Data Release on Rainfall, Streamflow, and Suspended Sediment Transport in the Redwood Creek Watershed, Humboldt County, California 1990 through 1998

Prepared by

Randy Klein, Hydrologist

and

Tom Marquette, Hydrologic Technician

Redwood National and State Parks
1111 Second Street
Crescent City, California 95531

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NOTICE

This document contains information of a preliminary nature, and was prepared primarily on an interim basis. The information contained herein may be revised or updated in the future. No guarantee, either expressed or implied, is made by the National Park Service for the information contained in this document.

INTRODUCTION

Purpose and Need

The Redwood National Park Expansion Act of March 27, 1978 (P.L. 95-250) directed the Secretary of the Interior to

> "...undertake and publish studies on erosion and sedimentation originating within the hydrographic basin of Redwood Creek with particular effort to identify sources and causes, including differentiation between natural and man-aggravated conditions..." (92 STAT.166).

As part of the efforts undertaken by Redwood National Park to comply with this directive, a hydrologic monitoring program was initiated in cooperation with the U S Geological Survey. A network of stream gaging and sediment sampling stations was established, along Redwood Creek and on several of its tributaries. While some of these gages were run for only a few years, several continue to be operated. The remaining active gages are presently operated either solely by Redwood National and State Parks (RNSP) or cooperatively by RNSP, the US Geological Survey (USGS), and the California Department of Water Resources (DWR). Data collected at these gages preceding water year (WY) 1992 were published by the US Geological Survey (Water Resource Data for California, various years).

Consistent with the expansion legislation, the objective of the gaging program is to measure streamflow and sediment transport and yield within Redwood Creek. Gage placement allows comparison of these variables both upstream and downstream of RNSP, although the only remaining upstream gage on the main channel (Redwood Creek near Blue Lake, Station No. 11481500) is approximately 15 miles upstream from the park's boundary. Thus, the ability to differentiate between "natural and man-aggravated conditions" is limited.

Another network of stream gaging stations with suspended sediment sampling was also established in 1990 in Prairie Creek, a relatively large tributary to lower Redwood Creek whose drainage area is mostly within RNSP. The objective for establishing these gages was to evaluate the effects of erosion from the Prairie Creek Bypass (State Highway 101 north of Orick) which occurred in the fall of 1989. Several of these gages continue to be operated. Two of the four remaining gaging stations within Prairie Creek drain relatively pristine basins, while the other two drain areas affected by highway construction and historic logging. The following map shows the Redwood Creek watershed and locations of all gaging stations for which data are included in this document.

History of Hydrological Monitoring in Redwood Creek

Prior to the creation of Redwood National Park in 1968, two gages were established along the main channel of Redwood Creek by the US Geological Survey (11482500, Redwood Creek at Orick, 1911; 1148150, Redwood Creek near Blue Lake, 1953). In the mid-1970's, the USGS began a Forest Geomorphology project, which consisted of a monitoring and research program designed to evaluate the effects of upstream and upslope land use (primarily timber harvest and associated road building) on park resources.

A number of other gaging stations were established within the Redwood Creek basin, both on the main stem of Redwood Creek and on several tributary basins, to measure streamflow and sediment discharge

for the USGS Forest Geomorphology project. Several gaging stations were also established within the Prairie Creek sub-basin beginning in 1989 to document the effects of erosion and sedimentation due to construction of the US Highway 101 Prairie Creek Bypass on Prairie Creek and several of its tributaries.

Many of the gages established within Redwood Creek were abandoned because they were no longer needed or because of lack of funds for operation, repairs and maintenance. As of water year (WY) 1998 (October 1, 1997, through September 30, 1998), the following stream gages remained in operation as part of the RNSP hydrological monitoring program:

11482110	Lacks Creek near Orick (**LAC**; tributary to Redwood Creek)
11482125	Panther Creek near Orick (**PAN**; tributary to Redwood Creek)
11482468	Little Lost Man Creek near Orick (**LLM**; tributary to Prairie Creek)
11482500	Redwood Creek at Orick (**ORK**)
11481500	Redwood Creek near Blue Lake (**OKN**)

In addition, the following gaging stations continue to be operated by RNSP in the Prairie Creek basin:

Prairie Creek above May Creek (**PRW**)
Prairie Creek below Brown Creek (**PRL**)
Prairie Creek above Brown Creek (**PRU**)

*(Note: the eight-digit numbers preceding station names are those used by the USGS; three-letter codes correspond to computer codes for accessing data via the California Data Exchange Center's internet access site for gaging stations supported by the California Department of Water Resources (***ORK** *and* **OKN**, *only); three-letter codes for other gaging stations are used for data management purposes, only.)*

METHODS AND EQUIPMENT USED

The following briefly discusses the methods used for collecting hydrologic data. For more details, the reader is referred to the "National Handbook of Recommended Methods for Water-Data Acquisition" by the US Geological Survey.

Stage

For most stations, stage (height of the water surface above a datum) is recorded continuously by means of a pressure transducer, which senses water depth, connected to a data logger, which records and stores the data. The pressure transducer is deployed into the stream inside a stilling well. The data logger is located inside a small hut up on the adjacent streambank, above the expected reach of high water. Data are downloaded to personal computers for processing.

Discharge

Periodic discharge measurements are made at each gaging station throughout the year using a spinning cup-type current meter to take velocity measurements across the gaging cross section. Occasional measurements are also made with an electromagnetic current meter. During non-stormflow periods, measurements are made by wading across the stream. During high flow events, measurements are taken from either a bridge or cableway using a winch apparatus to lower the current meter into the flow. These measurements yield data pairs of stage and discharge for each gaging station, which are used to develop and update stage-discharge relationships.

Continuous discharge is calculated from stage data using a stage-discharge relationship (rating table or curve) specific to each stream gage. Rating tables are developed graphically by plotting discharge data (from field measurements) against the corresponding stage at the time the discharge measurements are taken. Line segments are visually fit to the plotted points, and a rating table is developed from the data pairs at the endpoints of each line segment. Discharge measurements are taken at all gages every year in order to maintain accurate rating curves.

Although data from RNSP gages is, for the most part, collected continuously through the water year, the emphasis by RNSP has been on high flows. Minor changes in the configuration of the channel cross section at the gages, which occur virtually every year, can alter stage-discharge relationships at low flows. Consequently, discharge estimates are relatively inaccurate at the low flows. However, the USGS gages are re-rated more frequently during each low flow season and thus are more accurate for low flows.

Suspended Sediment

Stream water samples are occasionally taken for measuring suspended sediment concentration at gaging stations. These are taken during or shortly after rainstorms, which cause increases in discharge and transport of fluvial sediment in suspension within the water column. Samples are taken either manually, using specialized, isokinetic sampling devices or by automated pumping samplers. Manual samples are taken either by RNSP personnel and volunteers or by paid observers who reside near the gaging stations.

Automated pumping samplers are used at gaging stations on the smaller streams (all gages included here except the two gages on the main channel of Redwood Creek). A pumping sampler is housed in the gaging hut, and a water line is run to a depth-proportional intake device anchored to the streambed. The samplers are stage activated (they begin sampling when stream stage exceeds a preset threshold) and pre-programmed to sample more frequently as stage increases above the threshold. By this means, sampling intensity increases with both discharge and suspended sediment concentration. Manual samples are also taken during storms for calibrating the automated samplers. This technique yields more accurate estimates of suspended sediment transport than use of manual samples alone because extrapolation to periods of unknown concentration is reduced.

Suspended sediment concentrations of samples are determined by laboratory analysis. A filtration procedure is used to determine the weight of sediment in each sample, and concentration

(milligrams per liter) is calculated by dividing the sediment weight by the volume of the original sample.

Suspended sediment transport, or flux, is calculated by multiplying discharge for a specific period by the concentration representing that period, as indicated by a sample. Occasionally, endpoints for a period of suspended sediment transport are estimated using best professional judgement from graphical plots of stage and sediment concentration. This is done to avoid overestimating suspended sediment transport by applying within-storm concentrations to periods toward the end of a storm. Total suspended sediment flux for a water year is calculated by summing all within-storm and between-storm fluxes for the year.

DATA ORGANIZATION AND COVERAGE

This document is organized into the following sections:

- **Rainfall**: Daily rainfall depths are given in inches for the two recording gages maintained by RNSP (at the Lacks Creek and Little Lost Man Creek gaging stations). Also, cumulative rainfall (mass curve) graphs are included to help illustrate the distribution of rainfall through the water year. Note that for periods with missing or suspect data, both the mass curve as well as the monthly totals and other statistics in tabular format may be inaccurate (daily values which are missing are shown as "---"). The annual mass curve and table of daily depths for a particular water year are shown on facing pages for comparison.

- **Discharge**: Annual hydrographs which show instantaneous discharge rate in cubic feet per second (cfs) are provided. Missing records are indicated as gaps in the hydrograph. Note that for periods with missing or suspect data, the annual and monthly total runoff volumes and other statistics may be inaccurate (daily values which are missing are shown as "---"). The annual hydrograph and daily mean discharge table for a particular location and a particular water year are shown on facing pages for comparison.

- **Suspended Sediment Transport**: Annual mass curves of suspended sediment transport (or flux), in tons, are provided along with a table of daily transport tonnages. Note that for periods with missing or suspect data, both the mass curve as well as the monthly totals and other statistics in tabular format may be inaccurate (daily values which are missing are shown as "---"). The annual mass curve and table of daily tonnages for a particular water year are shown on facing pages for comparison.

Within each of these three sections, station data are organized in downstream order and chronologically. The following table lists information included in this document.

RAINFALL		
Station Number/Code	**Station Name**	**Water Years**
11482110/LAC	Lacks Creek near Orick	1993-1998
11482468/LLM	Little Lost Man Creek	1993-1998

STREAMFLOW		
Station Number/Code	**Station Name**	**Water Years**
11481500/OKN	Redwood Creek near Blue Lake	1993-1998*
11482110/LAC	Lacks Creek near Orick	1992-1998
11482125/PAN	Panther Creek near Orick	1992-1998
11482130/COY	Coyote Creek near Orick	1992-1995
NA/PRU	Prairie Creek above Brown Creek	1990-1998
NA/BRU	Upper Brown Creek	1990-1994
NA/BRL	Lower Brown Creek	1990-1995
NA/PRL	Prairie Creek below Brown Creek	1990-1998
NA/BOY	Boyes Creek	1995-1996
NA/PRW	Prairie Creek above May Creek	1991-1998
11482468/LLM	Little Lost Man Creek	1993-1998
11482500/ORK	Redwood Creek at Orick	1993-1998*

* Data contained herein for water year 1998 are preliminary; final data to be published by USGS.

SUSPENDED SEDIMENT TRANSPORT		
Station Number/Code	**Station Name**	**Water Years**
11481500/OKN	Redwood Creek near Blue Lake	1993-1998*
11482110/LAC	Lacks Creek near Orick	1992-1998
11482125/PAN	Panther Creek near Orick	1992-1998
11482130/COY	Coyote Creek near Orick	1992-1995
NA/PRU	Prairie Creek above Brown Creek	1990-1998
NA/BRU	Upper Brown Creek	1990-1994
NA/BRL	Lower Brown Creek	1990-1995
NA/PRL	Prairie Creek below Brown Creek	1990-1998
NA/BOY	Boyes Creek	1995-1996
NA/PRW	Prairie Creek above May Creek	1991-1998
11482468/LLM	Little Lost Man Creek	1993-1998
11482500/ORK	Redwood Creek at Orick	1993-1998*

* Data contained herein for water year 1998 are preliminary; final data to be published by USGS.

DATA PUBLICATION AND ACCESS

Several of the gaging stations for which data are included here are operated cooperatively by the US Geological Survey, California Department of Water Resources, and RNSP. Data included in this release for these gages should be considered preliminary and used with caution. These data were included here primarily because they were used for calculating suspended sediment transport. Ultimately, corrected data for these gaging stations will be published by the US Geological Survey in their annual publication, "Water Resources Data for California".

The graphical and tabular information included in this data release is intended to give the reader a general sense of the temporal and spatial variability in rainfall, discharge and suspended sediment transport at several locations within the Redwood Creek basin. This document is the first publication of these data by RNSP and, consequently includes several years worth of measurements. In future years, a data release will be published each year and will contain only the data collected in the previous water year.

Some users of the hydrologic data contained in this document may wish to examine or perform analyses on the more complete, original data sets from which the summaries included herein were derived. These may be obtained in electronic format by contacting:

Redwood National and State Parks
1111 Second Street
Crescent City, California 95531

(707) 464-6101