# Appendix D: Cumulative Watershed Effects Analysis Using R-5 ERA Model

## Assumptions and ERA Coefficients used for Travel Management Assessment

The Forest Service in Region 5 has adopted the Equivalent Roaded Acres (ERA) model as a method of addressing cumulative watershed effects. This model is designed as a preliminary indicator for managers to determine whether or not past and present land management disturbances in a given watershed approach or exceed a threshold of concern (TOC). Where ERAs approach or exceed a given watershed's TOC, further field work would be necessary to ascertain whether cumulative watershed effects are present and if land management activities would adversely add to those effects and result in detrimental impacts to beneficial uses.

The ERA methodology has both strengths and weaknesses. The analysis is readily duplicated and easily understood. It also incorporates rates of management disturbance and recovery times associated with those disturbances, an attribute which is missing in many other CWE models. On the other hand, it is only an office exercise based on management-related hill slope disturbance. It also does not address physical or biological processes in stream channels, nor does it account for the time lag associated with routing sediment delivered from a given activity. Recovery times in the ERA model apply only to onsite treatments, not to recovery of downstream impacts. When applying ERAs to grazing activities, many assumptions must be made that are perhaps overly simplistic. Livestock grazing is not a static activity as in the case of timber sales; and cattle move freely, so assumptions as to livestock grazing in riparian areas or grasslands are a best guess based on professional judgment.

### ERA Calculations

The CWE ERA analysis for the Travel Management Project was conducted on all lands within the affected watersheds (Public and Private lands). The CWE ERA model was adapted slightly to incorporate GIS information on hillslope positions and proximity to riparian reserves where appropriate. The methods used to calculate %ERAs for past and present land management activities are described below. The coefficients used in the ERA calculations are listed in tables 1 through 10, which includes the rational for assigning of coefficients.

## ERA Equations and Coefficients for Existing and Current Land Management Activities

### Timber Harvest

The timber harvest ERA is calculated using the following formula:

**ERA = [Acres Harvested] x [Logging System Coefficient]**

Table D-1 lists the coefficients assigned to various logging systems. In addition, the recovery times anticipated for each activity is included as well as the type of recovery curves. Some activities recover gradually and mimic a linear recovery while other activities recover rapidly initially and then gradually taper off. Those activities are better represented by a concave recovery curve.

**Table D-1. Logging System ERA Coefficient and Recovery Times**

| Logging Activity | Logging System | ERAs per Acre Coefficient | Recovery Time | Recovery Curve |
|---|---|---|---|---|
| Changes | Fire | 0.15 | 15 | Linear |
| Fuel-Treatment | Broadcast Burn | 0.04 | 4 | Concave |
| Fuel-Treatment | Burn Piles | 0.02 | 2 | Concave |
| Fuel-Treatment | Mechanical | 0.15 | 15 | Concave |
| Fuel-Treatment | Piling - hand | 0.02 | 2 | Concave |
| Fuel-Treatment | Piling - tractor | 0.15 | 15 | Concave |
| Fuel-Treatment | Under burning | 0.1 | 10 | Concave |
| Harvest | Change Detection, NFS | 0.2 | 20 | Concave |
| Harvest | Change Detection, Other | 0.25 | 25 | Concave |
| Harvest | Clear-cut | 0.25 | 25 | Concave |
| Harvest | Clear-cut, Skyline | 0.2 | 20 | Concave |
| Harvest | Clear-cut, Tractor/Mechanical | 0.3 | 30 | Concave |
| Harvest | Group Select | 0.2 | 20 | Concave |
| Harvest | Group Select, Helicopter | 0.1 | 10 | Concave |
| Harvest | Group Select, Skyline | 0.15 | 15 | Concave |
| Harvest | Group Select, Tractor/Mechanical | 0.2 | 20 | Concave |
| Harvest | Overstory Removal | 0.25 | 25 | Concave |
| Harvest | Overstory Removal, Helicopter | 0.1 | 10 | Concave |
| Harvest | Overstory Removal, Skyline | 0.2 | 20 | Concave |
| Harvest | Overstory Removal, Tractor/Mechanical | 0.3 | 30 | Concave |
| Harvest | Shelter wood | 0.25 | 25 | Concave |
| Harvest | Shelter wood, Skyline | 0.2 | 20 | Concave |
| Harvest | Shelter wood, Tractor/Mechanical | 0.25 | 25 | Concave |
| Harvest | Thin | 0.2 | 20 | Concave |
| Harvest | Thin, Skyline | 0.15 | 15 | Concave |
| Harvest | Thin, Tractor/Mechanical | 0.2 | 20 | Concave |
| TSI | Pre-commercial Thin | 0.05 | 5 | Concave |
| TSI | Pre-commercial Thin, Biomass | 0.15 | 15 | Concave |
| TSI | Pre-commercial Thin, Manual | 0.02 | 2 | Concave |
| TSI | Pre-commercial Thin, Tractor | 0.15 | 15 | Concave |

## Roads

The road ERA is calculated using the following formula:

**ERA = [Road Miles] x [Road Surface Type ERA/mile] x [Proximity to Riparian Reserve Coefficient]**

Road miles (all public, state, county and privately owned) were converted to acres (ERAs) based on estimated road width. Roads are a permanent feature on the landscape and unless they are decommissioned, they do not recover over time. As such, their recovery curve is shown in Table 2 as a flat curve. The ERAs associated with roads will stay constant over time and not reduce as in the case of timber sale acres that recover over time. Table D-2 lists the coefficients used to develop ERAs per road mile. Road ERAs were also weighted more heavily according to their proximity to riparian reserves. An assumption was made that all roads were not shown in the GIS layer so a "ghost roads" coefficient was added to account for this likelihood. A roads factor of 1.3 was included to account for ghost roads that are not evident on the GIS coverage on both Forest Service and private lands.

**Table D-2. Road ERA Coefficient and Recovery Times**

| Roads | ERAs per Mile | Recovery Time | Recovery Curve | Riparian Reserve Coefficient |
|---|---|---|---|---|
| NFTS | 3.7 | 47 | Flat | 1.2 |
| Private | 3.7 | 47 | Flat | 1.2 |

## Grazing

### Grasslands

The ERA grazing coefficients for past actions are presented below in Table D-3. Unlike timber harvest activities, grazing recur annually over the same area, therefore no recovery curves were assigned to grazing activities. Grazing ERAs were accounted for in both grazed grasslands as well as riparian areas.

For grazing on grasslands, the ERA is calculated using the following formula:

**ERA = [grazed grassland acres] x [% area impacted by trails and hoof prints] x [grazed grassland coefficient] x [proximity to Riparian Reserve coefficient]**

Grasslands are grazed annually and depending upon the spring turnout date, the effects of grazing can vary. Early spring turnout dates when soils are still moist and vulnerable to disturbance can influence the potential for compaction and surface erosion. In addition, the number of livestock and residual dry matter at the end of the grazing season can influence the amount of soil cover and the potential for surface erosion. Field investigation provided data as to the percent area within a grassland that was impacted by compacted hoof prints and trails and the density of the impacts relative to hill slope steepness and proximity to water. Other studies by Bryant (1982) and Walker and Heitschmidt (1986) corroborated the findings that livestock impacts on soils (trails etc) are influenced by slope gradient and proximity to water. These data were used to determine the acres impacted by past grazing practices and a grazing ERA coefficient was applied to this area to determine ERAs for grazed grasslands. If grasslands were near a riparian area, an additional riparian coefficient was applied to weight those areas more heavily.

**Table D-3. ERAs Grazing Coefficients**

| Grazed Grassland Acres | % Area in Hoof Prints or Trails | Grassland Grazing Coefficient | Riparian Reserve Coefficient |
|---|---|---|---|
| Less than 1/4 Mi from Water; Less than 35% slope | 9% | 0.15 | 1.2 |
| Less than 1/4 Mi from Water; greater than 35% slope | 20% | 0.15 | 1.2 |
| Greater than 1/4 Mi from Water; less than 35% slope | 9% | 0.15 | 1.0 |
| Greater than 1/4 Mi from Water; greater than 35% slope | 10% | 0.15 | 1.0 |

### Riparian Areas

Livestock have the potential to impact riparian areas through trampling, destabilizing stream banks, and excessively browsing on riparian vegetation. Excessive loss of vegetation can also influence channel maintenance process and lead to destabilized stream channels. ERAs were assigned to riparian areas by two means. The first was to identify riparian areas with the greatest likelihood of being grazed. Since livestock do not graze uniformly over the analysis area, a GIS query was made to isolate the riparian areas by slope, vegetation type, and stream gradient. An assumption was made that livestock will not graze in stream channels with gradients greater than 20%, in riparian areas with adjacent hill slopes larger than 35%, and only grazes in vegetative areas such as grasslands, oak woodlands, and early seral Douglas fir/oak woodlands for forage. All other riparian areas were assumed to have a low likelihood of being grazed.

Other Forests in Region 5 have used riparian grazing ERA coefficients and the weight of these coefficients varies considerably. In the North Fork Eel Grazing CWE analysis, the effects of grazing were generally considered greater than those impacts triggered by timber harvesting. Grazing has direct impacts to stream channels that recur on an annual basis, whereas in the case of timber harvesting, impacts are much less likely to occur due the application of stream buffers and due to the fact that harvest activities are a one-time event. Using this logic, riparian grazing ERA coefficients were established that were larger than those used for timber harvest activities.

For grazing in riparian areas, the ERA is calculated using the following formula:

**ERA = [grazed riparian acres] x [riparian grazing coefficient]**

The following table displays the riparian grazing ERA coefficient.

**Table D-4. Riparian Grazing Coefficient**

| | |
|---|---|
| Riparian Grazing Coefficient | 0.6 |

## Wildfire

Table D-5 shows the ERAs assigned to burned areas (within the past 15 years) in the analysis watersheds. It was assumed that light to moderate burn intensities had no negative watershed impacts. Moderate intensity burns were assumed to have a light impact on a watershed similar to that of an extremely light land management ground disturbing activity such as helicopter logging. Higher burn intensities were given ERAs/Acre similar to more ground disturbing activities such as skyline or cable suspension systems and in the case of the most intense burned areas, ERAs/Acre values were assign similar to disturbances associated with tractor yarding systems.

Wildfire burn severity ERAs were calculated using the following formula:

**ERA = Wildfire Acres x Burn Severity (ERAs/Ac) x Burn Recovery Coefficient****

**Table D-5. Wildfire Equivalent Roaded Acres**

| Wildfire Burn Severity Description | ERAs |
|---|---|
| 0 – no burn | 0.00 |
| 1 – low burn intensity | 0.00 |
| 2 – low to moderate burn intensity | 0.00 |
| 2a - moderate burn intensity | 0.05 |
| 3 – moderate to high burn intensity | 0.10 |
| 4a – high burn intensity | 0.15 |
| 4b – extreme burn intensity | 0.20 |

Table D-6 illustrates the estimates made as to how long it would take a burned area to recover relative to the burn severity. Estimates on recovery times were extremely conservative, especially since evidence exists that surface erosion is essentially negligible after the first 1-5 years after a fire. However, due to the decay of roots associated with dead trees, steep hillslopes may reach maximum instability 10 –15 years after the fire and become more susceptible to mass wasting processes.

**Table D-6. Years to Recover Post Wildfire**

| Burn Severity Descriptions | Years To Recovery |
|---|---|
| 0 – No burn | 0 |
| 1 – Low burn severity | 0 |
| 2 – Low to moderate burn severity | 0 |
| 2a - Moderate burn severity | 5 |
| 3 – Moderate to high burn severity | 10 |
| 4a – High burn severity | 15 |
| 4b – Extreme burn severity | 15 |

**Burn recovery coefficient = 1 – (current year– year burned)/years to recover after burn

## Percent ERAs for all Past Actions (existing condition):

The CWE ERA Analysis for the Travel Management project was conducted on 27 6th field HUC (Federal and private lands) watersheds. The methods used to calculate %ERAs for past and present land management activities are described below. The coefficients used in the ERA calculations are listed above in Tables 1 through 6.

The following equation is used to calculate total percent ERAs for all past actions and represents the current condition:

**%ERA = (([Timber Harvest ERA] + [Roads ERA] + [Grazing ERA] + [Wildfire ERA]) / [watershed acres]) x 100**

## ERA Calculations for Reasonably Foreseeable Future Land Management Activities

Similar equations to those that were described above were used to calculate ERAs for future timber sales and fuel treatment projects. Beaverslide Timber Sale and Fuels Reduction Project was added to the total percent ERAs in the Upper Tributaries Upper Mad, Lower Tributaries Upper Mad, Ruth Reservoir and Headwaters North Fork Eel River.

# Development of Threshold of Concern (TOC)

Thresholds of concern (TOC) by watershed were developed in 1995 Six Rivers National Forest Land and Resource Management Plan revision. The TOC is an estimated upper limit of total disturbance that a watershed can tolerate without adverse impacts to beneficial uses. In the event that the %ERAs are approaching a TOC, management actions should be evaluated to insure that detrimental cumulative watershed effects don't occur. In developing TOCs, several physical and biological parameters were evaluated, including inherent geologic stability, extent of inner gorges plus active and inactive landslides, erodibility of soils, slope steepness, status of anadromous fish, condition of riparian areas and others. Assigning a TOC to a given watershed is an interdisciplinary professional judgment that weighs the various environmental indicators described above. The TOCs for this project range between 9.0 percent ERAs in Horse linto to 14.3 in Upper Mad and Van Duzen watersheds (see table D-7).

**Table D-7. Thresholds of Concern for affected watersheds**

| 6th Field Watershed Name | Watershed Acres | Percent TOC |
|---|---|---|
| Grouse Creek | 36,252 | 11.0 |
| Hawkins-Sharber | 6,693 | 12.0 |
| Headwaters North Fork Eel River | 32,982 | 13.8 |
| Horse Linto and Cedar | 42,088 | 9.0 |
| Kekawaka Creek | 21,179 | 13.0 |
| Little Van Duzen | 26,400 | 14.3 |
| Lower Dobbyn Creek | 22,451 | 12.0 |
| Lower Middle Mad River | 31,023 | 14.3 |
| Lower Tributaries Lower South Fork Trinity | 28,805 | 11.0 |
| Lower Tributaries Upper Mad River | 27,981 | 12.8 |
| Lower Tributaries Upper Van Duzen River | 16,506 | 14.3 |
| Madden Creek | 14,876 | 11.5 |
| Middle Tributaries Upper Van Duzen River | 22,963 | 12.2 |
| Mill Creek | 47,522 | 11.0 |
| Pilot Creek | 25,405 | 10.0 |
| Ruth Reservoir | 20,250 | 13.4 |
| Salt Creek | 15,596 | 14.0 |
| South Dobbyn Creek | 25,426 | 12.0 |
| Tish Tang Creek | 27,523 | 14.3 |
| Upper North Fork Eel River | 22,003 | 12.8 |
| Upper Tributaries Lower Mad River | 32,588 | 13.8 |
| Upper Tributaries Lower Trinity River | 31,144 | 12.0 |
| Upper Tributaries Upper Mad River | 28,980 | 14.3 |
| Upper Tributaries Upper Van Duzen River | 15,242 | 11.7 |
| Willow Creek | 27,746 | 12.0 |

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