Chapter 4. Stream Flow and Water Quantity

STREAMFLOW CHARACTERISTICS

Water Yield and Peak Flows

The influence of timber harvest and roads on the timing and quantity of stream flow has received considerable attention during the last decades. Studies show that clearcut harvesting usually *increases* the summer flow of streams because of the absence of vegetation that had previously transpired water from the soil and intercepted rainfall. For example, a paired-watershed study of small drainages in the central Coast Range showed that annual minimum streamflow increased about 60% following complete clearcut harvest and broadcast burning of a small drainage (Harr and Krygier 1972). Minimum streamflow gradually dropped to pre-harvest levels as trees and brush grew back (about 15 years). Another nearby small watershed, this one 25% clearcut, showed little change in summer streamflow. Similarly, the complete clearcut harvest of one small watershed and the shelterwood harvest of 60% of another small watershed in the northern Cascades resulted in fewer low-flow days after logging (Harr et al. 1982). Further south in the central Cascades, August water yield increased an average of nearly 60% following clearcut harvest and burning of about one-quarter of a small watershed and then returned to normal levels as the watershed revegetated (Hicks et al. 1991). For a watershed in northwest California where 67% of the timber had been removed, the number of low-flow days over the summer decreased an average of 40% (Keppeler and Ziemer 1990).

In some studies, the peak flows of small streams during the rainy season have been shown to increase following complete clearcutting and intensive broadcast burning (Harr et al. 1975). Most other studies on watersheds, where no or less-intensive burning followed clearcutting or where they were in different climates, showed no meaningful increases in peak flows (Harr et al. 1982, Wright et al. 1990, Thomas and Megahan 1998). Where they occur, peak flow increases are associated with lesser recurrence intervals (i.e., less than average annual peak flow) and not for large floods (Beschta et al. 2000). Increases in peak flow for small, headwater basins do not necessarily translate to similar increases in larger streams. This is because peak flow increases in small basins become muted in a downstream direction since not all small streams throughout a watershed peak at once, and rarely are all small basins in a watershed harvested at once (Duncan 1986, Perkins 1997).

The only gauging site within or near the Forest with a record long enough to sufficiently evaluate stream flow characteristics is in the lower West Fork Millicoma River. No gauging information on basins of similar size, which experienced little or no timber harvest during the last 30 years, exists for the central or southern Oregon Coast. Consequently, there was not a control watershed that would allow examination of how flows in the West Fork Millicoma may have changed over several decades of road construction and timber harvest.

The West Fork Millicoma River gauging site was operated by the USGS from 1955-1981 (27 years of record) and was reactivated by the Coos Watershed Association in 2002. Only

the 1955-1981 flow records are used in this analysis. Nearly all of the land upstream of the West Fork Millicoma River gauge is within the Forest [46.9 square miles (sq. mi.)] and precipitation in this basin is typical of the Forest. Streams flowing from the western edge of the Forest may have slightly different flow characteristics; summer flows in these streams may not be as low due to their proximity to moist, marine air and diminished solar radiation due to persistent fog. Water withdrawals upstream of the gauging site were either small or non-existent during the period of record. The gauge is located near the boundary between the Forest and private ownership.

Monthly and annual instantaneous peak flow data [reported as cubic feet per second (cfs)] for the West Fork Millicoma River were obtained from the USGS web site. Because the annual peak flow value for water year 1980 seemed erroneously low in the digital record (115 cfs vs. 1,830 cfs for the next highest value), this year was not used in the analysis of peak flows. The log-Pearson Type III distribution of extreme events was used to evaluate peak flows associated with various recurrence intervals. The skew was determined from the flow record rather than using published regional values.

Streams in the Forest experience a period of extended low flow from June through September. The average flow in December, the month with the highest runoff, was 65 times greater than the average flow in August, the month with the lowest runoff (Figure 4-1). The flow in West Fork Millicoma River during August averaged 10 cfs, but during droughty summers (1958, 1966, 1967, 1970, 1972), August monthly flows dipped to nearly 3 cfs (Figure 4-2).

Figure 4-1. Average monthly flows for the West Fork Millicoma River.

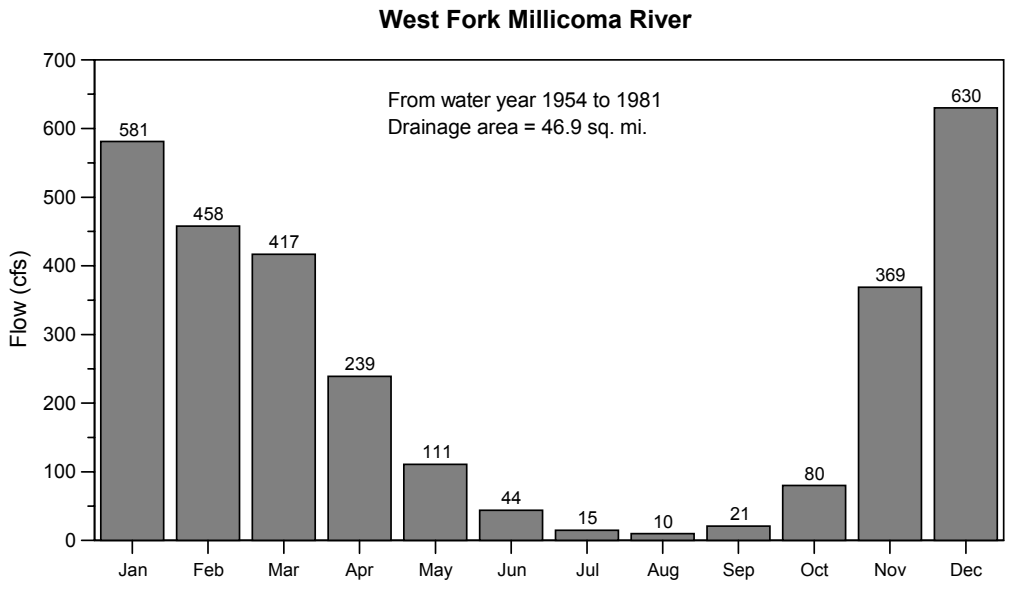
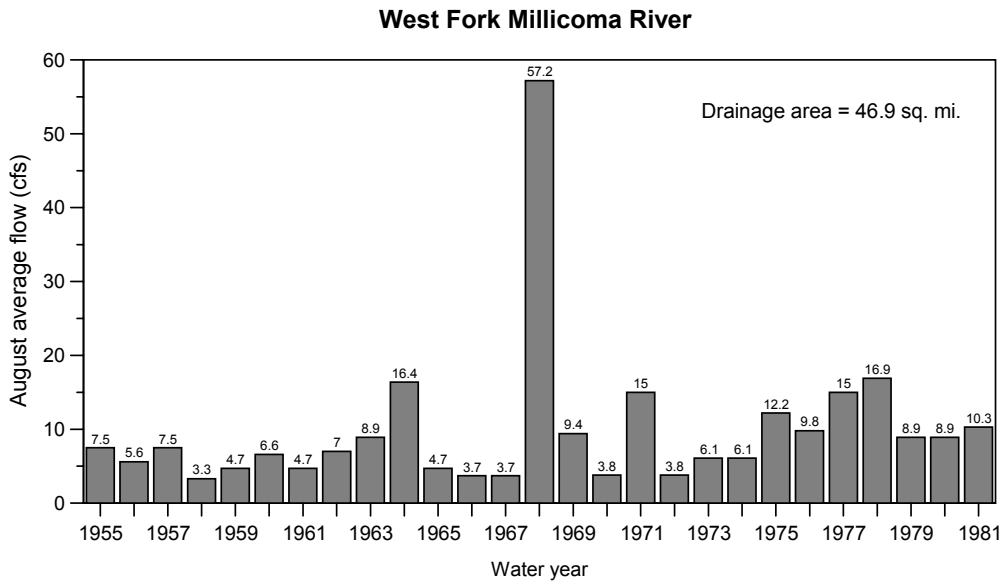
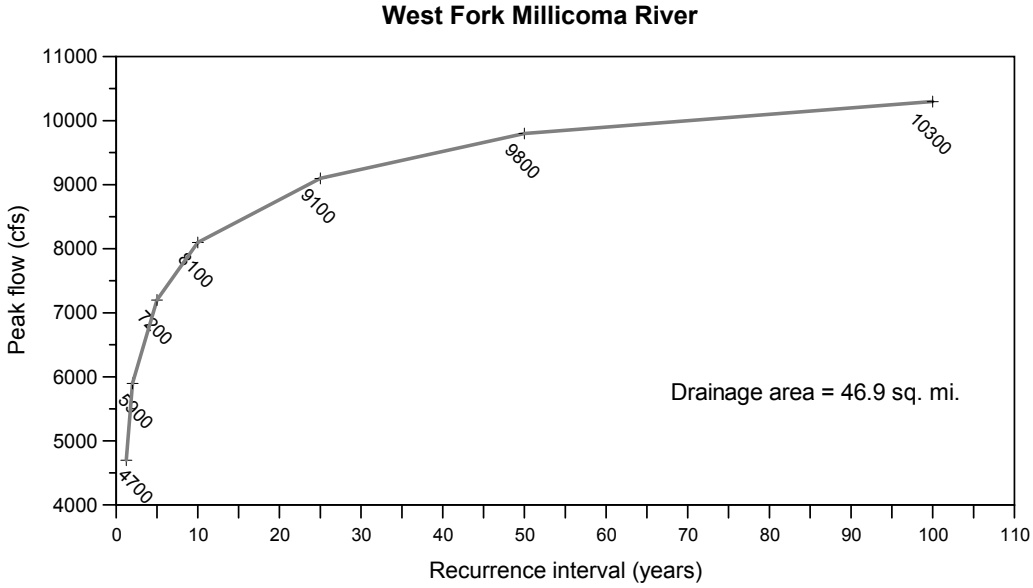


Figure 4-2. Average August flows for the West Fork Millicoma River, 1955-1981.



The peak flow associated with the 50-year recurrence interval was 9,800 cfs or a unit flow of 208 cfs per square mile of drainage area for the West Fork Millicoma River (Figure 4-3). This is typical for lower elevation mountains of the central Coast Range and agrees with the 50-year unit flow map that was prepared in 1994 by the ODF. Map 4.1, located in the map section, shows the 50-year peak flow values for streams in the study area.

Figure 4-3. Relationship between peak flow and recurrence interval, West Fork Millicoma River.



No peak flow events in the West Fork Millicoma River record stand out as unusually high. Even the floods in 1972 and 1965, abnormally high events elsewhere in western Oregon, were not unusually high in the West Fork Millicoma River record. As a result, the curve defining peak flow and recurrence interval is oddly flat at recurrence intervals greater than 10 years. The flow associated with the 100-year recurrence interval is only 13% greater than the flow associated with the 25-year recurrence interval. An analysis of streams with long-term records elsewhere in the Coast Range indicates that the magnitude of the 100-year recurrence interval flow averages 38% greater than the 25-year recurrence interval flow. The stage/rating curve for the West Fork Millicoma River may have been incorrect for the highest of flows.

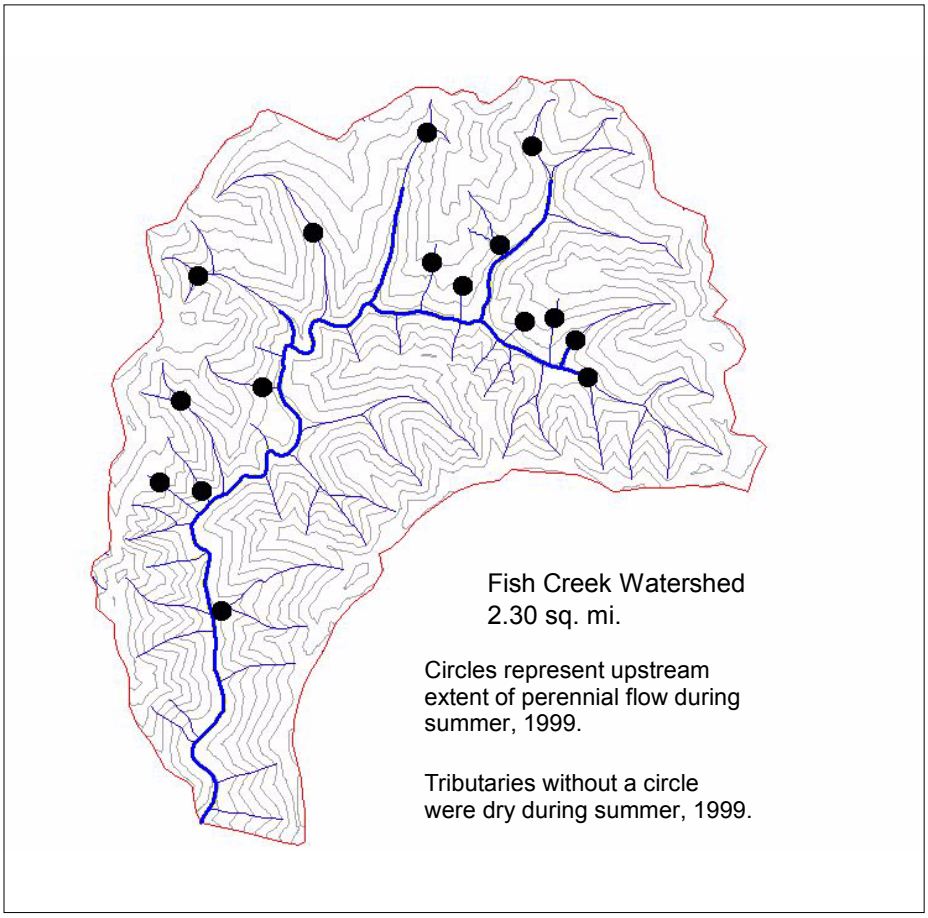
Perennial and Intermittent Flow

The determination of which stream segments have water and which are dry during the summer has had special importance for Forest staff because buffers of large trees have been retained along perennial streams but not seasonal streams. When a timber harvest unit was planned, the absence or presence of summer flow needed to be checked during the summer to determine its status. Large-scale planning of timber harvest units and evaluation of alternative stream protection measures were hampered by the inability to estimate in advance whether or not streams were perennial. This section summarizes the results of a study conducted by Forest staff to determine whether or not perennial streams can be identified by using simple measures such as drainage area, aspect, and distance from the drainage divide.

The Fish Creek watershed was selected for study. It is located in the upper one-half of the West Fork Millicoma River watershed and drains to the south. Fish Creek has a drainage area of 2.3 square miles and its conditions are typical for the Forest. The watershed contains 38 tributaries or draws that feed directly into fish-bearing streams (Figure 4-4). Many of these 38 channels have tributaries to them. Field surveys in July 1999 provided information on where the most upstream extent of perennial flow in the watershed. The watershed area and distance from divide were determined from topographic maps for each tributary at the most upstream extent of perennial flow and for tributaries with no flow.

No association between drainage area and upstream extent of perennial flow was found for the Fish Creek watershed (Figure 4-4). The same was true for the distance from drainage divide. Only one tributary in the southeast one-third of the watershed had perennial flow. The scarcity of summer flow in this part of the watershed may be due to the low elevation and generally west aspect. While much of the upper portion of the basin also faces towards the sun during the hottest part of the day, the high ridge forming the upper basin boundary may be an enhanced source of groundwater. There was no pattern between stand age and where tributaries were perennial.

Figure 4-4. Upstream extent of perennial flow in the Fish Creek watershed, July 1999.



There was perennial flow within some tributaries that had only a few acres of drainage area, as measured from topographic maps. Therefore, groundwater movement in this geology may not necessarily be associated with surface topography. Field observations indicate that water often surfaces at boundaries between sandstone beds where relatively porous siltstone is found. If much of the summer groundwater is carried along these weak layers, even a slight dipping in the strata may transfer flow from one topographic basin to the next.

Results from the Fish Creek study suggest that easy and reliable means do not exist to remotely predict whether or not a tributary has summer flow. The current practice of verifying the presence of water in small streams by field survey is probably the only practical solution.

CONSUMPTIVE WATER USES

Adjacent landowners commonly use water from streams flowing from forestland for irrigation, domestic use, and the filling of ponds. Some landowners may have water rights issued by the Oregon Water Resources Department (WRD) and others may use the water

illegally. The enforcement of water use laws in Oregon is mostly complaint driven and illegal uses are rarely discovered until there is a complaint laying claim to the water. In addition to a water use permit, a deed of water conveyance is required wherever the point of diversion is not on the same property as the user. This deed provides proof that an arrangement has been made with any adjacent landowners to convey water across their land from its extraction point to the place of use. Oregon water law also has a provision that for most water rights, the right expires if it is not used for any five consecutive years. Again, enforcement of this provision is complaint-driven and unused water rights may languish for decades without being cancelled. In this section, the analysis team explores the spatial pattern of surface water rights and the location of dwellings adjacent to the Forest, in order to better understand the magnitude of potential conflicts over water quantity and use between the Forest and its neighbors.

All buildings near the Forest boundary were mapped using USGS 7.5 minute topographic maps. Most of the maps covering the Forest were updated in 1985, although the map covering the southwest corner dated to 1971. The mapped buildings were limited to those within a half-mile downstream of the boundary and close enough to a stream channel that extraction of water via gravity was an option. Aerial photographs from 2002 were used to add new buildings constructed since the topographic maps were created, and delete buildings from lands that have come into Forest ownership since that time.

Barns and out-buildings were excluded as much as possible. This was often difficult since trailer houses often can be indistinguishable from out-buildings. In addition, many rural houses are small or disguised by trees. The pattern of driveways and other roads sometimes allowed distinguishing houses from barns and out-buildings in the aerial photographs.

Water right locations and information were obtained from the WRD and points of diversion were plotted. No attempt was made to match individual domestic water use permits with individual houses because this requires looking up detailed records for each permit, and water rights location information is usually incomplete for older rights.

There are 141 dwellings within one-half mile of the Forest boundary that could potentially receive surface water from streams exiting the Forest. Within this same zone, 167 surface water rights exist for purposes of domestic use, irrigation, and pond filling. Most diversion points are outside of the Forest, although the coarseness at which some diversion points are mapped makes it difficult to determine the exact location of many of the rights.

Houses within one-half mile of the Forest are often clumped along terraces in the valley bottoms. The locations of water permits for domestic use and irrigation generally correspond with locations of houses (see Map 4.2). Nevertheless, some individual houses or groups of houses are far from a surface water right extraction point. Some of these houses may have an alternative water source. Houses along the broad terraces of the two large rivers (West Fork Millicoma River, Mill Creek) may be able to get water from wells. Also, many of the houses along the Umpqua River are probably served by a community water system. Houses with no nearby surface water permit and no obvious alternative sources of domestic water occur on the west and east fringes of the Forest.

Because of incomplete information on water rights and individual house locations, it was not possible to make a detailed accounting of where water flowing from the Forest was being used by neighboring landowners. In general, individual water rights were small (usually a maximum use rate of 0.01 cfs or less), with only several larger water rights issued for purposes of irrigation.

The number of households along the Forest fringe that use water from streams and springs is relatively high along the east and west boundaries. These are not areas with much current timber harvest activity since the western slopes are designated as long rotation basins and the timber along the eastern boundary is still relatively young. Nevertheless, there are inherent conflicts with future timber harvest and downstream use of water for domestic purposes. Short-term increases in turbidity following road building or timber harvest can occur and make drinking water unusable or distasteful, especially considering that many rural households have rudimentary or non-existent water treatment systems. Water diversion structures and surface pipes can get crushed when trees are felled in harvest units. In addition, there are real and perceived issues concerning human health when herbicides are applied within drainages that are also used for domestic water.

The Forest is legally allowed to deny use of water from a stream or spring by a neighbor if the diversion point is on Forest property and the neighbor has no deed of conveyance or water right. Nevertheless, the long-term custom of forest landowners in the Coast Range is to avoid unnecessary conflict over water uses. Short of a detailed and comprehensive field study on neighboring residents and their source of domestic water, the Forest likely will need to resolve any potential water use problems on a case-by-case basis.

WATER USE BY THE ELLIOTT STATE FOREST

Water is used on managed forestland for fighting fire and to provide a source for filling herbicide application tanks and dust abatement trucks. Typically, small dams or road fills are constructed to pond water in areas with springs and small tributaries, or water is extracted directly from larger streams. Collectively, these are referred to as pump chances. Water use permits issued by the WRD are required for the storage and use of water for these purposes. Each point of diversion is assigned a maximum storage rate (in acre-feet) or use rate (in cfs), although the actual consumption of water for forest management is invariably small and infrequent.

A recent inventory throughout the Forest indicates that 115 pump chances exist. Only 17 of these pump chances have a water use permit or certificate issued by the WRD (Table 4-1). Filing for permits for the remaining pump chances involves hiring a water rights examiner to map and document the water use. Nearly all streams on the Forest are closed to further water allocation due to instream water rights (see next section); however, since pump chances involve little actual consumption of water, they may be approved by the WRD. Since pump chances are often heavily used by wildlife, especially amphibians, a water use permit application that includes both forest management and wildlife purposes may increase the likelihood of approval.

Table 4-1. Elliott State Forest water rights.

ID#, Priority Date, Use	Name	Maximum Storage or Use	Location
#69165 1/1/1993 Forest Management	Scholfield Ridge Reservoir	0.21 acre-ft	NW1/4 SW1/4 SEC35, T22S, R11W
	Bickford Ridge Reservoir	0.46 acre-ft	SE1/4 SW1/4 SEC22, T23S, R10W
	Footlog Ridge Reservoir	0.18 acre-ft	NE1/4 SW1/4 SEC22, T22S, R10W
	Salander Creek Reservoir	0.97 acre-ft	NW1/4 NE1/4, SEC10, T23S, R10W
#69166 1/1/1993 Forest Management	Big Saddle Reservoir	0.13 acre-ft	SEC6, T24S, R10W
	Beaver Point Reservoir	0.09 acre-ft	SEC2, T24S, R11W
	Trail Buhe Reservoir	0.58 acre-ft	NE1/4 SW1/4, SEC8, T24S, R11W
	Elk Wallow Reservoir	0.57 acre-ft	SW1/4 SW1/4, SEC25, T22S, R11W
	Elk Peak Reservoir	0.06 acre-ft	NW1/4 SE1/4, SEC29, T23S, R10W
	Elkhorn Ridge Reservoir	0.15 acre-ft	NE1/4 SW1/4, SEC24, T23S, R11W
#S53234 6/10/1994 Forest Management	Scholfield Creek	0.7 cfs	NW1/4 SW1/4, SEC35, T22S, R11W
	Mill Creek	0.7 cfs	NE1/4 SW1/4, SEC22, T22S, R10W
	Unnamed trib. to Matson Creek	0.7 cfs	SE1/4 SW1/4, SEC22, T23S, R10W
	Unnamed trib. to Salander Creek	0.7 cfs	NW1/4 NE1/4, SEC10, T23S, R10W
#S53235 6/10/1994 Forest Management*	Unnamed trib. to W. Fk. Millicoma R	0.7 cfs	SEC2, T24S, R11W
	Schumacher Creek	0.7 cfs	NE1/4 SW1/4, SEC8, T24S, R11W
	Elk Creek	0.7 cfs	NE1/4 SW1/4, SEC24, T23S, R11W

* Also recreation and wildlife

INSTREAM WATER RIGHTS

Instream water rights exist on 23 streams that flow partially or completely across the Elliott State Forest (Map 4.3, Table 4-2). Instream water rights are used to retain water within streams to benefit fish and other aquatic life. Most of the larger fish-bearing streams on the Forest have instream water rights. These rights were granted to the ODFW from 1974-1992. As is true for all other types of water rights, instream water rights have priority dates and are superceded by more senior water rights. Since most of the instream water rights were granted in 1990 and 1992, older consumptive water rights usually control the amount of water in streams during the summer. Nevertheless, the existence of instream water rights on these streams has largely prevented any further allocation of water, especially during the summer. However, the WRD can continue to grant domestic water rights (usually less than 0.01 cfs) for streams that are otherwise closed to further allocation.

Table 4-2. Instream water rights for streams partially or completely within the Forest.

Region	Stream	Priority Date	Minimum cfs in Fall	Minimum cfs in Winter	Location of Instream Right
Tenmile	Wilkins	1992	0.2	13.9	from headwaters (NWSW sec 25, T.22S, R.12W) to mouth
Tenmile	Murphy	1992	0.5	17.0	from headwaters (SWSW sec 29, T.22S, R.11W) to mouth
Tenmile	Big	1992	2.1	26.0	from tributary (NWNW sec 4, T.23S, R.11W) to mouth
Tenmile	Noble	1992	0.5	12.0	from headwaters (SWNE sec 8, T.23S, R11W) to mouth
Tenmile	Benson	1992	1.3	60.4	from tributary (NE1/4 sec 16, T.23S, R.11W) to mouth
Tenmile	Roberts*	1992	1.1	17.0	from tributary (NWSW sec 21, T.23S, R.11W) to mouth
Tenmile	Johnson	1992	2.8	17.0	from tributary (SESW sec 31, T.23S, R.11W) to mouth
Tenmile	Robertson	1992	0.1	3.8	from headwaters (NE1/4 sec 35, T.23S, R.12W) to mouth
Tenmile	Adams	1992	0.5	9.0	from tributary (SESE sec 28, T.23S, R.12W) to mouth
Coos	Palouse**	1990	1.5	26.0	from tributary (SWNW sec 10, T.24S, R.12W) to mouth
Coos	Larson	1990	1.5	26.0	from Sullivan Creek to mouth
Coos	Sullivan	1992	0.3	14.0	from headwaters (SE1/4 sec 23, T.24S, R.12W) to mouth
Coos	W.F. Millicoma (upper)	1990	3.1	100.0	from headwaters (sec. 16, T.23S, R.10W) to Deer Cr
Coos	W.F. Millicoma (lower)	1990	7.1	155.0	from Deer Creek to mouth
Coos	Deer	1992	0.5	26.0	from tributary (SE1/4 sec 2, T.23S, R.11W) to mouth
Coos	Knife	1992	0.4	17.0	from tributary (SE1/4 sec 31, T.22S, R.10W to mouth
Coos	Fish	1992	0.3	17.0	from headwaters (NE1/4 sec 5, T.23S, R.10W) to mouth
Coos	Elk	1992	1.0	43.0	from tributary (SE1/4, sec 24, T.23S, R.11W) to mouth
Coos	Marlow	1992	0.7	31.7	from tributary (NW1/4, sec 23, T.24S, R.11W) to mouth
Coos	Glenn	1992	2.1	85.0	from Silver Creek to mouth
Umpqua	Mill	1974	20.0	130.0	from Camp Creek to mouth
Umpqua	Dean	1974	2.0	20.0	from Hakki Creek to mouth
Umpqua	Scholfield	1974	2.0	20.0	from Oar Creek to mouth

*Roberts Creek also has an instream water right with a priority date of 1980; it applies throughout its main channel and tributaries. The amounts are 1 cfs in the fall to 10 cfs in the winter.

**Palouse Creek also has an instream water right with a priority date of 1980; it applies to a point near the mouth at tidewater (sec 25, T.24S, R.13W). The amounts are 2 cfs in the fall to 15 cfs in the winter.

Mill, Dean, and Scholfield Creeks have instream water rights with a priority date of 1974, while instream water rights for Roberts and Palouse Creeks date to 1980. These latter two streams also have 1990 or 1992 instream rights that are only slightly different than the 1980 versions. All other instream water rights date to 1990 or 1992. The permits specify minimum streamflow to be maintained in the stream (after satisfying all other senior rights) and these vary by month, with higher flows in the winter and lower flows in the summer and fall (Table 4-2). Like all other water rights, enforcement of instream water rights is largely complaint driven. The WRD has no program to determine the summer flow of streams on the Forest or ensure that junior water rights do not infringe on the maintenance of instream flows downstream of the Forest.

ANALYSIS

Summer Flow

Research on Pacific Northwest streams indicates that clearcut harvesting increases summer flows rather than decreases flow. Since summer base flows in Pacific Northwest streams are naturally low due to a scarcity of rain from June to September, increases in summer flow due to tree removal can be viewed as a benefit to fish and aquatic amphibians. The extra flow provides more living space for aquatic animals and the greater water depth helps moderate temperature increases. Since the increases in flow are not enough to create measurable increases in water velocity, aquatic animals are not negatively affected. Timber harvesting can have other influences on streams that could counteract the benefits of more water in the stream during summer.

Peak Flow

Research on Pacific Northwest streams indicates that increases in peak flows due to clearcut harvest and road building are minor for lower-elevation terrain and where harvest units do not experience hot broadcast burns. Increases in peak flow, where they do occur, are limited to minor runoff events; the magnitude of large floods is not affected. Any measurable increases in peak flow due to clearcut harvest and road building occur only in very small watersheds. In larger streams, the contributions from smaller subwatersheds, some of which may have increased peak flows and some with intact timber, results in a muted response since the timing of the maximum flow for the various subwatersheds is rarely synchronized for any given storm. Furthermore, any increase in peak flow due to clearcut harvesting is short-lived (less than 15 years) due to regrowth of brush and trees.

Seasonal Flow

The ODF pilot study to remotely identify perennial streams in the Fish Creek watershed indicates that predicting which stream segments have water during the summer is not possible using readily available information such as watershed area, aspect, vegetation, or distance from drainage divide. Sedimentary deposits on the Forest, consisting of thick blocks of non-porous sandstone separated by thin layers of porous siltstone, result in groundwater movement that does not necessarily correspond to topographic features.

Consumptive Water Uses

Water rights for consumptive uses of water are common (167 diversion points) along the fringe of the Forest, as are dwellings (141) located within one-half mile of its boundary. Inaccuracies in the mapping of points of diversion for each water right and uncertainty about which water right corresponds to which dwelling prevents the construction of a water use budget for each stream flowing from the Forest. Nevertheless, water use is generally small and limited to domestic use and the irrigation of scattered parcels of pastureland.

Without a detailed field investigation of individual water rights, it is not possible to determine where water diversions occur on the Forest. However, Map 4.2 suggests that most water diversions occur downstream of the Forest boundary. Although some illegal water diversions probably exist along the Forest fringe, few have been encountered by ODF over the last decades due, in part, to a general lack of timber harvest activity along the fringe.

Water diversions from streams and springs within the Forest boundary, both legal and illegal, create a challenge for Forest staff. The planning of timber harvest units near the Forest boundary is complicated by the need to protect water diversion infrastructure for legal water uses and by public relations challenges encountered when dealing with people who have illegal diversions.

Water Use by the Elliott State Forest

Currently, only 17 of 115 pump chances on the Forest have a water use permit or certificate issued by the WRD. A permit or certificate is required for each pump chance. The process of obtaining permits for the remaining pump chances involves some expense because a water rights examiner must be hired and the fees charged for each application. Also, approval of these applications may be complicated by the existence of instream water rights that may prevent further water allocation on most Forest streams.

Instream Water Rights

Most of the larger fish-bearing streams on the Forest have instream water rights. However, these rights have relatively recent priority dates. This means that actual flow levels in streams are controlled mostly by the more senior rights associated with consumptive uses. Nevertheless, the instream water rights eliminate further allocation of water for the low flow season, except for small domestic uses (0.01 cfs or less). As is true throughout the state, the measurement of summer stream flows and enforcement of instream water rights occurs infrequently, and will probably remain so because of limited staff within the WRD.

RECOMMENDED ACTIONS AND MONITORING

Summer Flow

The analysis team has no recommended actions or monitoring suggestions on the issue of summer flow increases from timber harvest because such increases in flows are a benefit to fish and aquatic amphibians.

Peak Flow

The analysis team has no recommended actions or monitoring suggestions on the issue of peak flow increases from timber harvest and road construction because: (1) increases are not likely to occur; (2) any increases that do occur are minor considering the climatic conditions on the Forest; and (3) hot broadcast burning does not occur on the Forest.

Seasonal Flow

The analysis team recommends that any further efforts to predict summer flow patterns throughout the Forest be suspended since the pilot study on Fish Creek suggests that little understanding can be gained using readily available parameters such as watershed area, distance from drainage divide, vegetation, and aspect. Instead, the analysis team recommends that the current practice of verifying the presence of water in small streams by field survey be continued. No monitoring is recommended other than documenting the results of summer field investigations of streams within proposed timber harvest units.

Consumptive Water Uses

The analysis team recommends that the current practice of using field investigations to determine the presence of legal and illegal water diversions on proposed harvest units be continued. There does not seem to be a need for a detailed Forest-wide evaluation of water diversions along the Forest fringe.

Forest staff could consider working with the WRD to set up a well-publicized effort to convert any illegal water diversions within the Forest boundary to legal uses. Since most of these diversions are probably for domestic uses and involve only small amounts of water use (less than 0.01 cfs), there would likely be little problem in granting these water rights even though senior water rights exist and often result in an over-appropriation of water. As water uses are discovered on the Forest, staff should insist (as required by Oregon water law) that the user file for a deed of water conveyance with the WRD, if none already exists. Also, Forest staff could consider refusing any new deeds of water conveyance where the point of water occurs on the Forest, and instead encourage those who are requesting a water right to locate the diversion point downstream of the Forest boundary. This would simplify the process of planning for future harvest units along the Forest fringe and relieve the need to protect water diversion infrastructure during timber harvesting.

Pump Chances

The analysis team recommends that the ODF obtain water use permits/certificates from the WRD for the 98 pump chances that do not have a permit/certificate.

Instream Water Rights

The analysis team has no recommended actions or monitoring suggestions on the issue of instream water rights. The measurement of streamflow and enforcement of water use lies with the WRD.