



ELLIOTT STATE FOREST WATERSHED ANALYSIS



OCTOBER 2003



PREPARED BY

**BIOSYSTEMS
WATER WORK CONSULTING
COOS WATERSHED ASSOCIATION
ALSEA GEOSPATIAL, INC.
KAREN BAHUS TECHNICAL WRITING**



ELLIOTT STATE FOREST WATERSHED ANALYSIS

Final Report

October 2003

BioSystems
P.O. Box 1025
Corvallis, OR 97339

Water Work Consulting
Coos Watershed Association
Alsea Geospatial, Inc.
Karen Bahus Technical Writing

Submitted to

Oregon Department of Forestry

Dan Clough, Project Manager

CONTRIBUTORS

CHIP ANDRUS, WATER WORK CONSULTING

Technical Lead

Chapter 1, *Introduction* (Lead Author)

Chapter 2, *Watershed Analysis Area Overview* (Lead Author)

Chapter 4, *Stream Flow and Water Quantity* (Lead Author)

Chapter 5, *Water Quality* (Lead Author)

Chapter 7, *Riparian Vegetation and Large Wood* (Lead Author)

Chapter 8, *Aquatic Organisms and Their Environment*

- *Fish passage*

KAREN BAHUS TECHNICAL WRITING

Technical Editing

KEVIN CRAIG, COOS WATERSHED ASSOCIATION

GIS Analysis and Map Production

Chapter 6, *Erosion and Sediment* (Lead Author)

JOHN RUNYON, BIOSYSTEMS

Project Management

Chapter 3, *Historical Conditions* (Lead Author)

Chapter 8, *Aquatic Organisms and Their Environment* (Lead Author)

Chapter 10, *Rare and Exotic Plants and Tree Diseases*

RACHEL SCHWINDT, ALSEA GEOSPATIAL

GIS Analysis and Map Production

JON SOUDER, COOS WATERSHED ASSOCIATION

Chapter 2, *Watershed Analysis Area Overview*

- *Social Context*

Chapter 3, *Historical Overview*

- *Human Disturbance*

- *Establishment of the Elliott State Forest and Early History*

Chapter 6, *Erosion and Sediment* (Co-Lead Author)

Chapter 9, *Terrestrial Wildlife* (Lead Author)

Chapter 10, *Rare and Exotic Plants & Tree Diseases* (Lead Author)

ABBREVIATIONS AND ACRONYMS

BLM	Bureau of Land Management
CCC	Civilian Conservation Corps
cu. ft.	cubic foot (feet)
cfs	cubic feet per second
DEM	digital elevation model
DEQ	Department of Environmental Quality
DOGAMI	Department of Geology and Mineral Industries
DBH	diameter at breast height
ESA	Endangered Species Act
ft.	foot (feet)
Forest	Elliott State Forest
GIS	Geographic Information System
HCA	Habitat Conservancy Area
HCP	Habitat Conservation Plan
HUC	hydrologic unit code
MMMA	Marbled Murrelet Management Area
m ²	square meter(s)
mg/L	milligrams per liter
MMBF	million board feet
ODFW	Oregon Department of Fish and Wildlife
ODF	Oregon Department of Forestry
ONHP	Oregon Natural Heritage Program
OSCUR	Ownership, Soil-site, Cover, Use, and Rating (state forest inventory system)
OWEB	Oregon Watershed Enhancement Board
PNCERS	Pacific Northwest Coastal Ecosystems Regional Study
RAIS	Riparian Aquatic Interaction Simulator
RM	river mile
sq. mi.	square mile(s)
TLBP	Tenmile Lakes Basin Partnership
TMDL	total maximum daily load
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
WRD	Oregon Water Resources Department
yd.	yard(s)

ELLIOTT STATE FOREST WATERSHED ANALYSIS

Table of Contents

CHAPTER 1. INTRODUCTION	1-1
Purpose and Approach	1-1
Key Issues	1-2
Geographic Focus	1-2
CHAPTER 2. WATERSHED ANALYSIS AREA OVERVIEW	2-1
Physical Setting	2-1
Watersheds and Ecoregions.....	2-1
Geology, Landforms and Soils	2-2
Climate Patterns	2-5
Streams and Other Water Bodies	2-5
Biological Features	2-8
Historic Hillslope Vegetation.....	2-8
Current Hillslope Vegetation.....	2-12
Riparian Vegetation.....	2-14
Fish and Wildlife Resources.....	2-17
Social Context.....	2-20
Population and Demographics.....	2-20
Economy.....	2-21
Recreation.....	2-21
Trends in Recreational Activities	2-22
Land Uses	2-24
Management of the Elliott State Forest	2-25
Elliott State Forest.....	2-25
Surrounding Land Parcels	2-26
Federally Listed Species and Clean Water Act Issues	2-26
CHAPTER 3. HISTORICAL OVERVIEW	3-1
Natural Disturbances	3-1
Floods.....	3-1
Windstorms	3-2
Human Disturbance	3-2
Early European Settlement.....	3-2
Splash Dams.....	3-3
Stream Cleaning	3-4
Early History of the Elliott State Forest.....	3-6
Management through Time	3-6
Harvest Programs	3-7
Road Building	3-8
Other Management and Policy Changes	3-10
CHAPTER 4. STREAM FLOW AND WATER QUANTITY.....	4-1
Streamflow Characteristics	4-1
Water Yield and Peak Flows.....	4-1
Perennial and Intermittent Flow	4-4

Table of Contents (continued)

Consumptive Water Uses	4-5
Water Use by the Elliott State Forest	4-7
Instream Water Rights	4-8
Analysis	4-10
Summer Flow	4-10
Peak Flow	4-10
Seasonal Flow	4-10
Consumptive Water Uses	4-11
Water Use by the Elliott State Forest	4-11
Instream Water Rights	4-11
Recommended Actions and Monitoring	4-11
Summer Flow	4-11
Peak Flow	4-12
Seasonal Flow	4-12
Consumptive Water Uses	4-12
Pump Chances	4-12
Instream Water Rights	4-12
 CHAPTER 5. WATER QUALITY	 5-1
Water Temperature	5-1
Methods	5-2
Results	5-4
Nutrients and Dissolved Oxygen	5-10
Methods	5-12
Results	5-12
Herbicides	5-15
Water Quality Limited Streams and Lakes	5-19
Analysis	5-20
Water Temperature	5-20
Nutrients	5-21
Herbicides	5-22
Recommended Actions and Monitoring	5-23
Water Temperature	5-23
Nutrients	5-23
Herbicides	5-24
 CHAPTER 6. EROSION AND SEDIMENT	 6-1
Background	6-1
Natural Climate and Precipitation Drivers	6-1
Tectonic Setting	6-1
Sources of Natural Sediment	6-2
Soil Mantle Production and Transport	6-2
Fluvial Processes that Detach and Transport Particles	6-3
Gravity-driven Processes	6-4
Soil Creep	6-4
Mass Movement	6-5
Deep-seated Landslides	6-6
Shallow, Rapidly Moving Landslides	6-7

Table of Contents (continued)

Noble Creek Landslide Study (TLBP 2003)	6-9
ODF Landslide Study (Robison et al. 1999)	6-11
Watershed Sedimentation from Fires	6-18
Natural Fire Regimes	6-18
Anthropogenic Fire Regimes.....	6-18
Other Anthropogenic Sediment Sources.....	6-20
Roads.....	6-21
Road Position	6-21
Road Slope	6-25
Road Age.....	6-28
Road-related Landslides.....	6-29
Road Surface Type and Level of Use.....	6-32
Road Drainage Features	6-35
Road Washouts.....	6-40
Analysis and Recommendations.....	6-42
Recommendations Related to Shallow Landsliding.....	6-44
Recommendations to Reduce Road-related Sedimentation.....	6-45
CHAPTER 7. RIPARIAN VEGETATION AND LARGE WOOD.....	7-1
Riparian Vegetation.....	7-1
Riparian Mapping and Field Inventory	7-2
Riparian Vegetation Characteristics	7-2
Large Wood in the Aquatic System.....	7-14
Modeling Streamside Stands and Large Wood	7-20
Evaluation of Management Options	7-31
Large Wood Originating from Steep Draws.....	7-36
Analysis	7-42
Current and Future Riparian Conditions	7-42
Streamside Forest Management and Future Conditions.....	7-43
Large Wood from Steep Draws.....	7-43
Recommended Actions and Monitoring.....	7-44
Current and Future Riparian Conditions	7-44
Streamside Forest Management and Future Conditions.....	7-44
Large Wood from Steep Draws.....	7-44
CHAPTER 8. AQUATIC ORGANISMS AND THEIR HABITAT	8-1
Natural Fish Passage Barriers.....	8-1
Road Changes to Stream Channels and Fish Passage Barriers.....	8-2
Methods.....	8-2
Results	8-3
Discussion	8-4
Fish Passage Barriers.....	8-4
Methods.....	8-4
Results	8-5
Discussion	8-6
Habitat Restoration Projects	8-6
Methods.....	8-6
Results	8-8

Table of Contents (continued)

Discussion	8-8
Fish Habitat Preferences and Population Status	8-9
Coho Salmon	8-12
Fall Chinook	8-16
Winter Steelhead	8-17
Sea-run and Resident Cutthroat Trout	8-18
Lamprey	8-18
Amphibians and Reptiles: Habitat Preferences and Population Status	8-19
Methods	8-19
Results	8-21
Discussion	8-22
Summary of Stream Habitat and Fish Population Inventories	8-23
Methods	8-24
Results	8-24
Discussion	8-34
Analysis	8-34
Overview	8-34
Aquatic Restoration Opportunities	8-35
High Quality Aquatic and Riparian Habitats	8-37
Recommended Actions and Monitoring	8-38
CHAPTER 9. TERRESTRIAL WILDLIFE	9-1
Summary of Wildlife Studies	9-1
Birds Utilizing Riparian Areas	9-2
Methods	9-2
Results	9-3
Northern Spotted Owl Management	9-5
Marbled Murrelet Management	9-6
Reserves Resulting from Management for Spotted Owls and Marbled Murrelets	9-7
Summary	9-8
Framework of Approaches	9-8
Recommendations	9-11
CHAPTER 10. RARE AND EXOTIC PLANTS AND TREE DISEASES	10-1
Rare Plants	10-1
Introduced Plant Species	10-2
Tree Diseases	10-3
Recommended Actions and Monitoring	10-4
CHAPTER 11. SYNTHESIS	11-1
Natural Characteristics that Influence Fish and Wildlife Productivity	11-1
Management Factors that Influence Fish and Wildlife Productivity	11-2
Roads	11-2
Landslides Not Related to Roads	11-4
Riparian Stands and Large Wood in Streams	11-5
Water Temperature	11-7
Fish Movement	11-8
Water Characteristics	11-9

Table of Contents (continued)

Timber Harvest.....	11-11
Conclusion	11-11

References

- Appendix A – Streamside Vegetation or Land-type Area by Stream Size and Distance from Stream for Fish-bearing Streams
- Appendix B – Current and Modeled Future Large Wood Volume for Fish-bearing Streams
- Appendix C – Aquatic Habitat Restoration Projects, 1995-2002
- Appendix D – Aquatic Habitat Inventory Summaries

List of Tables

Table 1-1. Scattered tracts of land associated with the Elliott State Forest.	1-3
Table 2-1. Area of the Elliott State Forest by region and ecoregion.....	2-2
Table 2-2. Description of soils on the Forest.	2-4
Table 2-3. Length of stream by size class for each watershed region.....	2-5
Table 2-4. Channel habitat types for fish-bearing streams by region and analysis basin.	2-7
Table 2-5. Stand age by region and analysis basin, 2000.	2-13
Table 2-6. Fish species occurring on the Forest.....	2-18
Table 2-7. Amphibian species occurring on the Forest.....	2-19
Table 2-8. Mileage and density of known fish-bearing streams.	2-19
Table 2-9. Rating of community characteristics related to why people reside in a community near Coos Bay.....	2-23
Table 2-10. Scattered tracts of land associated with the Forest.	2-27
Table 3-1. Timeline of major historical events.	3-3
Table 4-1. Elliott State Forest water rights.	4-8
Table 4-2. Instream water rights for streams partially or completely within the Forest.	4-9
Table 5-1. Maximum water temperature and related information for Forest streams.	5-3
Table 5-2. Significance and fit for a multiple regression equation examining variance in the 7-day maximum water temperature and the independent variables distance from divide (natural-log transformed) and shade.	5-5
Table 5-3. Mean ODFW shade values by active channel width by region.	5-9
Table 5-4. Selected water quality parameters for streams within or immediately adjacent to the Forest, June through September.....	5-13
Table 5-5. Annual suspended sediment yield from coastal watersheds and modeled sediment yields for five streams draining into Tenmile Lakes.	5-14
Table 5-6. General characteristics of herbicides that have been applied on the Forest since 1999, in order of volume of use.	5-15
Table 5-7. Aerial application of herbicides on the Forest, 1999-2002.....	5-17
Table 5-8. Studies on the toxicity of Roundup and salt of glyphosate on salmonids.	5-18
Table 5-9. Peak and maximum 24-hour average concentrations of herbicide within streams for treated clearcuts in western Washington.....	5-18
Table 6-1. Average landslide volumes in Noble Creek based on vegetation class at origin.....	6-10
Table 6-2. Landslide characteristics for three study areas in steep sandstone terrain of the central Coast Range following the 1996 storms.	6-12
Table 6-3. Jams of wood, rock, and sediment transported by landslides into fish-bearing streams.	6-15

Table of Contents (continued)

Table 6-4. Distance from initiation point to fish-bearing stream and slope steepness at initiation points for landslides that ended up in a fish-bearing stream.....	6-15
Table 6-5. Density of shallow, rapidly moving landslides (not related to roads) and associated erosion.	6-18
Table 6-6. Comparison of the annual suspended sediment yield for forested basins and basins logged and broadcast burned in Oregon.	6-20
Table 6-7. Miles of various road types and their landscape location in the Forest by watershed and 5 th field HUC.....	6-22
Table 6-8. Percentage of slides by slide volume interval and mean slide volume for ridgeline and mid-slope roads.....	6-24
Table 6-9. Coding scheme for road slope hazard analysis.....	6-25
Table 6-10. Miles of Forest roads by road and side-slope class (high hazard areas shaded).....	6-27
Table 6-11. Landslide characteristics for three study areas in steep sandstone terrain of the central Coast Range following the 1996 storms.	6-30
Table 6-12. Road-related landslides included in the 1997-1998 road inventory of the Forest by analysis basin.	6-31
Table 6-13. Calculated sediment yield per kilometer of road for various road types and use levels (Pacific Northwest Study).....	6-33
Table 6-14. Roads within 100 feet of streams.....	6-34
Table 6-15. Contributing ditch lengths to stream crossings on Forest roads.....	6-38
Table 6-16. Forest roads with sediment delivery potential from ditch delivery into stream crossing culverts.....	6-39
Table 6-17. Road and landing surveys conducted in the Forest.....	6-40
Table 6-18. Distribution of sediment transport capacity at stream crossing culverts.	6-41
Table 6-19. Forest roads with High and Moderate Sediment Transport Ratings.....	6-42
Table 6-20. Cumulative road sediment hazard ratings by Forest road number.	6-44
Table 7-1. Regression equations relating stand density and basin area to stand age for streamside areas.	7-9
Table 7-2. Streamside stand characteristics by stand type and age class as summarized from Figures 7-4 to 7-6.....	7-13
Table 7-3. Volume of wood in logjams during the 1960s for five relatively undisturbed Forest streams.	7-16
Table 7-4. Large wood volume in Forest streams, by region, and in BLM reference streams (mean values weighted by reach length).....	7-18
Table 7-5. Average values for large wood in streams by analysis basin, weighted by reach length.	7-19
Table 7-6. Large wood in streams by stream size class.	7-19
Table 7-7. Modeled large wood volume in comparison to measured values for Forest streams (<40 feet wide) and BLM reference streams.	7-24
Table 7-8. Modeled large wood in Deer Creek (2,800 feet upstream of the mouth) from the current year to 300 years in the future.....	7-30
Table 7-9. Current and projected large wood volume in Forest streams by analysis basin.	7-31
Table 7-10. Information on stream segments within a tributary drainage of Cougar Creek and ranking according to the likelihood that landslides reach fish-bearing streams and expected abundance of large wood and boulders in the contributing stream segment.	7-40
Table 8-1. Summary of length of roads within 100 feet streams by size class.	8-3
Table 8-2. Status of culverts in fish-bearing streams on the Forest.	8-5
Table 8-3. Culverts in fish-bearing streams by region and analysis basin that were removed, washed out, or recently replaced.....	8-5

Table of Contents (continued)

Table 8-4. Characteristics of older culverts currently in place on the Forest.....	8-7
Table 8-5. In-channel habitat and fish passage improvements projects on the Forest, as reported in the OWEB database, 1995-2002.....	8-8
Table 8-6. Distribution, preferred habitats, and legal status of salmonid species on the Forest.	8-10
Table 8-7. Distribution, preferred habitats, and legal status of non-salmonid species on the Forest.	8-11
Table 8-8. Coho densities for stream reaches in the Forest, 1998-2002.	8-14
Table 8-9. Aquatic and riparian-dependent amphibians found on the Forest.	8-20
Table 8-10. Amphibians found in fire pump chance ponds on the Forest.	8-21
Table 8-11. Miles of streams inventoried by gradient class for each region.....	8-25
Table 8-12. Average pool characteristics for inventoried streams reaches of less than 4% gradient by region.	8-26
Table 8-13. Average riffle gravel percentages for inventoried stream reaches.....	8-33
Table 8-14. Stream reaches with limited pools and minimal in-channel wood with active channel widths less than 40 feet and gradients less than 4% that provide opportunities for aquatic habitat restoration (Map 8.7).....	8-36
Table 8-15. Stream reaches with limited pools and minimal in-channel wood with active channel widths greater than 40 feet and gradients less than 4% that provide opportunities for aquatic habitat restoration (Map 8.7).....	8-37
Table 8-16. High quality aquatic (in-channel large wood) and mature riparian conifer (stand age older than 99 years) habitat for inventoried stream reaches with gradients less than 4% (all active channel widths, Map 8.7).	8-38
Table 9-1. Number of Individual birds observed at survey stations located in riparian areas of the Forest by management basin.	9-4
Table 9-2. Land allocation for spotted owl habitat protection in the Forest.	9-6
Table 9-3. Percentage of the Forest in Marbled Murrelet Management Areas.....	9-7
Table 9-4. Land allocations for spotted owl habitat protection.....	9-7

List of Figures

Figure 2-1. Location of township corners and identification numbers created from the General Land Office township survey notes for the Forest and the 1868 fire boundaries as mapped by Phillips.	2-9
Figure 2-2. Diameter distributions of live-bearing trees that survived the 1868 fire for the original land survey of township lines in the Forest.....	2-10
Figure 2-3. Species distribution of live-bearing trees that survived the 1868 fire noted in the original land survey of township lines in the Forest.....	2-11
Figure 2-4. Quadratic mean conifer diameter by age class for current stands in Forest and for conifer bearing trees noted in the 1878-1893 land surveys.....	2-12
Figure 2-5. Percent riparian stand type by stream size for all Forest regions (fish-bearing streams only).	2-16
Figure 2-6. Percent riparian stand age by stream size for all Forest regions (fish-bearing streams only).	2-17
Figure 2-7. Level of participation in recreational activities.....	2-23
Figure 4-1. Average monthly flows for the West Fork Millicoma River.	4-2
Figure 4-2. Average August flows for the West Fork Millicoma River, 1955-1981.....	4-3
Figure 4-3. Relationship between peak flow and recurrence interval, West Fork Millicoma River...	4-3
Figure 4-4. Upstream extent of perennial flow in the Fish Creek watershed, July 1999.	4-5
Figure 5-1. Variation in maximum water temperature with distance from drainage divide for 13 West Fork Millicoma sites.	5-4

Table of Contents (continued)

Figure 5-2. Comparison of DEQ and ODFW shade integrated 2 miles upstream of the gauge sites.	5-6
Figure 5-3. Predicted increases in 7-day maximum water temperature for West Fork Millicoma sites.	5-7
Figure 5-4. Variation in maximum water temperature with distance from drainage divide for seven Tenmile sites.	5-8
Figure 5-5. Variation in ODFW shade with active channel width along fish-bearing streams.....	5-9
Figure 5-6. Seasonal changes in nitrate concentrations for three streams draining from the Forest to Tenmile Lake.	5-11
Figure 5-7. Downstream trend in water temperature for Meacham Creek, an eastern Oregon stream that has abundant gravel.....	5-21
Figure 6-1. Rainfall-runoff relationships in the West Fork Millicoma River.	6-4
Figure 6-2. Landslide density (top) and erosion (bottom), not related to roads, for three areas of sandstone geology in the central Coast Range and one area of basalt geology in the Cascade Mountains following intense rainfall in December and February 1996.....	6-13
Figure 6-3. Distribution of slope steepness at landslide initiation point and distance traveled to fish- bearing stream for upslope landslides inventoried after the 1996 storms.	6-16
Figure 6-4. Road miles by surface type and 5th field HUC.....	6-34
Figure 6-5. Number of Forest road crossings with diversion potential by ditch length class.	6-37
Figure 7-1. The acreage of non-forested areas by type and by stream size for the Coos, Umpqua, and Tenmile regions of the Forest (fish-bearing streams only).	7-3
Figure 7-2. The percent riparian stand type by stream size for the Coos, Umpqua, and Tenmile regions of the Forest (fish-bearing streams only).....	7-5
Figure 7-3. The percent riparian stand age by stream size for the Coos, Umpqua, and Tenmile regions of the Forest (fish-bearing streams only).	7-7
Figure 7-4. Relationship between stand density and age for conifer-dominated, conifer/hardwood, and hardwood-dominated stands. The regression line for conifers is shown as a solid line and as a dashed line for hardwoods.	7-10
Figure 7-5. Relationship between stand basal area and age for conifer-dominated, conifer/hardwood, and hardwood-dominated stands. The regression line for conifers is shown as a solid line and as a dashed line for hardwoods.	7-11
Figure 7-6. Relationship between mean diameter (DBH) and age for conifer-dominated, conifer/hardwood, and hardwood- dominated stands.	7-12
Figure 7-7. Large wood in undisturbed streams bordered by stands 88-408 years old on BLM ownership south and east of the Forest (Ursitti 1990).	7-14
Figure 7-8. Relationship between logjam height and logjam volume.....	7-15
Figure 7-9. Wood volume in logjams during 1960s surveys versus total wood volume in streams during current surveys. Also shown is total wood volume in undisturbed streams bordered by mature timber (88-118 years old) for nearby BLM land.....	7-16
Figure 7-10. Large wood volume in Forest streams, by region, as compared to the volume of wood in BLM reference streams.	7-18
Figure 7-11. An illustration of how streamside stands were characterized using the GIS coverage of fish-bearing streams within the Forest. Filled circles indicate points along transects (spaced 50 feet) with 400-foot-long spacing between transects.	7-21
Figure 7-12. The probability of a tree landing in the stream as a function of its relative distance from the stream for observed fall patterns (Andrus and Froehlich 1992).....	7-22
Figure 7-13. Proportion of wood volume remaining as a function of time for conifer and hardwood logs in streams.....	7-23

Table of Contents (continued)

Figure 7-14. Modeled changes in conifer and hardwood wood volume for streams bordered by conifer-dominated, conifer/hardwood, and hardwood-dominated stands (assumes wood from the previous stand does not persist beyond year 30.).....	7-25
Figure 7-15. Modeled net volume of large wood in streams and the distance class from which it originated.	7-26
Figure 7-16. The positions for large wood of various decay classes along a decay curve where the k factor is 0.03 (smaller conifers).	7-27
Figure 7-17. Calculated decline in initial wood volume over time for the average Forest stream, as a composite of three decay classes.....	7-28
Figure 7-18. Modeled large wood in streams combining the wood initially in the stream at time of stand initiation (assumes a Forest-wide average of 193 cu. ft. per 100 ft.) plus the wood added by the developing streamside stand.....	7-28
Figure 7-19. Stand type and age for Deer Creek, 2,800 feet upstream of the mouth.	7-29
Figure 7-20. Current and projected large wood in Forest streams by analysis basin.	7-32
Figure 7-21. Differences in large wood for streams with 150- and 200-foot-wide buffers.	7-33
Figure 7-22. Comparison of retaining hardwood-dominated stand within 150 feet of stream versus retaining only first 50 feet and establishing new plantation beyond 50 feet.	7-35
Figure 7-23. Modeled levels of wood in streams where the combination of wood falling from the streamside stand and placed wood is used to maintain a given amount of wood through time. ...	7-37
Figure 7-24. Rule-of-thumb proposed by Benda and Cundy (1990) for estimating the downstream extent of landslide travel.	7-38
Figure 7-25. Stream segments and draws for a tributary of Cougar Creek with information needed to prioritize draws according to the likelihood of landslides reaching fish-bearing stream segments and the relative amount of large wood and boulders likely to accumulate.	7-41
Figure 8-1. Annual estimates of wild coho spawner abundance for stream systems within the mid-south coast and lower Umpqua management areas, 1990-2001.	8-13
Figure 8-2. Palouse and Larson Creek (Coos Bay tributaries) spawning survey numbers for adult and jack coho salmon, 1950 to 2002.....	8-13
Figure 8-3. Number and species of amphibians in nine pairs of streams flowing through clearcuts with riparian buffer strips and late-seral forests (>80 years old).	8-22
Figure 8-4. Miles of Forest streams with aquatic habitat inventories.	8-24
Figure 8-5. Miles of streams inventoried by gradient class for each region.	8-25
Figure 8-6. Pools deeper than 3.3 feet and complex pools for streams less than 2% gradient and active channel width less than 40 feet for streams by region.	8-27
Figure 8-7. Percent pools for streams less than 2% gradient and active channel width less than 40 feet for streams by region.....	8-28
Figure 8-8. Pools deeper than 3.3 feet and complex pools for streams between 2.1% and 4% gradient and active channel width less than 40 feet by region.	8-29
Figure 8-9. Percent pools for streams between 2.1% and 4% gradient and active channel width less than 40 feet for streams by region.....	8-30
Figure 8-10. Pools deeper than 3.3 feet and complex pools for streams less than 2% gradient and active channel width more than 40 feet for streams by region.....	8-31
Figure 8-11. Percent pools for streams less than 2% gradient and active channel width more than 40 feet for streams by region.....	8-32
Figure 8-12. Average percent gravels for inventoried reaches by region.	8-33
Figure 9-1. Most common (>1%) bird species observed from riparian areas.....	9-3

Table of Contents (continued)

Map Section

- Map 1.1 Study Area
- Map 2.1 Ecoregions
- Map 2.2 Watershed Analysis Basins
- Map 2.3 Topography
- Map 2.4 Slope Steepness with Terrain Features and Faults
- Map 2.5 Soil Types
- Map 2.6 Average Annual Precipitation, 1961-1990
- Map 2.7 Streams and Lakes
- Map 2.8 Channel Habitat Type
- Map 2.9 Land Ownership
- Map 3.1 Historic Locations of Large Wood Debris Sites and Stream Substrate Survey Reaches, 1950-1967
- Map 3.2 Early Roads in the Elliott State Forest
- Map 4.1 50-year Peak Flow Values for Streams
- Map 4.2 Consumptive Water Use within ½ Mile of Elliott
- Map 4.3 Instream Water Rights
- Map 5.1 Water Quality Limited Streams and Lakes
- Map 6.1 Topographic Stability Model on the Elliott State Forest
- Map 6.2 Road-related Landslides 1997-1998
- Map 6.3 Road Landscape Position and Road Surface Types
- Map 6.4 High-gradient Roads Traversing Steep Terrain in the Elliott State Forest
- Map 6.5 Ditch Lengths, Sediment Transport, and Road Wash at Stream Crossings in the Elliott
- Map 7.1 Riparian Vegetation Types, Watershed Analysis Basin #4
- Map 7.2a Large Wood Volume in Fish-bearing Streams – Current and Projected (200 Years from Present), North Elliott State Forest
- Map 7.2b Large Wood Volume in Fish-bearing Streams – Current and Projected (200 Years from Present), Central Elliott State Forest
- Map 7.2c Large Wood Volume in Fish-bearing Streams – Current and Projected (200 Years from Present), South Elliott State Forest
- Map 8.1 Fish-bearing Streams
- Map 8.2 Roads within 100 feet of Stream
- Map 8.3 Restoration Projects, 1995-2002
- Map 8.4 Juvenile Coho Pool Density, 1998-2002
- Map 8.5 Aquatic Habitat Survey Extent
- Map 8.6 Low-gradient Stream Channels
- Map 8.7 Stream Restoration Opportunities
- Map 8.8 High Quality Streams
- Map 9.1 Land Allocations for Northern Spotted Owl Protection in the Elliott State Forest
- Map 9.2 Spatial Arrangement of Marbled Murrelet Management Areas (MMA) and Mapped Marbled Murrelet Habitat
- Map 9.3 Existing Land Allocation for Reserves in the Elliott State Forest
- Map 9.4 Stand Age Classes
- Map 10.1 Distribution of Introduced Plants on the Elliott State Forest