF	---	---	---	---	---	---	---	---	---	---	---	D?	D?	---	D?	---	---	---
Road Prescription-Scale Effectiveness Monitoring	in prog	EFF	---	---	---	---	---	---	---	---	---	---	D	D	I	---	---	---	---	---
Roads Validation Program and Cumulative Sediment Effects																				
Intensive Watershed-Scale Monitoring to Assess Cumulative Effects	delayed	INT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Rule and Project Tools: Rule Implementation Tools (RIT) needed to correctly implement the rules; includes accurately delineating prescription boundaries
Research & Development (R&D) includes literature reviews and development of research protocols

[1] Direct or Indirect Measurement: Direct = actual field measurement; Indirect = modeling/correlations, etc.

[2] Riparian/Wetland Stand Objectives/Targets include windthrow, potential LWD recruitment, DFC basal area targets, and other stand conditions, etc.

[3] In-Stream/Wetland Habitat Objectives/Targets include fish and amphibian habitat ID, substrate, flow, etc.

[4] Stream Bank/Equipment Limitation Zone (ELZ) includes bank erosion, delivery of sediment from the ELZ

[5] "Intermit Flow" refers to spatially intermittent flow below the uppermost point of perennial flow in Type Np streams.

[6] Type N Exp Buffer Treatment in Hard Rock Lithologies: This project is repeated in two programs (Type N Effectiveness and Amphibian Response); however, the designation of functions is shown only once in order to not overdesignate projects that address those functions. The functions are designated under the Type N Effectiveness Program.